Recombinant Service System Engineering

Daniel Beverungen, Hedda Lüttenberg, Verena Wolf

Paderborn University, Department Wirtschaftsinformatik, Paderborn, Germany
{daniel.beverungen,hedda.luettenberg,verena.wolf}@upb.de

Abstract. Although many methods have been proposed for engineering services and customer solutions, most of these approaches give little consideration to recombinant service innovation. In an age of smart products and smart data, we can, however, expect that many of future service innovations need to be based on adding, transferring, dissociating, and associating existing value propositions. The purpose of this paper is to outline what properties constitute recombinant service innovation and to identify if current service engineering approaches fulfill these properties. Based on a conceptual in-depth analysis of 24 service engineering methods, we identify that most methods focus on designing value propositions instead of service systems, view service independent of physical goods, are linear or iterative, and incompletely address the mechanisms of recombinant innovation. We discuss how these deficiencies can be remedied and propose a first conceptual model of a revised service system engineering approach.

Keywords: Service engineering, recombinant innovation, (product-)service system, literature analysis, new service development

1 Introduction

The structured design of value propositions—also referred to as Service Engineering or as Product-Service Systems (PSS) Engineering [1–3]—has been a focal area of the Service Science discipline since the 1980s. Ever since, a plethora of methods has been proposed for designing 'services' or 'customer solutions' that consist of services, products, and information technology [1]. Against the properties of 'service' as the basic unit of exchange [4], we will refer to all these methods as 'service engineering' here for short. Most service engineering methods prescribe service design as a top-down engineering process that spans from idea management to introduction of a value proposition onto the market. Subsequently, service is co-created by service providers and service customers, thereby generating value-in-use for the stakeholders involved.

While the relevance of service engineering has increased [5], our understanding of service engineering has also shifted conceptually. In particular, the advent of smart products has enabled companies to offer value propositions that rely on context-specific field data that are made available in real-time. Discussed under the headword 'Internet of Things' or 'Internet of Services', these trends usher a new era of (smart) service systems engineering that is increasingly focused on designing integrated conglomerates

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of products, services, and information technology, which jointly provide value propositions based on which service and value-in-use are co-created [4], [6], [7].

However, as opposed to a considerable body of knowledge on service engineering, the value and applicability of the available methods for the era of smart service is questionable for two reasons. First, many of the available methods seem complex, over-engineered and overwhelmingly cumbersome, and require large investments to be made before a value proposition can be offered on the market [3], [8]. Second, most approaches implicitly assume an inside-out perspective that is based on defining (modular) value propositions that service providers offer to their clients [8], [9]. In contrast, the progressing availability of smart products and smart data suggests that many future innovations will be recombinant instead [10]. A recombinant innovation is not designed and brought to market by means of a top-down engineering process, but is developed by combining existing resources and solutions supplied by different stakeholders, and filling the gaps between them to co-create innovative value-in-use in a service system.

The purpose of this paper is to conceptualize recombination as a type of service innovation and—based on this conceptualization—to assess the suitability of existing service engineering methods to foster this type of innovation. We answer the following research question: To what extend do current service engineering methods support recombinant service innovation?

The remainder of the paper is structured as follows. In Section 2, we review and discuss related literature on service engineering, new service development, and (product-)service system engineering, as well as literature on service innovation and service modularization. In Section 3, we explain and justify our research method that includes a literature review and a conceptual analysis of service engineering methods. In Section 4, we report the findings of our conceptual analysis. In Section 5, we propose design principles and present a conceptual service system engineering approach that implements these design principles. Section 6 concludes the paper.

2 Related Research on Service Engineering and Innovation

2.1 Developing/Engineering (Product-)Service (Systems)

The first approaches covering the development of services were published under the banner of "New Service Development" (NSD) in the Anglo-American literature of the 1980s [11]. Johnson et al. [12] outline why "NSD research mirrors that in NPD" (New Product Development) and focuses on success factors, which "address *what* should be done, not *how* it should be done" [12] (emphases contained in the text). NSD mainly focuses on particular issues in service development, e.g. quality [13], [14], prerequisites for services [13], service blueprinting [15], or enablers for service development [12]. The approaches often contain frameworks or (partial) processes without presenting detailed methods or tools for service development [12]. Also, they often focus on a service management or service marketing perspective [11], [13], [16].

In parallel to NSD, another research stream started in the 1990s, transferring know-how from engineering disciplines and software development to service development

[5]. Standardized process models, methods, and tools for product and software development were analyzed and adapted for service development [5]. The aim was to build on advantages of engineering processes like improved efficiency, reduced development time and costs, and increased quality for service development [11].

A center of activities in this research stream was in Germany, where the term “service engineering” was used since the mid-1990s [5]. Here, several initiatives, conferences, and publicly funded projects were initiated since 1994 to strengthen the research activities and competences in structured service development [5]. From the funding program *Dienstleistungen für das 21. Jahrhundert* (Services for the 21st Century), service engineering emerged as an independent focus topic [5].

Several process models for service engineering have been designed in papers and several PhD theses [17–19]. Early approaches feature three to seven steps that can be repeated iteratively. These approaches have close references to product engineering approaches and, therefore, consider service as a product without taking into account other aspects, such as organizational or social impacts [2], [11], [19], [20].

More recent research extends the point of view from designing a value proposition to designing a service system. Scheuing and Johnson [16] already highlight the necessity to convert “the new service concept into an operational entity”. Klein [17] develops a systems engineering approach based on considering the service engineering system as a social system. Becker et al. [3] identify different conceptualizations of product-service systems. Böhmann et al. [2] “conceptualize a service system as a socio-technical system that enables value co-creation guided by a value proposition”; it includes “not only data and physical components, but also layers of knowledge, communication channels and networked actors” [2]. Service is a “collaborative process creating context-specific value” and can be supported by information systems [2]. Engineering service systems comprise defining service architectures (i.e., modules of a service system and their interactions), designing interactions in service systems, and mobilizing human, physical, and information resources [2].

2.2 Recombinant (Service) Innovation

Innovation in general can be defined as a discontinuous change and describes a new solution or renewal of an existing solution [21]. As opposed to mere invention, innovation has practical or commercial value [22].

The extant literature conceptualizes six innovation processes [23] that can be either planned, intentional, or unintentional, which emphasizes an innovation’s emergent character [24]. These innovation processes are: radical innovation, improvement innovation, incremental innovation, ad hoc innovation, recombinant innovation, and formalization innovation. In theory, most innovations are based on some sort of recombination [22], since hardly any innovation cannot be deduced from prior known building blocks [25]. Therefore, we will focus on recombinant innovation here.

Recombinant innovation relies on combining existing elements to design new services or to generate a new relationship between previously uncombined components [26]. It has been claimed to be a role model for service innovation [24] that can lead to incremental improvements as well as radical changes [27] in service systems.

The four basic operations of recombinant innovation are summarized and visualized in Figure 1. They can be concatenated to build more complex innovation patterns.

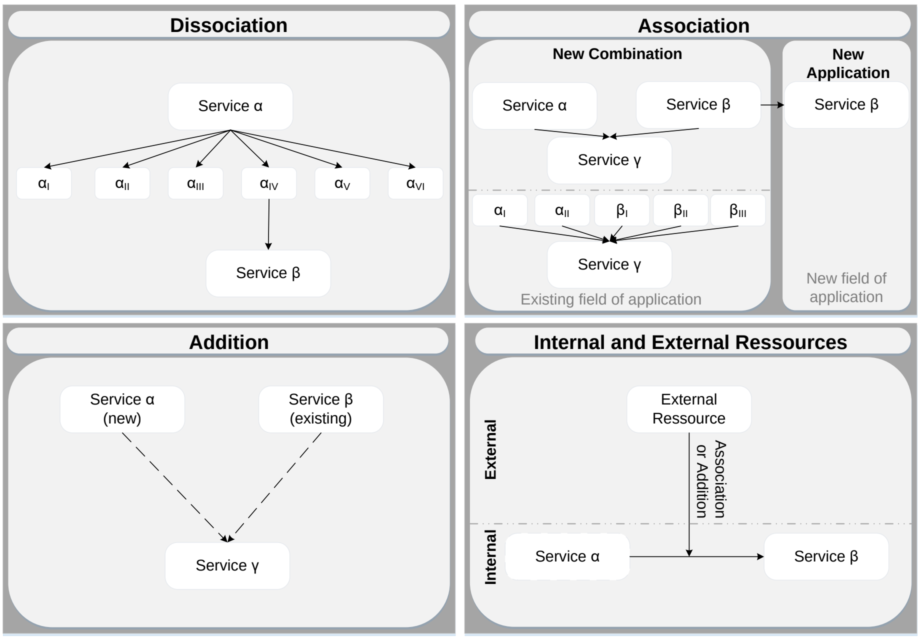

Figure 1. The four basic operations of recombinant innovation

Dissociation and association are two basic principles of recombinant innovation [28]. Association refers to designing a new value proposition by combining (or "associating") two or more existing services. Theoretically, any component can be recombined with any other component [26]. This indicates that the number of new combinations is a combinatorial function of the number of existing ideas [29]. An existing service can also be transferred to another context for which it was initially not designed [21]. Dissociation refers to designing a new value proposition by splitting up an existing one, isolating certain characteristics or a subset of operations, categorizing them, and turning certain elements into marketable services [30]. Services that have been split up into elements can be combined or integrated with other elements that were unconnected before [27]. Another principle of recombination is the addition of new value propositions [29].

Knowledge that is recombined can be drawn from internal and external resources. Internal resources refer to the capability to recombine a company's internal procedures in storing, retrieving, and processing knowledge [23]. Externally, firms retrieve knowledge through their relation with customers, suppliers, and other stakeholders that are involved in a service system [23]. Their relations give them access to valuable resources that cannot be generated internally. If resources possessed by the involved parties are similar, knowledge can be transferred efficiently leading to innovations, which however are rather incremental [31]. Integrating distant resources can lead to innovative breakthroughs, but presuppose that the actors can overcome cognitive disparities to absorb new knowledge efficiently.

Recombinant innovation relies on assumptions. First, it is assumed that a service can be broken down into clearly identified and defined elements [31]. Second, it is assumed that firms have the ability to maintain variety [27]. Third, recombinant innovation operates through continuous and cumulative creation of knowledge [30]. Managing this knowledge is complex [30], since successful recombinant innovation requires formalization and is therefore often built on a modular architecture [32]. This architecture allows the systematic reutilization of elements, which also leads to major resource savings [30]. Fourth, recombinant innovation requires certain competences of the agents, development work, and creativity [23].

2.3 Mass Customization and Modularization of Value Propositions

Mass customization [33] is a well-known strategy to efficiently deal with heterogeneous customer demand, based on configuring (seemingly) individualized value propositions that are composed of pre-defined modules.
Most of these methods include a service engineering process in which an initial set of goods, services, and IT modules are designed, often by defining a catalogue of items that are for sale [34], [35]. The design of modules is based on principles of strong cohesion and loose coupling. A crucial part of the engineering process is to specify modules and configuration rules with a (semi-)formal modeling language [35], [36]. The service engineering process is concluded with publishing a modular service architecture [37] that specifies the available components independent of specific customer requests.

In order to develop a value proposition for a particular customer, a service provider has to identify the needs, wants, and demands [38] of a particular customer, and configure a value proposition accordingly. The configuration process is based on fitting a subset of pre-defined modules together, allowing service providers to offer (seemingly) individual value propositions that fit a particular customer's demand.

3 Research Method

We performed a literature review to elicit what properties constitute recombinant innovation and analyzed which service engineering methods fulfill these properties.

The literature review was performed in line with the guidelines proposed by Webster and Watson [39]. After completing an informal screening phase, we compiled service engineering methods in several electronic libraries by applying German and English search strings. The literature research was conducted in the online data bases "Business Source Complete (via EBSCO Host)", "Association of Information Systems Electronic Library" (AISEL), and "Scopus". In addition, an extensive search was conducted in the journal Service Science, a local university library, and an inter-library loan system. Additional papers were compiled in a forward and backwards search to pinpoint articles that remained unidentified in the initial phase [39]. The search identified 24 methods.

Based on the literature we developed a concept matrix with eight dimensions. The dimensions were derived from the key properties of recombinant innovation and service engineering. Three coders individually used the concept matrix to analyze the identified service engineering methods. The initial inter-coder reliability [40] was measured using average pairwise percent agreement (A_0= 0.861), Fleiss' Kappa (κ=0.676), average pairwise Cohen's Kappa (κ=0.676), and Krippendorff's Alpha (α= 0.677). As all values are above the critical value of α_{min}= 0.667, concordance between the agents regarding the identified criteria can be assumed. Subsequently, we conducted a workshop to discuss and remedy conflicting assessments, until saturation was reached.
From the resulting concept matrix, a conceptual analysis was performed to identify the current state and research perspectives for service system engineering. Conceptual research can be used to initiate theory development and to assess and enhance theory [41]. Based on the analysis, we identify design principles that need to be considered by service system engineering methods and develop a conceptual approach as a prototype that communicates the design principles.

4 Conceptual Analysis of Service Engineering Methods

We use a concept matrix to provide a systematic review of service engineering methods [39]. While the matrix identifies the completeness of each method vis-á-vis theoretical concepts, any gaps and other topics are identified on the population level [39].

Our concept matrix is built on four types of constructs (Table 1). First, we identify addition, dissociation, and association as basic operations of recombinant innovation. Addition refers to recombining an existing value proposition with a novel characteristic. While each service engineering approach adds a new value proposition, we excluded approaches that did not explicitly identify preexisting value-propositions. Dissociation refers to a value proposition that is disaggregated into sub-components that are marketable themselves and/or can be combined with other modules adjacently. Association is a new combination of pre-existing value propositions or transfer of value proposition in a context for which this value proposition was not explicitly designed. Importantly, we submit that assembling pre-defined modules into (seemingly) unique solutions—as often done in modular service architectures—is not association in terms of a recombinant innovation, since modular service architectures often assume a finite solution space. Instead, we consider association to happen at design time, establishing new composite modules and/or new configuration rules.

Second, we identify if a service engineering method applies to designing a value proposition or if it is focused on designing a service system as socio-technical system for value co-creation. Since recombinant innovation often represents a combination of internal and external resources [42], service system engineering should identify the resources contributed by stakeholders in a service system early on.

Third, the type of process is identified as linear, iterative, or prototyping [43]. Linear models are characterized by discrete and consecutive process steps [43]. Iterative models exhibit multiple repetitions of the involved activities [43]. In prototyping models, a value proposition is refined by means of prototypes that communicate design ideas and explore the solution space, as proposed in Design Thinking [44].

Fourth, we identify if a service engineering method comprises the design of value propositions solely or if it also covers the design of value propositions in combination with physical goods. This combination of value propositions with physical goods results in Product-Service System (PSS), which allow the creation of new business models and added values for the customers [45].

Table 1. Conceptual analysis of service engineering methods, in chronological order

	addition	dissociation	association: new combination	association: transfer	internal / external resources	model scope	model type	type of solution
Scheuing et al. [16]	-	-	-	-	x	Value Prop.	linear	Service
Shostak et al. [15]	-	-	-	-	-	Value Prop.	iterative	Service
Edvardsson et al. [13]	-	-	-	-	-	System	linear	Service
Ramaswamy [14]	-	-	-	-	-	Value Prop.	linear	Service
Schwarz [46]	-	-	-	-	-	Value Prop.	linear	Service
DIN Fachbericht 75 [20]	x	x	x	-	-	Value Prop.	linear	Service
Jaschinski [19]	x	x	x	-	x	System	iterative	Service
Johnson et al. [12]	-	-	-	-	-	System	iterative	Service
Schreiner et al. [47]	-	-	-	-	-	Value Prop.	linear	Service
Meiren et al. [11]	-	-	-	-	-	System	linear	Service
Morelli [48]	-	x	x	x	-	System	iterative	PSS
Schneider et al. [43]	x	-	-	x	x	Value Prop.	linear	Service
Kunau et al. [49]	x	-	x	-	x	System	iterative	Service
Herrmann et al. [50]	-	x	-	x	x	Value Prop.	linear	Service
Bullinger et al. [51]	-	-	-	-	-	Value Prop.	iterative	Service
Kersten et al. [52]	-	x	x	-	x	Value Prop.	linear	Service
Lindahl et al. [53]	-	-	-	-	-	Value Prop.	linear	PSS
Botta [18]	x	x	x	-	-	Value Prop.	iterative	PSS
Tuli et al. [54]	-	-	x	-	x	Value Prop.	linear	PSS
PAS 1082 [55]	x	-	-	-	x	System	iterative	Service
Becker et al. [9]	-	-	-	-	-	Value Prop.	linear	PSS
Vasantha et al. [56]	-	-	-	-	x	System	iterative	PSS
Kim, et al. [57]	x	-	x	x	-	Value Prop.	linear	PSS
Müller [45]	x	x	x	-	x	System	linear	PSS

Our literature analysis of (product-)service (systems) engineering methods revealed four insights. First, few methods take a service system perspective, but rather focus on engineering a value proposition. Only ten methods consider the resources of customers, but limit the customers' role to requirements or need elicitation.

Second, using the identified basic operations of recombinant innovations as device of mind reveals that addition, dissociation, and association are seldom included in available service engineering methods. Twelve of the 24 analyzed approaches do not cover one of the stated operations at all, including all considered NSD approaches. Although eleven of the twelve remaining approaches include association, only four methods feature the operation transfer, which shows the largest gap.

Third, value propositions are not always perceived as solutions that can comprise both physical goods and services. Many approaches refer merely to engineering services without reference to any physical goods. Although only eight of the evaluated approaches focus on combining physical goods and services into customer solutions, these approaches became more frequent recently. Since 2006 all developed methods except one target PSS, which reveals a clear trend towards introducing all available types of resources into the co-creation of value.

Fourth, all evaluated approaches represent sequential or iterative processes and do not feature a prototypical approach as it is much discussed in Design Thinking or Software Engineering nowadays. As product development models are often linear approaches, some adapted methods for service engineering retained this structure.

5 Discussion

5.1 Design Principles for Service System Engineering Methods

The design principles are based on the four insights from literature analysis. They can be regarded as theory for design of service system engineering methods [58]. Thereby, the design principles explicitly prescribe how to build a service system engineering approach for recombinant innovation.

Design Principle 1: Take a service system engineering perspective

The analysis reveals that many service engineering methods present processes for designing a value proposition that is offered to a customer, but they refrain from specifying how the co-creation of value would be performed. Many approaches seem to implicitly take a goods-dominant logic perspective [4], [6] in which “services”, “customer solutions”, or “product-service systems” are engineered as marketable solutions, while refraining to specify the properties of a service system as a socio-technical system. This perspective is in line with methods for product engineering, foremost with the VDI-Standard 2221 [59], according to which many service engineering methods were designed. Even in Service Science, early papers defined a product-service system as “a mix of tangible products and intangible services designed and combined so that they jointly are capable of fulfilling final customer needs” [60]. As a result, “service engineering models, methods, and tools rarely focus on the development of service architectures” [2]. We argue that with the proliferation of technology in all societal sub-systems, integrating fragmented resources in socio-technical service systems will be increasingly crucial to provide superior value-in-use.

In line with this claim, the service-dominant logic of marketing [4], [6] posits that companies cannot offer *service* per se, as they can only offer *value propositions* that are enacted through a value co-creation of service providers and service customers, creating value-in-use for the actors involved. “Service systems comprise service providers and service clients working together to coproduce value in complex value chains or networks” [61]. Later, service systems were coined the basic abstraction in Service Science and defined as “a dynamic configuration of resources, including people, organizations, shared information (language, laws, measures, methods), and technology, all connected internally and externally to other service systems by value propositions“ [7], [61]. (Product-)service systems are socio-technical systems that enable co-creation of value by service providers and service customers [3], [2].

We argue that the design of service systems has to take a broader account than specifying the value proposition offered. But it should also focus the organizational and technological context that is required to turn a *value proposition* into *value-in-use*. Organizational and technological context comprise the assets and core competences that are brought to bear on the co-creation of value by (networks of) service providers and (networks of) service customers, including people, assets, processes, information systems and data, money, and relations with other actors that participate in a service (eco-)system. This view is beyond an abstract ‘implementation’ phase—as included in many current methods—since implementation refers to building up internal resources.

Design Principle 2: Recombine related resources in service systems

The analysis reveals that few of the reviewed service engineering methods refer to all aspects that constitute recombinant (service) innovation. Instead, many methods seem to perceive service engineering as a genuinely creative process that is conducted to design new value propositions from scratch, while not explicitly reusing or integrating solutions that are available in the service (eco-)system. As opposed to this finding, Brynjolfsson and McAfee [10] argue that in our *Second Machine Age* most innovations will be created based on recombining existing resources.

Recombinant innovation differs from configuring value propositions based on predefined modules. Methods for service modularization and configuration [35], [36], [62] usually presuppose that a finite solution space can be designed that is constrained by all permutations of the specified modules. Müller [45] refers to this approach as the *configuration shortcut*. In contrast, our approach is focused on service engineering itself, in which solutions are recombined to identify any missing modules that are required to set up a new value proposition and to co-create value-in-use.

In line with addition, dissociation, association, and transfer as the basic operations of recombinant innovation, we argue that service system engineering methods should explicitly identify the properties of the current service system as well as the value-propositions that can be designed and co-created with these resources. This relational approach goes beyond many available approaches [63], most of which focus on requirements elicitation and analysis. We argue that this perspective is inherently goods-dominant, since it does not put assets and core competencies of the involved stakeholders center-stage. As a result, requirements analysis is often not described as relational process, but as activity that is performed by a service provider alone.

Based on the socio-technical properties of service systems, a relational view on service system engineering would fit assets and core competencies of the involved actors together (association), further advance and detail existing assets and core competencies (dissociation), engineer new value propositions and transform the service system (addition), and apply resources outside their intended context of use (transfer).

Design Principle 3: Conceptualize value-in-use as based on both access to external resources and transfer of ownership of physical goods

Not surprisingly, our analysis refers to different types of service engineering approaches. While many methods in NSD focus on designing immaterial value-propositions, Service Engineering often explicitly integrates physical goods and services. Service research in the latter stream has come a long way from hybrid value-creation [64] to cyber-physical systems that view smart objects as resources in service systems.

Since we expect that many future service systems will be based on data and functionality provided by smart objects, we strongly argue that service systems must be designed to explicitly consider all resources that are available for recombination. Supporting this view, service-dominant logic [4], [6] has long advocated that physical goods are distribution mechanisms for service, since they stem from operand resources that stakeholders contribute to service systems. The rental-access paradigm [65] has highlighted that the core of service (as opposed to transferring ownership of products) is temporary access to resources, which customers do not own themselves.

Design Principle 4: Use prototypes to communicate the design of service systems

The analysis revealed that many methods conceptualize service engineering as a linear or iterative process, but seldom suggest prototypical approaches. Service engineering methods, in particular, feature many steps before a value proposition is offered to a customer. In contrast, innovation literature states that innovation is emergent and can even happen unintentionally or unplanned [24].

Recently, the Design Thinking movement has argued strongly for organizing engineering as a cyclic process that comprises several design cycles, each of which ends with a prototype. Similar approaches have been applied in software engineering for some time, including Scrum and other agile software development methods. A cyclic approach is also in line with the basic tenets of design science research that conceptualize design as building and evaluation [66], or with the cyclic approach presented in Action Design Research [67].

Since future service systems will rely strongly on data and information systems, we propose that they need to be designed with agile methods, as those proposed in software engineering. Service system engineering methods should, therefore, feature cycles of design and evaluation, followed by processes of organizational learning.

5.2 A Service Systems Engineering Approach for Recombinant Innovation

We visualize the design principles by presenting a conceptual method for service system engineering (Figure 2). The method builds on many established concepts of service engineering, since we reviewed all steps that current service engineering methods feature, and reorganized them for compatibility with our design principles. Our method comprises Service System Analysis, Service System Design, and Service System Transformation as its three basic sub-processes.

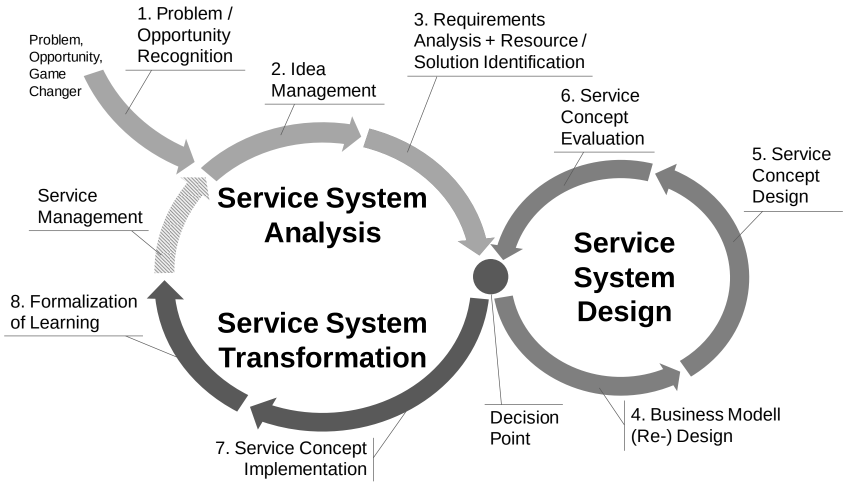

Figure 2: A method for recombinant service system engineering

Service System Analysis is started to remedy a problem or to realize an opportunity by (re-)designing a service system. In Idea Management, different ideas are identified and evaluated to identify those that are worth pursuing in a detailed analysis. Subsequently, an extensive Requirements Analysis is performed. Extending current methods, Requirements Analysis explicitly identifies the resources present in a service system, to enable the involved actors to recombine their assets and core competencies.

Service System Design comprises Business Model Design, followed by Service Concept Design, and Service Concept Evaluation. These activities are organized is cycles, in line with the design science paradigm that conceptualizes design as “to build” and “to evaluate” [66]. The Service Concept Design can comprise physical goods whose ownership is transferred in exchange processes and resources that can be rented/accessed by other actors in a service system.

Service System Transformation comprises implementing the final Service System Concept in order to integrate further resources and learn additional core competencies that are required to co-create the intended value-in-use. Therefore, the service system is transformed as a socio-technical system, beyond designing value propositions and then implementing resources. The service system engineering process is dynamic and focuses on developing viable prototypes as result of each cycle.

A **Decision Point** connects all three sub-processes. After Requirements Analysis is completed, service system engineers can decide to either recombine existing resources (transfer, association) and commence with Service Concept Implementation, or to commence with Service Concept Design (addition, dissociation). At the same time, the decision point marks the judgement to leave the design cycle after a viable Service Concept has been designed that complies with the identified requirements.

6 Conclusion

Based on a conceptual analysis of service engineering methods, our paper offers three contributions to research and practice. First, we provide an update on the methods for service engineering that have been proposed in various research streams in the Service Science discipline. Second, we identified conceptual shortcomings with respect to (a) applying a service systems perspective, (b) considering the basic operations of recombinant innovation that will likely become more prominent in what Brynjolfsson and McAfee [10] have termed the Second Machine Age, (c) considering the transfer of ownership for physical goods and the rental of/access to external resources, and (d) prototypes for designing value propositions. Third, we proposed design principles for service system engineering and visualized them with a conceptual model.

Limitations refer to the lack of generalizability that is inherent to conceptual and qualitative research. While we took precautions to objectify the coding process and attain inter-coder reliability, we acknowledge that other researchers might have come to different assessments of the reviewed service engineering methods.

Other researchers and practitioners can build on our results in multiple ways. First, as an IT artifact the design principles can be subjected to demonstration and evaluation that inform further design cycles. In particular, we are eager to see how the four basic operations of recombinant innovation can be applied successfully. Second, an evaluation could also shed light on how intensively or loosely product engineering and service systems engineering should be intertwined. While a close integration seems favorable to design consistent value propositions, loosely coupling the processes could keep the design of service systems agile, while decoupling them from more inflexible product development processes. Third, researches should investigate if organization do have the necessary resources at their disposal to implement the proposed approach. Concomitant, investigating synergist effects can be another area for future research.

References

1. Cavalieri, S., Pezzotta, G.: Product-Service Systems Engineering: State of the Art and Research Challenges. Computers in Industry 63, 278–288 (2012)
2. Böhmann, T., Leimeister, J.M., Möslein, K.: Service Systems Engineering. A Field for Future Information Systems Research. Business & Information Systems Engineering 6, 73–79 (2014)
3. Becker, J., Beverungen, D.F., Knackstedt, R.: The challenge of conceptual modeling for product–service systems: status-quo and perspectives for reference models and modeling languages. Information Systems and e-Business Management 8, 33–66 (2009)
4. Vargo, S.L., Lusch, R.F.: Why "service"? Journal of the Academy of Marketing Science 36, 25–38 (2008)
5. Fähnrich, K.-P., Opitz, M.: Service Engineering - Entwicklungspfad und Bild einer jungen Disziplin. In: Bullinger, H.-J., Scheer, A.-W. (eds.) Service Engineering, pp. 85–112. Springer, Berlin (2006)

6. Vargo, S.L., Lusch, R.F.: Service-Dominant Logic: Continuing the Evolution. Journal of the Academy of Marketing Science 36, 1–10 (2008)
7. Maglio, P.P., Vargo, S.L., Caswell, N., Spohrer, J.: The Service System is the Basic Abstraction of Service Science. Information Systems and e-Business Management 7, 395–406 (2009)
8. Meyer, K., Böttcher, M.: Entwicklungspfad Service Engineering 2.0. Neue Perspektiven für die Dienstleistungsentwicklung. Univ, Leipzig (2011)
9. Becker, J., Beverungen, D., Matzner, M., Müller, O., Pöppelbuß, J.: Design Science in Service Research: A Framework-Based Review of IT Artifacts in Germany. In: Jain, H., Sinha, A.P., Vitharana, P. (eds.) Proceedings of the Sixth International Conference on Design Science Research in Information Systems and Technology (DESRIST 2011), 6629, pp. 366–375. Springer, Berlin (2011)
10. Brynjolfsson, E., McAfee, A.: Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. Norton & Company, New York City, NY, USA (2014)
11. Meiren, T., Barth, T.: Service Engineering in Unternehmen umsetzen. Leitfaden für die Entwicklung von Dienstleistungen. Fraunhofer-IRB-Verl., Stuttgart (2002)
12. Johnson, S.P., Menor, L.J., Roth, A.V., Chase, R.B.: A Critical Evaluation of the New Service Development Process. In: Fitzsimmons, J.A., Fitzsimmons Mona J. (eds.) New Service Development, pp. 1–32. SAGE Publications (2000)
13. Edvardsson, B., Olsson, J.: Key Concepts for New Service Development. The Service Industries Journal 16, 140–164 (1996)
14. Ramaswamy, R.: Design and Management of Service Processes. Keeping customers for life. Addison-Wesley, Reading, Massachusetts (1996)
15. Shostack, L.G., Kingman-Brundage, J.: How to Design a Service. In: Congram, C.A., Friedman Margaret L. (eds.) The AMA Handbook of Marketing for the Service Industries, pp. 243–261 (1991)
16. Scheuing, E.E., Johnson, E.M.: A Proposed Model for New Service Development. Journal of Services Marketing 3, 25–34 (1989)
17. Klein, R.: Modellgestütztes Service Systems Engineering. Theorie und Technik einer systemischen Entwicklung von Dienstleistungen. Dt. Univ.-Verl., Wiesbaden (2007)
18. Botta, C.: Rahmenkonzept zur Entwicklung von Product-Service Systems. Product-Service Systems Engineering. Josef Eul Verlag, Lohmar, Köln (2007)
19. Jaschinski, C.: Qualitätsorientiertes Redesign von Dienstleistungen. Shaker, Aachen (1998)
20. DIN Deutsches Institut für Normung e. V.: DIN-Fachbericht 75 - Service Engineering. Beuth Verlag GmbH, Berlin (2008)
21. Toivonen, M., Tuominen, T.: Emergence of Innovations in Services. The Service Industries Journal 29, 887–902 (2009)
22. Cooke, P.: Four Minutes to Four Years. The Advantage of Recombinant over Specialized Innovation – RIS3 versus 'Smartspec'. In: European Planning Studies, 24, pp. 1494–1510
23. Gallouj, F., Weinstein, O.: Innovation in services. Research Policy 26, 537 (1997)
24. Gremyr, I., Witell, L., Löfberg, N., Edvardsson, B., Fundin, A.: Understanding New Service Development and Service Innovation through Innovation Modes. Journal of Business & Industrial Marketing 29, 123–131 (2014)
25. Wirth, M., Friesike, S., Flath, C., Thiesse, F.: Patterns of Remixes or Where Do Innovations Come From: Evidence from 3D Printing. In: Proceedings of the 23rd European Conference on Information Systems (ECIS), Münster (2015)
26. Fleming, L.: Recombinant Uncertainty in Technological Search. Management Science 47, 117 (2001)

27. Cecere, G., Ozman, M.: Innovation, Recombination and Technological Proximity. Journal of the Knowledge Economy 5, 646–667 (2014)
28. Kim, J., Park, Y.: E-Service Concept Design in Recombinative Innovation: A Morphology Analysis Approach. In: Proceedings of the 19th International Conference on Industrial Engineering and Engineering Management (IEEM), Hong Kong (2012), pp. 666–670
29. Tsur, Y., Zemel, A.: Towards Endogenous Recombinant Growth. Journal of Economic Dynamics and Control 31, 3459–3477 (2007)
30. Gadrey, J., Gallouj, F., Weinstein, O.: New Modes of Innovation. International Journal of Service Industry Management 6, 4–16 (1995)
31. Antonelli, C., Krafft, J., Quatraro, F.: Recombinant knowledge and growth. The case of ICTs. Structural Change and Economic Dynamics 21, 50–69 (2010)
32. Windahl, C., Andersson, P., Berggren, C., Nehler, C.: Manufacturing Firms and Integrated Solutions. European Journal of Innovation Management 7, 218–228 (2004)
33. Gilmore, J.H., Pine II, B.J.: The four faces of mass customization. Harvard Business Review 75, 91–101 (1997)
34. Böhmann, T., Langer, P., Schermann, M.: Systematische Überführung von kundenspezifischen IT-Lösungen in integrierte Produkt-Dienstleistungsbausteine mit der SCORE-Methode. WIRTSCHAFTSINFORMATIK 50, 196–207 (2008)
35. Becker, J., Beverungen, D., Knackstedt, R., Müller, O.: Pricing of Value Bundles: A Multi-Perspective Decision Support Approach. Enterprise Modelling and Information Systems Architectures (EMISA) 6, 54–69 (2011)
36. Becker, J., Beverungen, D., Knackstedt, R., Müller, O.: Model-Based Decision Support for the Customer-Specific Configuration of Value Bundles. Enterprise Modelling and Information Systems Architectures (EMISA) 4, 26–38 (2009)
37. Dörbecker, R., Boehmann, T.: Tackling the Granularity Problem in Service Modularization. In: Proceedings of the 21st American Conference on Information Systems (AMCIS), Puerto Rico (2015)
38. Baida, Z.: Software-Aided Service Bundling: Intelligent Methods and Tools for Graphical Service Modelling (2006)
39. Webster, J., Watson, R.T.: Analyzing the Past to Prepare for the Future: Writing a literature Review. MIS Quarterly 26, 13–23 (2002)
40. Krippendorff, K.: Content Analysis: An Introduction to Its Methodology. SAGE Publications, Thousand Oaks, CA, USA (2013)
41. Yadav, M.S.: The Decline of Conceptual Articles and Implications for Knowledge Development. Journal of Marketing 74, 1–19 (2010)
42. Senyard, J., Baker, T., Steffens, P., Davidsson, P.: Bricolage as a Path to Innovativeness for Resource-Constrained New Firms. Journal of Product Innovation Management 31, 211–230 (2014)
43. Schneider, K., Scheer, A.-W.: Konzept zur systematischen und kundenorientierten Entwicklng von Dienstleistungen. Veröffentlichungen des Instituts für Wirtschaftsinformatik 175, 1–45 (2003)
44. Kolko, J.: Design Thinking Comes of Age. Harvard Business Review, 66–71 (2015)
45. Müller, P.: Integrated Engineering of Products and Services. Fraunhofer, Stuttgart (2014)
46. Schwarz, W.: Methodisches Konstruieren als Mittel zur systematischen Gestaltung von Dienstleistungen. IPK, Berlin (1997)
47. Schreiner, P., Klein, L., Seemann, C.: Die Dienstleistungen im Griff - erfolgreich gründen mit System. Fraunhofer-IRB-Verl., Stuttgart (2001)
48. Morelli, N.: Product-service systems, a perspective shift for designers. A case study: the design of a telecentre. Design Studies 24, 73–99 (2003)

49. Kunau, G., Junginger, M., Herrmann, T., Krcmar, H.: Ein Referenzmodell für das Service Engineering mit multiperspektivischem Ansatz. In: Herrmann, T. (ed.) Konzepte für das Service-Engineering, pp. 187–216. Physica-Verl., Heidelberg (2005)
50. Herrmann, K., Klein, R., The, T.-S.: Computer Aided Service Engineering-Konzeption eines Service Engineering Tools. In: Bullinger, H.-J., Scheer, A.-W. (eds.) Service Engineering, pp. 649–678. Springer, Berlin (2006)
51. 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, pp. 53–84. Springer, Berlin (2006)
52. Kersten, W., Kern, E.-M., Zink, T.: Collaborative Service Engineering. In: Bullinger, H.-J., Scheer, A.-W. (eds.) Service Engineering, pp. 341–357. Springer, Berlin (2006)
53. Lindahl, M., Sundin, E., Sakao, T., Shimomura, Y.: An interactive design methodology for service engineering of functional sales concepts: a potential design for environment methodology. In: Proceedings of the 13th CIRP International Conference on Life Cycle Engineering (LCE), pp. 589–594. Leuven, Belgium (2006)
54. Tuli, K.R., Kohli, A.K., Bharadwaj, S.G.: Rethinking Customer Solutions: From Product Bundles to Relational Processes. Journal of Marketing 71, 1–17 (2007)
55. German Standards Institute: Publicly Available Specification (PAS) 1082: Standardisierter Prozess zur Entwicklung industrieller Dienstleistungen in Netzwerken. Beuth, Berlin (2008)
56. Vasantha, A., Vijaykumar, G., Hussain, R., Roy, R., Tiwari, A., Evans, S.: A Framework for Designing Product-Service Systems. In: Proceedings of the 18th International Conference on Engineering Design (ICED11), Copenhagen, Denmark (2011)
57. Kim, K.-J., Lim, C.-H., Lee, D.-H., Lee, J., Hong, Y.-S., Park, K.: A Concept Generation Support System for Product-Service System Development. Service Science 4, 349–364 (2012)
58. Chandra, L., Seidel, S., Gregor, S.: Prescriptive Knowledge in IS Research: Conceptualizing Design Principles in Terms of Materiality, Action, and Boundary Conditions. In: 2015 48th Hawaii International Conference on System Sciences (HICSS), pp. 4039–4048
59. Verein Deutscher Ingenieure: Methodik zum Entwickeln und Konstruieren technischer Systeme und Produkte. Beuth Verlag, Berlin (1993)
60. Tukker, A., Tischner, U.: Product-Services as a Research Field: Past, Present and Future. Reflections from a Decade of Research. Journal of cleaner production 14, 1552–1556 (2006)
61. Spohrer, J., Maglio, P.P., Bailey, J., Gruhl, D.: Steps Toward a Science of Service Systems. IEEE Computer 40, 71–77 (2007)
62. Dörbecker, R., Böhmann, T.: FAMouS - Framework for Architecting Modular Services. In: Proceedings of the Thirty Sixth International Conference on Information Systems (ICIS), pp. 1–18. Fort Worth (2015)
63. Dyer, J.H., Singh, H.: The Relational View: Cooperative Strategy and Sources of Inter-organizational Competitive Advantage. Academy of Management Review 23, 660–679 (1998)
64. German Standards Institute: Publicly Available Specification (PAS) 1094: Product-Service Systems – Value Creation by Integrating Goods and Services. Beuth, Berlin (2009)
65. Lovelock, C., Gummesson, E.: Whither Services Marketing?: In Search of a New Paradigm and Fresh Perspectives. Journal of Service Research 7, 20–41 (2004)
66. March, S.T., Smith, G.F.: Design and Natural Science Research on Information Technology. Decision Support Systems 15, 251–266 (1995)
67. Sein, M.K., Henfridsson, O., Purao, S., Rossi, M., Lindgren, R., Saunders, C., Iivari, J.: Action Design Research. Management Information Systems Quarterly 35, 37–56 (2011)