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A Framework for Design Research in the Service Science Discipline

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ABSTRACT

The emerging discipline of Service Science Management and Engineering (SSME) apart from developing theories strives to build and evaluate IT artifacts of utility for the service economy. Especially due to the interdisciplinary character of this new discipline and the imprint of rather behavioral science oriented disciplines, for some problem areas only few innovative artifacts have been scientifically published and evaluated. To counter this deficiency, we present a research framework for design research in the service science discipline. The framework is based on design (science) research literature and widely acknowledged service science perspectives. It addresses three dimensions: (1) four IT artifact types, (2) four perspectives on the service science, and (3) three levels of abstraction. Using the framework, gaps in the service science discipline yet to be addressed by IT artifacts can be identified. On the other hand, if abundant IT artifacts can be identified for any of the proposed research areas, artifacts might need to be systematized or combined.

Keywords

Service Science Management and Engineering, Service Science, Design Research, Research Framework

AN INTRODUCTION TO SERVICE RESEARCH

In recent years service-orientation has increasingly been debated both in research and practice. While some researchers postulate a paradigm shift towards services as the basic unit of exchange in economies (Vargo and Lusch, 2004; Vargo and Lusch, 2008), many companies struggle to efficiently provide the right business services to their customers. As a subset of this trend, many industries are experiencing a transition from a goods-based to a service-based economy. Traditional manufacturing companies strive to professionalize their business service portfolio to provide products and services as integrated customer solutions, delivered in relational processes with customers (Tuli, Kohli and Bharadwaj, 2007).

Today, many customer solutions already comprise both physical products and related value-added services. Services provided to customers can be related to all product lifecycle stages, such as planning, operation or replacement (cf. Figure 1). For example, services in the planning stage comprise pre-sales activities like consulting or engineering. During the operation stage, most services focus on keeping physical goods in operation, but might as well include training, optimization, or personnel allocation services. Referring to the replacement stage, physical goods might be refurbished, recycled, or sold again. Benefits to be expected from combining physical products and related services into customer solutions are manifold (Quinn, Baruch and Paquette, 1988), such establishing superior client relationships, increasing flexibility of use for products, adding value to products (Howells, 2003) or establishing new (e.g. performance-based or value-based) business models.

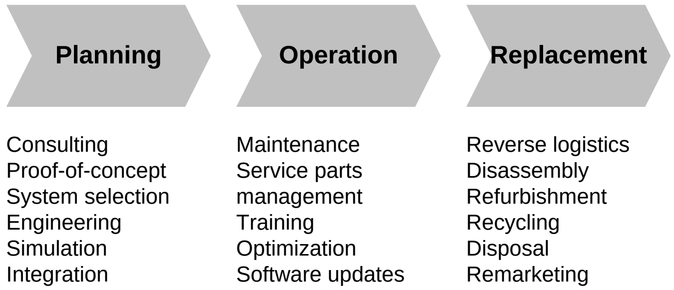

Figure 1: Exemplary services related to the lifecycle of a physical good

Service science is an interdisciplinary and emerging discipline. Consistently, various communities emphasize their own point of view on the service science discipline and apply their own paradigms, methodologies, and knowledge bases. Some major points of view include the following (see also Becker, Beverungen and Knackstedt (2009a)).

In their influential state-of-the-art article Fisk, Brown and Bitner (1993) identify that a service marketing perspective traditionally tends to focus on

- *service quality* (e.g. Parasuraman, Zeithaml and Berry (1988)),
- *service encounters and experiences* including (1) management of customer and employment interactions in service encounters, (2) the customer's role in service production and delivery, and (3) the role of tangibles and physical environment in the customer's evaluation of encounters (e.g. Czepiel, Solomon and Surprenant (1985))
- *service design* with an emphasis on customers (e.g. (Kingman-Brundage, 1989; Shostack, 1982; Shostack, 1984)),
- *customer retention and relationship marketing* (Berry, 1983),
- *internal marketing* (e.g. service people and service mentality (George, 1990).

After conducting an exhaustive literature survey, they state a research agenda comprising some of the traditional topics but also emerging topics like *technology infusion* or *modeling and measurement*. However, all of the proposed research directions imply a rather behavioral science perspective on service science, while neglecting design research topics.

The emerging research discipline of service science and its design research oriented "normative" (Spohrer, Vargo, Caswell and Maglio, 2008) part – service sciences management and engineering – focus on the design and delivery of services in *service systems*. Service systems constitute the basic abstraction of service science. They are dynamic value co-creation configurations of resources, including people, organizations, shared information, and technology, all connected internally and externally to other service systems by value propositions (Spohrer et al., 2008). Service systems can be seen as the basic unit of analysis of service science, comprising providers (or even value networks of providers) as well as customers cooperating to generate mutual value. Foundational areas for research comprise (Chesbrough and Spohrer, 2006): *close interaction of supplier and customer*; *nature of knowledge created and exchanged*; *simultaneity of production and consumption*; *combination of knowledge into useful systems*; *exchange as processes and experience points*; *exploitation of ICT and transparency*.

The discipline of service operations management deals with *understanding the needs of customers*, *managing the processes that deliver services*, *ensuring that objectives are met*, and *continuously improving services* (Johnston and Clark, 2008). It also emphasizes the need for multidisciplinary cooperation across several functional areas, such as human resources, marketing or management accounting, to maximize the efficiency in actually delivering services to customers. Steps from customer analysis to product/service engineering, delivery, and disposal are not examined in detail, but seen as one output of the cooperation (Hanna and Newman, 2006).

The discipline of information systems (IS) is an integrative research discipline "that is at the intersection of knowledge of the properties of physical objects (machines) and knowledge of human behavior" (Gregor, 2006). Therefore, the discipline not only emphasizes to build theories on how the world is like, but also acknowledges the need for setting up IT artifacts such as language constructs, conceptual models, methods, or instantiations. With regard to the creation of IT artifacts, designing service processes, setting up value propositions for customers, and delivering services efficiently in cooperation with customers (e.g. by using conceptual models) are some special areas of interest. One strategy to build these artifacts is to draw from past successes in e.g. supply chain management (SCM), materials resource planning (MRP), or enterprise resource planning (ERP) (Dietrich, 2006). From an operations research perspective, mathematical models may be set up and solved to optimize resource allocation or business processes across the involved businesses or business units.

Engineering disciplines like mechanical engineering or electrical engineering traditionally focus on designing, building, and operating physical products. With a focal point of research in Germany under the headword “service engineering” (Bullinger and Scheer, 2006; Ganz, 2006), engineering disciplines often strive to also apply engineering methods to the design of business services. Even so, Sampson and Froehle (2006) state that manufacturing processes differ fundamentally and managerially from service processes, in contrast to the perception by other disciplines which take a high level perspective on service and manufacturing processes.

Apart from these disciplines, customer solutions from an ecological standpoint are seen as a means to create value with less environmental impact (Manzini and Vezzoli, 2003; Mont, 2004). Customer solutions, if offered in performance contracting business models by specialized providers, may allow for resources to be used more efficiently due to exploiting economies of scale. Therefore, value for customers would be created in an environmentally “sustainable” way. Authors arguing from this point-of-view tend to explicitly incorporate environmental aspects into their definitions of customer solutions.

The remainder of the paper is structured as follows. In the next section, we will propose our framework for design research in the service science discipline. Next, we present the framework in detail according to its three levels of abstraction. Finally, we give a brief conclusion that highlights the main contributions of the presented framework to the service science discipline.

A FRAMEWORK FOR DESIGN RESEARCH IN SERVICE SCIENCE

Although exhaustive research activities have been carried out in the last years, experience from real-life scenarios suggests that for most companies a shift towards the service paradigm is not easily accomplished. Especially companies in industry sectors which are traditionally deep-rooted in delivering complex physical goods to their customers – like the mechanical and electrical engineering industries – experience substantial difficulties in advancing their companies into service businesses. In effect, though the total turnover related to business services is increasing (e.g. Stille (2003)), substantive potential to increase revenues from services still remains unexploited.

What seems to be particular lacking are innovative artifacts which can be used by companies to advance their businesses into services businesses. To address this lack of sufficiently designed artifacts, apart from building and testing “conventional” theory, the contribution of IS-related service science should be to establish theories “for design and action” (type 5 theories as proposed by Gregor (2006)), i.e. to design and evaluate IT artifacts.

Regarding processes of building and evaluating artifacts as *design (science) research* dates back to the early contributions made by Alexander (1970) and Simon (1996). Likewise, the design science paradigm has received growing attention in the IS discipline since then. Some main contributions include the research framework proposed by March and Smith (1995), a complementary research cycle of the behavioral science and design science paradigms in the IS field governed by seven guidelines (Hevner, March, Park and Ram, 2004), design science research process variants (Peffers, Tuunanen, Rothenberger and Chatterjee, 2008), or the nature of design science in Europe (Winter, 2008).

To guide design research in the service science discipline, we systematize research areas for the design and evaluation of IT artifacts into a framework (cf. Figure 2). The proposed framework encompasses three dimensions. The first dimension is constituted by the four types of IT artifacts (Hevner et al., 2004; March and Smith, 1995): *Constructs* (vocabulary and symbols), *models* (abstractions and representations), *methods* (algorithms and practices), and *instantiations* (implemented and prototype systems).

The second dimension comprises different perspectives on service science. Based on the frameworks of Ramaswamy (1996), and Edvardsson and Olsson (1996), the perspectives in this dimension constitute (Becker et al., 2009a): *Potential* (integrating resources to be used to manufacture physical goods and to deliver services and their implementation into organizations), *process* (integrating service processes and manufacturing processes, i.e. an aspect of bridging the front-stage and back-stage in service systems (Glushko and Tabas, 2008)), *outcome* (creating integrated customer solutions from physical goods and services which jointly fulfill a customer’s needs), and *market* (recognizing the customer as a co-creator of value of the solution and defending competitive edge against competitors).

The third dimension encompasses three different levels of abstraction. On a *micro-level*, the need for IT artifacts addressing a specific perspective can be identified, which helps clarifying the focus and expressiveness of the desired artifact. On a *meso-level*, collections of IT artifacts, e.g. all artifacts related to a particular research project, can be positioned. By doing so, the framework can be used to e.g. systematize all artifacts created in a particular research project, such that the outcome of the project can be evaluated: For any blind spots in the framework it should be assessed whether no artifacts have been created on purpose, or additional artifacts have to be built to achieve the objectives of the project.

On a *macro-level*, all artifacts related to specific research streams of service science can be charted. Such an overview might e.g. reveal that (a) a variety of artifacts has already been created in different research areas, which might entail efforts to combine artifacts or to distinguish them from each other, or that (b) a lack of sufficient artifacts occurs in several of the dimensions, which might inspire the creation of additional artifacts (pointing back to the micro-level). Therefore, on a macro-level the research framework can inform researchers about the knowledge base of (specific research streams within) service science. The applicability and benefits of our framework to design-oriented research in service science is exemplified in more detail in the consecutive sections.

Micro-Level

The micro-level of our proposed framework is meant to hold artifacts (constructs, models, methods, and instantiations) that address problems from a certain perspective (potential, process, outcome, market) of the service science discipline. To be of interest for the design research community, innovative artifacts must represent

- a solution to a so far unsolved problem or
- a more efficient way of tackling an already resolved problem (Hevner et al., 2004).

To illustrate the application of the micro-level of the proposed framework we will now pose some exemplary problem areas from the service science discipline which (as far as we know) lack innovative artifacts. Of course, these examples can by no means be complete. We chose our examples from a special class of service systems, namely product-service systems which provide customer solutions consisting of physical products as well as related services (e.g. a leased car with insurance and maintenance services).

Exemplary problem area 1: constructs addressing the outcome perspective

Constructs form the vocabulary of a domain (March and Smith, 1995). They build the basis for defining problems and specifying their solutions. Modeling languages are a typical example of constructs. Defining product requirements and specifying product designs accordingly has long been in focus of the engineering disciplines and has lead to a number of product modeling languages and a considerable degree of standardization. Especially STEP (STandard for the Exchange of Product model data) has gained importance. Since the 1990s adapting traditional engineering techniques to the design of services has been discussed under the label of service engineering. Since then, a number of modeling languages for designing services has been proposed. However, a consolidation of approaches similar to the standardization efforts in product engineering cannot be ascertained (Becker et al., 2009a). When focusing on integrated customer solutions, modeling languages which are able to describe the function and structure of a physical product as well as the capabilities and interactions of a service would be of great interest. Building and evaluating commonly accepted constructs that allow for the modeling of products as well as services is an interesting area for design research focusing on the outcome perspective of the service science discipline.

Exemplary problem area 2: models addressing the process perspective

Models are sets of statements expressing relationships between constructs (March and Smith, 1995). Building on constructs, models are meant to represent certain situations of problems or solutions. The primary concern of models is utility – in contrast to theories, whose concern is truth. Reference models, which describe a class of relevant real world phenomena on an abstract level, are examples of models which provide such utility and e.g. can inform design decisions. Reference models like the SCOR (Supply Chain Operations Reference) model have successfully been applied in manufacturing. Similar reference models in the service science discipline are scarce (Becker et al., 2009a). In the context of integrated customer solutions reference models describing the coordination of manufacturing processes and service processes to deliver integrated value propositions would be of great utility to both researchers and practitioners. Hence, building and evaluating such reference models is an interesting area for design research focusing on the process perspective of the service science discipline

Exemplary problem area 3: methods addressing the market perspective

Methods are sequences of steps used to perform a task (March and Smith, 1995). Typical examples are algorithms, procedures or guidelines. Methods are often based on constructs and models to represent the inputs and outputs of steps. Marketing has developed numerous methods to aid pricing-decisions for products or services. However, when it comes to pricing customer solutions comprising physical products and related value-added services methodical support is rare. Traditional cost-based pricing methods are inappropriate for most services as it is often difficult to assign costs to intangibles (Harmon, Demirkan, Hefley and Auseklis, 2009). In practice, especially manufacturers selling complex technical products experience severe difficulties to set and enforce profitable prices for their product-related services as customers tend to take such services for granted and hence have a low willingness to pay. Building and evaluating appropriate methods for measuring the willingness to pay and setting more value-based prices integrated customer solutions is an attractive research problem which can be addressed by design research focusing on the market perspective of the service science discipline.

Exemplary problem area 4: instantiations addressing the potential perspective

Instantiations are realizations of constructs, models, or methods in information systems (March and Smith, 1995). Instantiations implement artifacts in their environment. Enterprise resource planning (ERP) systems are examples of instantiations involving constructs (e.g. bill of material), models (e.g. mathematical representations of networks) and methods (e.g. optimization algorithms such as linear programming). During the last decades ERP systems supporting resource planning in manufacturing have matured. However, IT-support for resource planning in services lags behind (Dietrich, 2006). For example, software tools to forecast the time-phased demand for resources used to deliver product-related services on the basis of past product sales are still very immature. Building and evaluating implementations that support such an integrated optimization of resources required for manufacturing and services could be a task for design research focusing on the potential perspective of the service science discipline.

Meso-level

We demonstrate the application of the meso-level of our framework by systematizing and analyzing a collection of artifacts developed in the course of research project FlexNet. FlexNet aims at supporting the delivery of integrated customer solutions consisting of physical products and related services by providing a flexible information systems architecture. The project seeks to integrate manufacturing processes and service processes by building reference models for coordination activities and information flows that are necessary to integrate both sides. These reference models are instantiated in form of a service-oriented architecture (SOA).

In the following, we will apply our research framework to classify the artifacts that have been built, instantiated, and evaluated within the project (cf. Figure 2). We will also discuss some artifacts the project has used but which have been designed by other researchers. Where applicable, we explicate links between artifacts to outline their dependencies. The focus of the research project FlexNet is on the process perspective of the proposed framework.

Constructs

Entering the domain, the research group identified and formulated problems (Hevner et al., 2004) by making use of constructs originating from the existing body of knowledge. The team referred to concepts from the service science discipline, mainly stemming from approaches of customer integration in service marketing. For example, the *line of visibility* (Shostack, 1982; Shostack, 1984) depicts activities that are visible to business partners or customers as parts of service processes (Teboul, 2006), likewise the *line of interaction* separates activities carried out by service providers, manufacturers, and customers.

Methods

The aforementioned constructs have been incorporated into a *method for the service-oriented analysis of business processes* (Beverungen, Knackstedt and Muller, 2008). The basic idea behind the method is to adjust the illustrated lines of visibility and interaction. Thus, information to be made visible and activities to be in- or outsourced can be determined. The method supports design decisions regarding the setup of service systems: Adjusting the line-of-visibility implies more or less visibility into manufacturing and service processes for external stakeholders. Adjusting the line-of-interaction implies to vary the degree to which stakeholders are participating in the process of value creation. Furthermore, the method identifies activities that are suitable to be implemented as web services, either for the sake of providing information (visibility) or enabling stakeholders to co-produce value (interaction). If visibility or interaction potentials are present, the identified *web service candidates* are subsequently checked concerning technical feasibility. This is done by applying the SOA design principles as evaluation criteria.

Models

The service-oriented analysis method has subsequently been used to analyze more than 40 *business processes models* within different service systems. As a result, coordination activities that are distinctive for cooperating in service systems have been identified. Furthermore, information flows have been identified and modeled (Becker, Knackstedt, Matzner and Pöppelbuß, 2008a). Coordination activities and information flows were generalized and combined to form *reference process models* that can govern the cooperation in service systems. The models provide reusable solutions for setting up cooperative business processes in service systems (Becker, Beverungen, Knackstedt and Matzner, 2009b). Information flows have been subjected to an official standardization project. In this standardization project, specifications have been defined that allow for a standardized information exchange between business partners when providing integrated customer solutions.

Instantiations

The standardized information flows have subsequently been instantiated as *web services* that allow for interlinking the information systems of service system members. Finally, project results have been consolidated into a *tool for the conceptual modeling of cooperation scenarios in service systems*. The tool instantiates the various artifacts presented here. It supports business architects in designing integrated business processes for providing customer solutions. Reference process models can be utilized and altered to design a specific cooperation scenario (Becker et al., 2009b). The information flows required to connect the business processes of the involved stakeholders are explicated. The implementation of these information flows is facilitated by providing specifications for corresponding web services (Becker et al., 2008a).

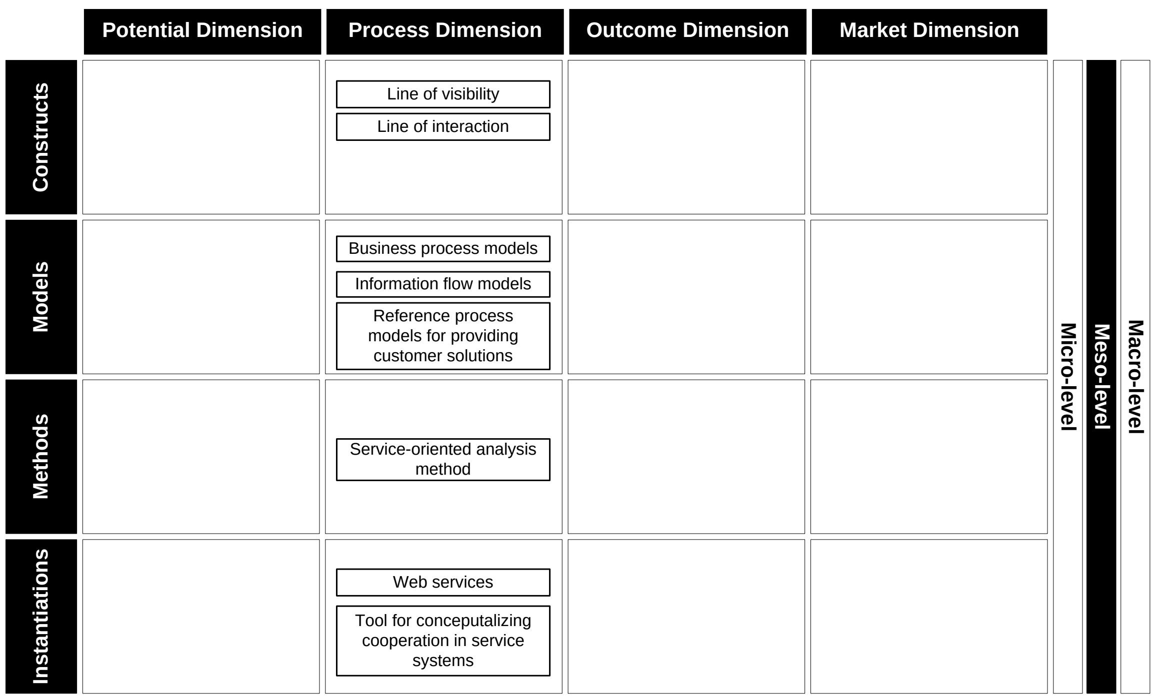

Figure 2: A classification of the presented artifacts of the FlexNet project in the proposed research framework

Macro-level

As highlighted in the introductory section, multiple research communities (e.g. service marketing, operations management, information systems, and engineering) have addressed the service science discipline from different perspectives. Thus, their contribution to this domain is multidisciplinary, they may be empirical or design-oriented and they could have been emerged with respect to different epistemological backgrounds. Due to the manifold research endeavors in the diverse research disciplines and the fact that service science has become an important topic on governmentally funded research agendas in many countries like the US, Germany, UK, the Netherlands, Finland, Switzerland and Ireland, an abundance of new theories, empirical studies – and innovative artifacts in particular – have been generated in recent years. For instance, a substantial number of research projects design artifacts that are supposed to solve specific problems of the provisioning and marketing of customer solutions (Becker, Knackstedt, Matzner and Pöppelbuß, 2008b).

For a mutual support of research endeavors, it is important to share information about long-existing and recently-designed artifacts across the borders of research disciplines. This information sharing allows for revealing (a) that a variety of useful artifacts has already been created in several of the research areas, which might entail efforts to combine artifacts or to distinguish them from each other; or (b) that a lack of sufficient artifacts occurs in several of the dimensions, which might inspire the creation of additional artifacts.

Online research maps are a valuable contribution to diminish the ignorance of related research findings across disciplines. They are internet-based knowledge management instruments, which present research activities through answering different questions, like “who is conducting the research?”, “what is being researched?”, “what results have been achieved?”, and “who is funding the research?” Thus, research maps give a general overview of the involved parties, research topics, and achieved results, trying to emphasize existing mutual relationships. Online research maps can significantly reduce the effort put in the search for existing experts and the respective designers/experts due to structured – often visual – representation (Eppler, 2001). Online research maps allow researchers and practitioners to enter and search results relevant to this domain. Their database can be analyzed by means of quantitative methods and online analytical processing (OLAP) functionality (Codd, Codd, Salley and Codd, 1993).

The concept of an online research map has already been applied to the research area of customer solutions (Becker et al., 2008b). The research map on costumer solutions is accessible online at http://www.forschungslandkarte-hybridewertschoepfung.de (German title: Forschungslandkarte zur hybriden Wertschöpfung). This research map allows researchers and practitioners to enter and search results relevant to this domain according to the following dimensions. On the one hand, research results are categorized as constructs, models, methods, and instantiations as well as empirical studies and theories. The former four categories explicitly refer to the different types of design artifacts that we included in our research framework. When adding findings to the research map, artifacts can be assigned to the lifecycle stages they support (planning, operation or replacement; cf. Figure 1). Further attributes to classify the findings are *scope*, *target group* and *degree of completion*.

The presented dimensions form the basis for quantitative OLAP analyses. By this means reports can be generated that e.g. show where research institutions are located geographically, how many research results have been published by institutions as well as how often research results of a certain type or with a certain scope have been entered. Based on the presented information, research gaps can be identified and discussions can be held – e.g. to determine in which areas useful artifacts are still missing. The research map can serve researchers in the domain of customer solutions as a stimulation to identify own strengths and weaknesses and thereby disclose opportunities for further research.

CONCLUSION

In this paper, we presented a framework for design research in the service science discipline. The framework consists of three dimensions, namely the IT artifact types introduced by March and Smith (1995) and Hevner et al. (2004), the different perspectives often regarded in the service science discipline (Becker et al., 2009a; Edvardsson and Olsson, 1996; Ramaswamy, 1996), and a micro-, meso- and macro-level of detail.

The primary contribution of the framework is to allow for the systematization of research regarding the design and evaluation of innovative IT artifacts in the service science discipline. With respect to design processes, the framework can reveal areas of interest for further design research. With respect to evaluation, existing IT artifacts on each level of abstraction can be validated with the framework: In case an artifact does not address all of the proposed dimensions, it can be ascertained: (1) if the artifact has been designed not to address a subset of dimensions on purpose, no further action might be required; (2) if the artifact has been designed to fit the dimensions but fails to do so, it might have to be revised or extended with respect to additional requirements imposed by its environment. As outlined in the paper, additional dimensions can be introduced into the framework when implementing a research map of IT artifacts for the service science discipline.

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