Service Engineering Models: History and Present-Day Requirements

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Abstract. Since the field of service engineering emerged in the late 20th century, the service industry has undergone drastic changes. Among the reasons for these changes is the increasing digitalization, which has made it difficult for companies to successfully develop new service offerings. While numerous service engineering models are available to provide guidance during the design of new services, many of them cannot keep up with the requirements of today's economic environment. The present paper examines the requirements that service engineering models need to meet in order to be suitable guidelines for the digital age. To this end, the introduction illustrates how digitalization has changed the service industry. Afterwards, selected service engineering models and related norms are presented. Finally, a set of requirements for modern service engineering models derived from best practices from recent years is introduced.

Keywords: Smart services · Service engineering · Digitalization

1 Introduction

Since the 1990s, service engineering has established itself as a systematic process for the development of services. As a strategic and creative process that aims at designing and implementing services and individualized solutions in a model-based way, service engineering is to services what product planning and development are to physical products. Among the overarching goals of service engineering are an efficient service development and a high level of service quality. Therefore, service engineering promises a competitive advantage and an increase in quality and customer satisfaction [1, 2]. Various service engineering models and related norms have been published over the course of the past decades. Service engineering models aim at supporting companies in developing successful service offers by providing a course of action that companies can follow in the development process, and many of them have proven their value for the development of services in the past. However, the service industry has changed significantly during the last years. One major factor contributing to this change is the ongoing digitalization, which has created a variety of new challenges. It has drastically changed the way services are created and delivered [3, 4], and lower barriers of entry have paved the way for stronger competition and an overall increased supply [5].

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Companies must therefore differentiate themselves from competitors by continuously delivering innovative solutions that speak to the individual customer needs.

As an effective tool to achieve this goal, digital services and smart services in particular have gained significant importance in recent years. Smart services can be defined as individualized combinations of physical and digital services that generate added value for providers and customers and offer demand-oriented value via digital platforms. They are based on smart products, which are connected to the internet, interact with their environment and gather environmental data. The collected data sets are combined with other easily accessible information and processed into so-called smart data, based on which smart services are designed [6]. In this digitalized economic environment, many companies struggle to develop successful digital services. This is partly caused by the lack of service engineering methods that are suited for this task [7], as many old models lack the flexibility that is required to keep up with the dynamic of today's market. The increasing share of digital components in service engineering reveals deficits in the direct application of classical service engineering methods to smart services. Thus, the development of smart services requires a new service engineering process that can quickly adapt to evolving customer needs, is efficient, requires little resources and is centered on the customer and the value it can create through data insights [8, 9]. The present paper suggests a list of requirements that service engineering models need to fulfill to succeed in today's economic environment. Before these requirements are presented, however, the following section provides an overview of selected service engineering models and norms that touch upon the topic of service engineering.

2 Selected Service Engineering Models and Related Norms

Numerous service engineering models have been published in the past. They prescribe a course of action that serves as a guideline for the development of new services and usually consists of phases that represent a high-level outline of how the model is structured and describe an overarching goal for each stage of the model. Each phase can comprise various activities that describe the individual tasks the company needs to complete to fulfill the phase's goal [10]. There are three main types of service engineering models. The first type is the linear model in which each development phase builds on the previous one. While these models benefit from their simplicity and transparency, their one-track direction leads to a lack of flexibility and adaptability. The second model type is the iterative model, in which the individual development phases are meant to be repeated several times. With each iteration, a finer concept of the service is developed. This approach offers quick results and a flexibility in correcting mistakes; however, maintaining an overview of tasks fulfilled requires a high level of coordination. The third type is the prototyping model, which focuses on the early development of prototypes that can be tested with customers and improved based on customer feedback. Prototyping ensures a strong customer orientation although it demands a high level of complex coordination among all parties in order to function properly [7, 11, 12].

Apart from service engineering models, numerous norms touch upon the subject of service engineering directly or indirectly. Table 1 provides a short overview of German and international norms related to the service engineering process and of selected service engineering models. Due to the limited scope of this paper, these cannot be explained in detail. For further information, please refer to the sources listed in Table 1. Many of these norms and models have proven to be valuable aids for the development of services in the past. However, a majority of the available models are not compatible with today's market situation, as they are too complex and require excessive resources and development time before initial results can be produced and tested for value [8]. They are often inflexible and thus unsuitable for most fields of applications today [32]. Researchers and companies alike agree that existing models must catch up with the new requirements for creating innovative service solutions. The next section explores what requirements a model needs to fulfill in order to be suitable for today's market.

Table 1. Selected service engineering models and related norms

Models	Related norms
• Scheuing and Johnson's linear model (1989) [13, 14]	• DIN Fachbericht 75 [20]
• Edvardsson and Olsson's linear model (1996) [15]	• ISO/IEC 15940:2013 [21]
• Ramaswamy's linear model (1997) [16]	• DIN ISO 9004-2:1991 [22]
• Jaschinski's iterative model (1998) [17]	• DIN PAS 1082 [23]
• Liestman's iterative model (2002) [18]	• DIN PAS 1094 [24]
• Bullinger and Schreiner's circular model (2006) [19]	• DIN PAS 1091 [25]
• Cernavin's linear model (2007)	• DIN PAS 1014 [26]
• Meyer and Böttcher's approach (2011) [9]	• DIN PAS 1018 [27]
• Leimeister's model (2012) [8]	• DIN PAS 1019 [28]
• Roth's approach (2017)	• DIN PAS 1047 [29]
• Pöppelbuß and Durst's Smart Service Canvas (2017)	• DIN SPEC 91310 [30]
	• DIN PAS 1076 [31]

3 Requirements for Modern Service Engineering Models

As explained above, many service engineering models are no longer suitable for today's economic environment as they lack agility and flexibility, which calls for the development of new service engineering methods. In order to identify requirements for service engineering models for the digital age, it seems sensible to have a look at methods that have recently proven their utility and success in practice and to find out what characteristics they share. While no all-encompassing recipe for service engineering has emerged yet, certain methodologies have established their worth in adding value out of a specific focal point. An analysis of recommendations from recent literature and trends in service engineering reveals three main best practices that exhibit proven results in various industries. These will be discussed in the following paragraphs.

The first best practice found in several recent and successful service engineering models is user centricity. While a clear focus on customer needs has always been important in service engineering, it has gained importance in the digital age as customers have become more empowered through a greater selection of increasingly individualized products. In the sense of customer centricity, an offering is created by integrating the user into the entire development process and thus co-creating a positive customer experience. The closer a user is involved in the development process, the more the offering will reflect their needs. Customer ideas can be used to create a first prototype, which is then presented to the user for testing and feedback. This is repeated in as many iterations as needed until the prototype and user expectations are matched. This approach requires an extensive collection and analysis of data concerning customer satisfaction and experience, but it also allows for a high degree of customization [33–35].

The second best practice is the utilization of service ecosystems. Services are normally not developed and implemented by a company alone but through a collaboration of a multitude of actors and resources. Service ecosystems can be defined as "relatively self-contained, self-adjusting system[s] of mostly loosely coupled social and economic (resource-integrating) actors connected by shared institutional logics and mutual value creation through service exchange" [36]. They provide a fertile environment for companies to innovate and realize challenging ideas as they enable them to partner with actors that can complement and expand their own resources. Today, digital infrastructures allow for more diverse actors and more resources to be integrated in a service ecosystem, which cultivates value co-creation on an immense scale. In a service ecosystem, all actors should be empowered by gaining access to the various ecosystem assets and infrastructures. That way, companies can tap into a wealth of resources that a service design model can develop into an innovative service offering [4, 36, 37].

The third best practice can be described by the term 'agile'. An agile mindset involves a quick and flexible development process, is customer centric and collaborative in nature as cross-functional teams are brought together. Moreover, it is output oriented and entails constant reflection on previous work to identify shortfalls. In addition, the agile mindset is efficient in its use of resources [38, 39] and enables the design process to be adapted to changing requirements at any time. Furthermore, it allows for a shorter time to market. One essential method is the development of a minimum viable product (MVP), which means that a new offering is created with the bare minimum of core features that enable sufficient interaction for constructive user feedback. The final product is completed after multiple iterations of the MVP feedback loop. Agile approaches also tend to follow the lean mindset, which includes a reduction of waste and aims to achieve more with fewer resources, including time and information [40, 41].

The requirements resulting from these best practices, their purpose and suggestions for their application can be found in Fig. 1. For further information, please refer to the references listed in the table [2, 9, 36–50].

	Requirement	Purpose	Application	Reference
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	Fosters strong relationship with customer and allows for the development of a unique customizable offering with superior customer value, delivering a competitive advantage.	Early identification of (lead) users, representative of larger market needs, and their functional and emotional needs, e.g. through Design Thinking methods. Incentivize collaboration by communicating benefits and providing development toolkits. Integrate user centric KPIs into design of service interface.	(s. Vargo and Lusch 2008; Lusch and Nambisan 2015; Piller and West 2014; Randhawa and Scerri 2015; Piller and Blazek 2014)
	Validated - Hypotheses constantly tested and aligned with user - Constructs fixed feedback channels	Ensures assumptions/ specifications are consistent with user needs and expectations. Reduces uncertainty and allows for the swift development of viable prototypes.		
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	Allows company to identify and take advantage of potential synergies and connect with complementary partners. Improves resource density and efficiency, promoting Open and Recombinant Innovation, thereby, increasing offering's differentiation and customer value.	Analysis of actors within the value network, the services they offer and resources they own. Digitizing and publicizing internal processes and knowledge to allow others to access and add to it. Integrate offering into solution system and envision physical components as medium for offering additional services. Design using standardized digital components, interfaces and software languages.	(s. Immonen et al. 2016; Maglio and Lim 2016; Ismail et al. 2014; Olsen 2015; Randhawa and Scerri 2015; Meyer and Böttcher 2011; Lusch and Nambisan 2015)
	Digital - Integrates complementary data for deriving user insights - Exercises multichannel service delivery - Applies modular architecture in offering's design	Pushes company to seek data to be processes for user centered applications. Modularity allows the exploitation of existing digital infrastructures and increases compatibility.		
Agile	**Adaptable** - Pivots to meet changing requirements - Progresses in iterative consistent development cycles - Value continuously measurable during development	Reduces the need for redevelopment and redundancies as changes are directly adapted in next iteration, thereby, decreasing time-to-market and leading competitors. Allows for offering to be scaled more efficiently to meet increased demand.	Adopting and implementing agile frameworks such as Scrum. Integrating agile and lean mindsets into company culture. Adopting cross-functional project teams whose members complement each other and are afforded the necessary resources. Fostering a culture of experimentation and entrepreneurism. Defining measures and KPIs for success that can monitored and reviewed at any time. Aligning the goals and incentives for all team members.	(s. Beck et al. 2001; Olsen 2015; Ries 2011; Groll 2017; Richter and Tschandl 2017; Lamberth-Cocca and Meiren 2017; Steve Blank 2013)
	Lean - Output oriented, adopting rapid MVP prototyping cycles - Prioritizes working prototype over thorough documentation - Prioritizes resources for creating measurable customer value	Increases resource utility and reduces development time. Aligns the design process towards the swift development and testing of prototypes to achieve early and superior customer value.		
	Cross-Functional - Employs multidisciplinary self-organizing project teams - Upholds constant communication between all functions	Crosspollination of knowledge leads to more creative solutions while team independence fosters creativity and accountability. Shorter communication paths reduce transactional costs and overall development time.		

Fig. 1. Requirements for modern service engineering models

4 Outlook

Even though the present paper has argued that many existing service engineering models are no longer suitable for today's economic environment, it is worth mentioning that some promising models that incorporate the requirements listed in Fig. 1 have already been or are currently being developed. Among these are Smart Service Engineering [51], Multilevel Service Design [52], Design Thinking for Industrial Services [53] and Recombinant Service System Engineering [54]. Whether these models will prove their success in practice in the long run remains to be seen.

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References

1. Schuh, G., Gudergan, G., Senderek, R., Frombach, R.: Service Engineering. In: Schuh, G., Gudergan, G., Kampker, A. (eds.) Management industrieller Dienstleistungen Handbuch Produktion und Management, pp. 169–199. Springer, Heidelberg (2016)

2. Richter, H.M., Tschandl, M., Platsch, M., Mallaschitz, C.: Erfolg durch neue Services: Service Design & Engineering. Methoden. Werkzeuge und Vorgehensweisen, Kapfenberg/Steyr (2016)
3. Roth, A., Höckmayr, B., Möslein, K.: Digitalisierung als Treiber für Faktenbasiertes Service-Systems-Engineering. Dienstleistungen 4.0, pp. 185–203. Springer, Wiesbaden (2017). https://doi.org/10.1007/978-3-658-17550-4_8
4. Acatech: Smart Service Welt. Digitale Serviceplattformen - Praxiserfahrungen aus der Industrie. Best Practices. acatech - Deutsche Akademie der Technikwissenschaften, Munich (2016)
5. Gotsch, M., Fiechtner, S., Krämer, H.: Open Innovation Ansätze für den Dienstleistungs-innovationsprozess. Die Entwicklung eines Service Open Innovation Frameworks. In: Thomas, O., Nüttgens, M., Fellmann, M. (eds.) Smart Service Engineering, pp. 29–54. Springer Fachmedien Wiesbaden, Wiesbaden (2017). https://doi.org/10.1007/978-3-658-16262-7_2
6. Acatech: Smart Service Welt. Umsetzungsempfehlungen für das Zukunftsprojekt Internet-basierte Dienste für die Wirtschaft. Arbeitskreis Smart Service Welt (2014)
7. Bullinger, H.-J., Fähnrich, K.-P., Meiren, T.: Service engineering methodical development of new service products. Int. J. Prod. Econ. **85**(3), 275–287 (2003). https://doi.org/10.1016/s0925-5273(03)00116-6
8. Leimeister, J.M.: Dienstleistungsengineering und -management. Springer, Berlin (2012)
9. Meyer, K., Böttcher, M.: Entwicklungspfad Service Engineering 2.0. Neue Perspektiven für die Dienstleistungsentwicklung. Leipziger Beiträge zur Informatik, vol 29 (2011)
10. Gudergan, G.: Service engineering. multiperspective and interdisciplinary framework for new solution design. In: Maglio, P.P., Kieliszewski, C.A., Spohrer, J.C. (eds.) Handbook of Service Science. Service science. Research and innovation in the service economy. Springer, New York, London pp 387–415
11. Richter, H.M., Tschandl, M.: Service Engineering – Neue Services erfolgreich gestalten und umsetzen. Dienstleistungen 4.0, pp. 157–184. Springer, Wiesbaden (2017). https://doi.org/10.1007/978-3-658-17550-4_7
12. Bullinger, H.-J., Scheer, A.-W. (eds.): Service Engineering. Entwicklung und Gestaltung innovativer Dienstleistungen, 2nd edn. Springer, Berlin (2006)
13. Scheuing, E.E., Johnson, E.M.: A proposed model for new service development. J Serv Mark (1989). https://doi.org/10.1108/eum0000000002484
14. Schneider, K., Daun, C., Behrens, H., Wagner, D.: Vorgehensmodelle und Standards zur Entwicklung von Dienstleistungen. In: Bullinger, H.-J., Scheer, A.-W. (eds.) Service Engineering Entwicklung und Gestaltung innovativer Dienstleistungen, 2nd edn, pp. 113–138. Springer, Heidelberg (2006)
15. Edvardsson, B., Olsson, J.: Key concepts for new service development. Serv. Ind. J. **16**(2), 140–164 (1996)
16. Ramaswamy, R.: Design and Management of Service Processes: Keeping Customers for Life. Addison-Wesley Publishing Company, Boston (1996)
17. Jaschinski, C., Luczak, H., Eversheim, W. (eds.): Qualitätsorientiertes Redesign von Dienstleistungen. Schriftenreihe Rationalisierung und Humanisierung, vol 14, pp 1–148 (1998)
18. Liestmann, V., Luczak, H., Eversheim, W. (eds.): Dienstleistungsentwicklung durch Service Engineering: von der Idee zum Produkt, 2nd edn. FIR e.V. an der RWTH Aachen, Aachen (2002)

19. Bullinger, H.-J., Schreiner, P.: Service Engineering Ein Rahmenkonzept für die systematische Entwicklung von Dienstleistungen. In: Bullinger, H.-J., Scheer, A.-W. (eds.) Service Engineering. Entwicklung und Gestaltung innovativer Dienstleistungen, 2nd edn, pp. 53–84. Springer, Heidelberg (2006)
20. DIN Service Engineering. Entwicklungsbegleitende Normung (EBN) für Dienstleistungen. DIN-Fachbericht 75. Beuth Verlag GmbH, Berlin (1998)
21. International Organization for Standardization. Systems and software engineering. Software Engineering Environment Services. ISO/IEC 15940 (2013)
22. DIN Qualitätsmanagement und Elemente eines Qualitätssicherungssytems. Leitfaden für Dienstleistungen. DIN EN ISO 9004–2. Beuth Verlag GmbH, Berlin (1992)
23. DIN DIN SPEC PAS 1082. Standardisierter Prozess zur Entwicklung industrieller Dienstleistungen in Netzwerken (Standardized process for the development of industrial services in networks). Beuth Verlag GmbH, Berlin (2008)
24. DIN DIN SPEC: PAS 1094. Hybride Wertschöpfung - Integration von Sach- und Dienstleistung. Beuth Verlag GmbH, Berlin (2009)
25. DIN DIN SPEC: PAS 1091. Schnittstellenspezifikationen zur Integration von Sach- und Dienstleistung. Beuth Verlag GmbH, Berlin (2010)
26. DIN DIN SPEC: PAS 1014. Vorgehensmodell für das Benchmarking von Dienstleistungen. Beuth Verlag GmbH, Berlin (2001)
27. DIN DIN PAS 1018:2002–12. Grundstruktur für die Beschreibung von Dienstleistungen in der Ausschreibungsphase. Beuth Verlag GmbH, Berlin (2002)
28. DIN DIN SPEC: PAS 1019. Strukturmodell und Kriterien für die Auswahl und Bewertung investiver Dienstleistungen. Beuth Verlag GmbH, Berlin (2002)
29. DIN DIN PAS 1047:2005-01. Referenzmodell für die Erbringung von industriellen Dienstleistungen - Störungsbehebung. Beuth Verlag GmbH, Berlin (2005)
30. DIN DIN SPEC 91310:2014-08. Klassifikation von Dienstleistungen für die technische Betriebsführung von Erneuerbare-Energie-Anlagen. Beuth Verlag GmbH, Berlin (2014)
31. DIN DIN PAS 1076:2008-02. Aufbau, Erweiterung und Verbesserung des internationalen Dienstleistungsgeschäfts. Beuth Verlag GmbH, Berlin (2008)
32. Meiren, T., Edvardsson, B., Jaakkola, E., Khan, I., Reynoso, J., Schäfer, A., et al.: Derivation of a service typology and its implications for new service development. In: Gummesson, E. (ed.) The Naples Forum on Service 2015, pp. 1–10. University of Naples Federico II, Naples (2015)
33. Meyer, C., Schwager, A.: Understanding customer experience. Harvard Busp. Rev. **85**(2), 116–126 (2007)
34. Deloitte: What is digital economy? Unicorns, transformation and the internet of things (2016). https://www2.deloitte.com/mt/en/pages/technology/articles/mt-what-is-digital-economy.html. Accessed 1 Aug 2018
35. McKinsey & Company: From touchpoints to journeys: seeing the world as customers do (2016). https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/from-touchpoints-to-journeys-seeing-the-world-as-customers-do. Accessed 23 Aug 2018
36. Lusch, R.F., Nambisan, S.: Service innovation: a service-dominant logic perspective. MISQ (2015). https://doi.org/10.25300/misq/2015/39.1.07
37. Immonen, A., Ovaska, E., Kalaoja, J., Pakkala, D.: A service requirements engineering method for a digital service ecosystem. SOCA (2016). https://doi.org/10.1007/s11761-015-0175-0
38. Lamberth-Cocca, S., Meiren, T.: Towards a reference model for agile new service development using the example of e-mobility service systems. Procedia CIRP. (2017). https://doi.org/10.1016/j.procir.2017.03.052
39. Groll, J.G.: The Agile Service Management Guide. DevOps Institute (2017)

40. Ries, E.: The Lean Startup: How Today's Entrepreneurs use Continuous Innovation to Create Radically Successful Businesses, 1st edn. Crown Business, New York (2011)
41. Blank, S.: Why the lean start-up changes everything. Harvard Bus. Rev. **91**(5), 63–72 (2013)
42. Vargo, S.L., Lusch, R.F.: Service-dominant logic: Continuing the Evolution. J. Acad. Mark. Sci. (2008). https://doi.org/10.1007/s11747-007-0069-6
43. Piller, F.T., Blazek, P.: Core capabilities of sustainable mass customization. In: Felfernig, A., Hotz, L., Bagley, C., Tiihonen, J. (eds.) Knowledge-Based Configuration, pp 107–120. Elsevier, Amsterdam (2014)
44. Randhawa, K., Scerri, M.: Service innovation: a review of the literature. In: Agarwal, R., Selen, W., Roos, G., Green, R. (eds.) The Handbook of Service Innovation, pp. 27–51. Springer, London (2015). https://doi.org/10.1007/978-1-4471-6590-3_2
45. Piller, F., West, J.: Firms, users, and innovation. an interactive model of coupled open innovation. In: Chesbrough, H.W., van Haverbeke, W., West, J. (eds.) New Frontiers in Open Innovation, pp. 29–49. Oxford UP, Oxford (2014)
46. Maglio, P.P., Lim, C.-H.: Innovation and big data in smart service systems. J. Innov. Manag. **4**(1), 11–21 (2016)
47. Ismail, S., Malone, M.S., van Geest, Y., Diamandis, P.H.: Exponential Organizations. Why New Organizations are Ten Times better, Faster. and Cheaper Than Yours (And What to do About it). Diversion Books, New York (2014)
48. Olsen, D.: The Lean Product Play Book. Wiley, Hoboken (2015)
49. Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M. et al.: Manifesto for agile software development (2001). http://agilemanifesto.org. Accessed 23 Aug 2018
50. Richter, H.M., Tschandl, M.: Service Engineering – Neue Services erfolgreich gestalten und umsetzen. Dienstleistungen 4.0, pp. 157–184. Springer, Wiesbaden (2017). https://doi.org/10.1007/978-3-658-17550-4_7
51. Senderek, R., Jussen, P., Moser, B., Ragab, S.: Smart service engineering. an agile approach to develop data-driven services. In: CNSM (ed.) Proceedings of the 14th International Conference on Network and Service Management, pp 1–5, Rome, Italy. IEEE (2018)
52. Patrício, L., Fisk, R.P., Falcão e Cunha, J., Constantine, L.: Multilevel service design. From customer value constellation to service experience blueprinting. J Serv Res. (2011). https://doi.org/10.1177/1094670511401901
53. Redlich, B., Becker, F., Fischer, S., Fromm, J., Gernreich, C, Lattemann, C.P. et al. (2019) Design Thinking für das Service Engineering in kleinen und mittelständischen Unternehmen. In: Schuh, G., Gudergan, G., Senderek, R., Jussen, P., Krechting, D., Beverungen, D. (eds.) Dienstleistungsinnovation durch Digitalisierung. Springer (2019, in press)
54. Beverungen, D, Lüttenberg, H, Wolf, V: Recombinant Service System Engineering. In: Leimeister, J.M., Brenner, W. (eds.) Proceedings der 13. Internationalen Tagung Wirtschaftsinformatik. 13th International Conference on Wirtschaftsinformatik, St. Gallen, pp 136–150 (2017)