Towards Managing Smart Service Innovation: A Literature Review

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Abstract. Smart services are increasingly gaining in popularity amongst diverse industries. Their special character–combining physical components, smart components, and connectivity components supported by embedded ICT and big data analytics–allows for an entirely new approach of service offering. Adopting smart services within their solution portfolio, confronts companies with challenges related to servitization and digital transformation that are not only impacting their operation, but also their innovation. Based on a literature review, this study investigates the current state of research on innovation management for smart services. Findings are conceptualized within six categories: Topics, Resources, Knowledge & Information, Processes, Principles, and Methods & Tools.

Consequently, this study consolidates existing knowledge on challenges, changes and approaches for smart service innovation in a structured manner and identifies the need as well as potential for further research in this field.

Keywords: Smart service · Innovation management · Service Design

1 Introduction

Digital transformation is challenging diverse industries–forcing companies to redefine the way they think of their products, as well as their entire business. Two megatrends are omnipresent and particularly fueling the urge to transform [1–3]: servitization and digitalization. Not only are companies increasingly trying to enhance their traditional products and business models with additional or supplementary services, most of them also feel the need to adopt the use of digital technologies within their organizations and offerings in order to not be left behind [4].

As a result, smart services emerge in the intersection of both challenges by (1) expanding the service portfolios of companies and (2) following the technological trend of digitalization. While services reflect "the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity" [5] the term 'smart' emphasizes the use of intelligent digital technologies in service provision [6, 7]. MICHELIN Fleet Solutions, a service offered by the tire manufacturing company Michelin, uses sensors that measure miles travelled and thus allows truck fleet managers to rent tires as a service instead of buying them.

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CLAAS, an agricultural machinery manufacturer, uses digital technologies within their machines to—for example—precisely determine the amount of fertilizer needed in a specific field section based on the planting density.

Smart services, thus, reflect a special type of services that are composed of three core elements: physical components, smart components, and connectivity components [9]. Their data-driven character is facilitated by sensors, cyber-physical or embedded systems, and cloud computing [6] which allows for sensing conditions and surroundings and giving in-time feedback [11].

Smart services differ from traditional (e-)services in multiple ways: (1) Smart services rely on embedded information and communications technology (ICT) that allows for data transmission and information generation [13]. (2) Smart services integrate and are enabled by big data analytics [14]. (3) Smart services are completely or at least partly automated and they are perfectly aligned with human interaction. Such automated service actions are only possible by the integration of smart components like cognitive systems [14]. (4) From a customer perspective, smart services allow for greater customization of services by reacting on environmental-conditions or customer-requests (e.g. smart services adapt based on users' location data).

The new smart level of services not only results in various new opportunities, but also in challenges—especially for the innovation management in companies. Innovation and implementation of additional smart features for services need a completely new technology infrastructure and skillset including software development, systems engineering, data analytics and online security expertise [16]. Furthermore, the additional technology perspective within smart service systems are related to extended opportunities for both value creation solutions and value co-creation between different companies. Based on the integrated smart features in the service system, completely new service offerings are made possible and nearly every existing industry might get chances to design new smart services. At the same time, the value chain is getting more interfaces for cooperation. Thus, more actors and industries could be involved in the value creation process of smart services [15].

Despite the popularity of smart services in industry, they are barely represented in academia, especially in non-technical contexts. Regarding the nature of smart services, being different from products and mere services e.g. in terms of value proposition or skills and departments necessary for their development and operation, both the potential and the need can be perceived to further explore the challenges and changes evoking by smart services.

This study especially focuses on how smart services are innovated and developed. While innovation is a key competence to stay competitive, it is explored, whether and how innovation management must adapt to the specifics of smart services.

In context of this paper **smart service innovation** is understood as the development and market introduction of a new, redesigned or substantially improved solution [13] consisting of physical, smart and connective elements. The meaning of **innovation management** is understood as "[s]haping frame conditions in order to enable the emergence and successful implementation of new ideas" as well as the "[a]ctive search, development and implementation of innovation ideas". [18] It describes the initiation, planning, execution and control activities necessary to cause innovations. By connecting these definitions, smart service innovation management can be defined as

activities shaping frame conditions and support actively the emergence, development and successful implementations [18] of new, redesigned or substantially improved goods and services [19] consisting of physical, smart and connective elements.

In order to start this endeavor, we conduct a literature review, focused on pre-existing knowledge on how to innovate smart services. Our research, therefore, contributes to the current body of knowledge by providing an overview of existing theoretical knowledge on smart service innovation management, and by identifying gaps for further research. The remainder of this study is structured in the following manner: Within the next section, the design of the literature review is described. Chapter three summarizes and conceptualizes the findings, and chapter 4 discusses them. Finally, a short conclusion and implications for future work are given.

2 Design of the Literature Review

The literature review follows the approach of Webster and Watson [20]: Relevant papers are identified by a database research and investigated by authors citied forward as well as backward and findings in the chosen papers are processed in a matrix by authors and paper contents.

Starting with the database search, the two following combinations of relevant keywords are applied in the four scientific databases Academic Research, Google Scholar, JSTOR and Science Direct: First “Smart AND Service AND Innovation” and second “(Digital OR IoT) AND Service AND Development”.

Papers that were published between January 2007 and November 2017 are selected if they fulfill at least one of the following selection criteria: Either a direct relation to innovation processes for smart services can be seen or an indirect relation to the innovation process for smart services can be assumed. More precisely, four guiding questions are used to decide if a paper is relevant: (1) WHAT topics are relevant for SSI, (2) WHO should participate in the SSIM process, including what knowledge does this person has to have, (3) WHICH assets are needed for SSI (e.g. resources or processes), (4) HOW is SSI be done, meaning methods and tools are needed. The questions are oriented on the 8W model [42]. The 8W model is used to understand and describe processes in companies. Since the model is very comprehensible and straight forward, it serves as a good starting point to structure content of unknown and not yet completely defined processes—which is the case for the process of SSIM. A paper has to provide answers to at least one of those questions. In the first iteration, the titles and abstracts of the papers are screened. In the second iteration, the papers that are selected in the first iteration are completely scanned to decide if a paper is relevant. Next, backward search (BS) and forward search (FS) are conducted to complete final papers selection.

This literature basis is analyzed regarding approaches and tendencies in the field of SSIM. The findings are clustered in defined categories for each paper and are connected in concept clusters. By mapping papers and relevant findings, a comprehensive overview of current research tendencies is generated.

3 Findings

In total, 3.304 papers have been found with the data base search, including possible overlaps. In the first step the paper titles and abstracts were screened, which resulted in 30 potentially relevant papers. Those papers were screened considering the complete paper in a second iteration. Finally, 14 papers were identified as relevant after those two steps. In the BS, six more papers could be found. In the following FS, ten additional papers were selected.

Combining all literature research steps, in total 27 relevant papers are identified. The distribution of papers across databases and search process steps is presented in Fig. 1.

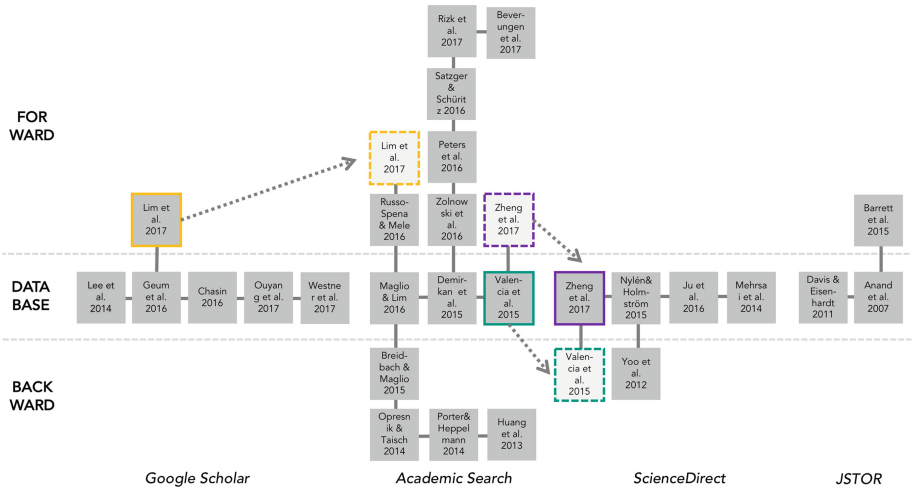

Fig. 1. Overview of the papers selected including research overlap

To structure the relevant papers and to give an overview over the content of the papers, a combined top down – bottom up approach is used. In the first step the relevant papers were structured bottom down in the four clusters defined by the four guiding questions explained in section two. A paper that provides answers to more than one of the four questions is assigned to all relevant clusters. In the second step, clusters are divided bottom up to sharpen the categories. Ultimately, the combination of (1) the questions from the 8 W model used in the top down analysis and (2) the further findings based upon the bottom up subdivision of the clusters, results in the following six categories: *Topics* from the question 'WHAT', *Knowledge & Information* from the question 'WHO', *Resources and Processes*, both evolving from 'WHICH' as well as *Principles* and *Methods & Tools* as categories from the 'HOW' cluster. A description and differentiation of the categories, and their connection to the four guiding questions is shown in Fig. 2.

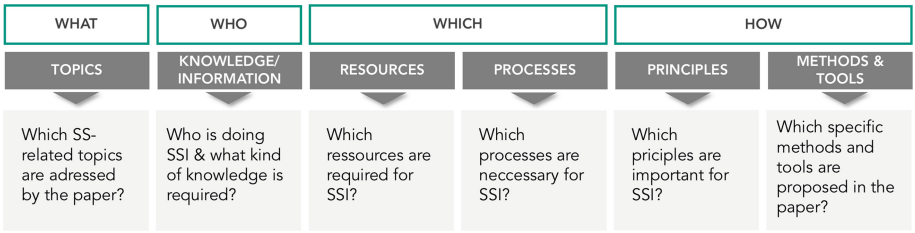

Fig. 2. Paper content categories.

The main findings within each category are described in the following.

Topics. A huge variety of topics are discussed and covered in the papers. This also represents the complexity of SSIM. Topics dealing with general *design principles and approaches* (e.g. Valencia et al. [12]) including data driven innovation processes [10, 21], the importance of *big data analytics* (e.g. Ju et al. [22]) and new ways of *stakeholder interaction & communication* (e.g. Mehrsai et al. [23]) appear most frequently. Moreover, *information & communication technology (ICT)* [24–26], *digital transformation & technology* [8, 17, 27], and changing *service ecosystems* [22, 28, 29] are discussed. Some authors also focus on *business model innovation* [28, 30] complete *life-cycle management* [8], *knowledge integration & structure* [31, 32], new approaches for *idea generation* [10, 33], as well as the need for *legal regulations & warranty issues* [9, 15].

Resources. SSIM requires an increasing set of resources. First of all, the complexity of smart services require *strong R&D capabilities* [34] including researchers from diversified disciplines [25]. To handle the huge amount of knowledge from different industries and areas, a *knowledge based structure* of the resources is necessary [32]. Moreover, *systems engineers* are required to cope with the increasing complexity of the systems [9]. Additionally, several authors raise demand for an improved *collaboration and ICT infrastructure*, to ensure seamless interaction between the stakeholders [31]. With reference to this, both, an excellent ICT infrastructure ensuring efficient communication [23, 28, 35], and approaches such as an *open ecosystem* [22] and digital platforms (e.g. for co-creation) are discussed in the papers [36]. Besides, smart services require a new *technology infrastructure* [9], for example, as already mentioned, a state of the art ICT infrastructure including all time connectivity, this time to ensure a flawless use of smart services for users. Beverungen et al. [29] also mention smart products as resources to develop smart services. Ultimately, data related resources, such as a *quality scale for smart service systems* [14] to guarantee basic quality standards for *data analytics,* are seen as relevant [22] (Fig. 3).

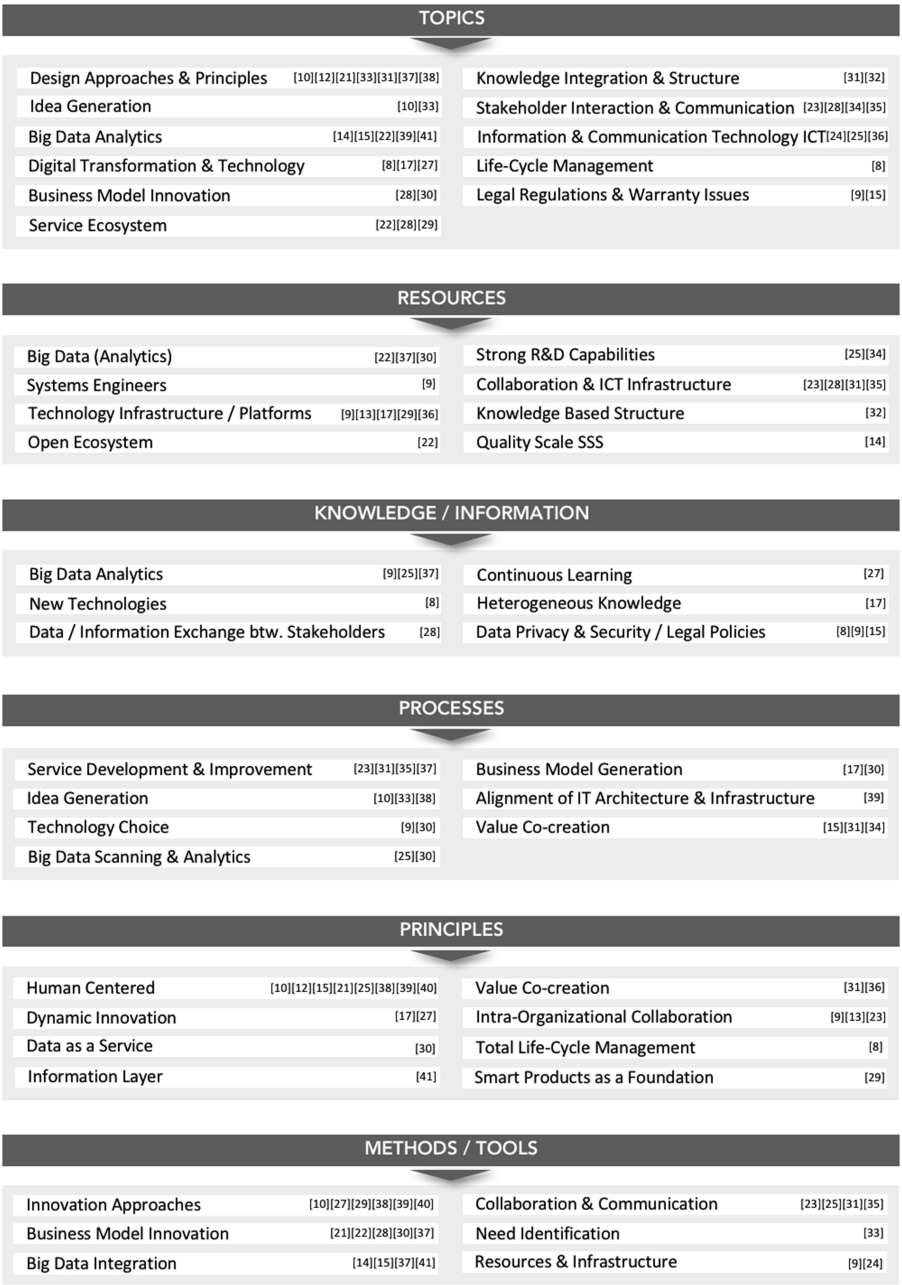

Fig. 3. Concept clusters of current literature related to SSIM.

Knowledge & Information. Papers dealing with topics related to knowledge or information, put a clear focus on knowledge around data. For instance, Demirkan et al. [15] raise the need for knowledge in the area of *data privacy and data security*, incl. existing regulations and standards and Thomas [8] states that new *legal policies* are required. Furthermore, several authors highlight the need of expert knowledge in *data analytics* [9, 25, 37]. Stakeholders involved in the service creation are in need of an easy and safe way to *exchange data and information* as well [28]. From a more general perspective, *heterogeneous knowledge* [17] e.g. on *new technologies* [8] is required. Finally, *continuous learning* mechanisms are needed to keep up with a fast-changing environment [27].

Processes. New processes have to be developed in the areas of *idea generation* (e.g. Lee et al. [38]), *service development and continuous improvement* (e.g. Mehrsai et al. [23]). In this context, Lim et al. [37] propose nine concrete process steps "From Data to value". Moreover, it should be specifically concentrated on the process to define the functions needed for smart services [9] and to *choose* the right *technology* by using *data analytics* [30]. Schuritz et al. [30] also state, data analytics should be integrated as an additional specific part in the *business model generation*. Yoo et al. [17] focus on creating business models around platforms, including license agreements for technology use. Furthermore, *value co-creation* processes [31, 34]—also across industry boarders [15]—have to be defined. Since service innovation is more and more distributed [17], and many players are involved, *IT architecture and the service infrastructure have to be aligned* [39].

Principles. Several underlying principles can be identified in the papers. Many of them deal with demonstrating needs for new services from a *human centered* perspective [40]. Some of them combine the user perspective with market gaps [38] and new technologies as enablers [10]. Beverungen et al. [29] name *smart products as a foundation* for developing smart services, since they serve as boundary objects between the physical world and the service layer. Moreover, *dynamic innovation* is necessary. Specifically, innovation needs to be continuous, relentless and fast [17] and balanced between structure and flexibility [27]. Schuritz et al. [30] name *data as a service* as new business principle, while Opresnik et al. [41] introduce the *information layer* as a new principle. Additionally, *value co-creation* and *intra-organizational collaboration* are important SSIM principles [13, 26]. Ultimately, it is important to consider the *complete lifecycle* for SSIM [8].

Methods & Tools. More than two thirds of the papers propose methods and tools for SSIM. However, many of them are rather concepts, ideas and needs for future methods and are not yet tested or verified. Many authors propose methods that serve as *innovation approaches* such as the "integrated market pull technology push morphology" by Geum et al. [10]. Methods and tools in the area of *business model innovation* are proposed by Schuritz et al. [30] ("5 patterns of data-infusion") and by Ju et al. [22] ("IoT Business Model Canvas"), amongst others. Chasin's "Social Representations Model" [33] describes an approach to *identify future needs*, by analyzing social media. Several authors propose the *integration of big data*, e.g. Opresnik et al. [41] in form of a big data strategy. Furthermore, several *collaboration and communication* tools are

explained—such as a VR toolset [35] and Collaborative Innovation Centers [31]—to enable seamless interaction between stakeholders. Finally, it is dealt with the development of *resources and infrastructure*. While Breidbach et al. [24] pledge to reallocate the existing resources to develop smart services, Porter et al. [9] propose to establish a completely new technology stack.

Reflecting the results for each category by looking at the leading questions 'WHAT', 'WHO', 'WHICH' and 'HOW' makes different levels of detail visible and demonstrates the current status in research on SSIM. Most findings are referring to the questions on 'WHAT' *Topics* and 'HOW' in relation to *Methods & Tools*. But, whereas the described *Topics* are already representing a good overview on the most relevant components that should be included in SSIM, the granularity of the identified *Methods & Tools* only give a broad answer to how SSIM can be realized and mainly refer to already existing approaches from (non-smart) service innovation processes. In comparison to this, less results are found for the questions on 'HOW' in relation to *Principles,* 'WHO' in relation to *Knowledge & Information* and 'WHICH' in relation to *Resources & Processes*. Apparently, even the relevant topics seem to be obvious, the translation on what is specifically needed is not clearly exposed so far. In addition, for each category focal points can be defined by the number of sources found: Regarding to the category *Topics*, Design Principles and Approaches as well as Big Data Analytics are connected with SSIM most frequently. In terms of *Resources* needed in the SSIM process, Technology as well as ICT- and Collaborative Infrastructures are the focused. The most relevant *Information & Knowledge* sources seem to be Big Data Analytic skills and experiences combined with Data Security and Legal Policies. Besides, Service Design and Improvement is the main component when looking on the category of *Processes*. In relation to the *Principles,* this should be especially combined with a Human Centered approach. Finally, the *Methods & Tools* focus on innovation approaches first, followed by Business Model innovation and Big Data Integration.

4 Discussion

Our literature review revealed that only very few papers which are directly related to "smart service" or "smart service innovation" still exist. First relevant publications are from 2012, whereas nearly all relevant papers were published within the last five years. The number of published papers relating to SSIM are slightly increasing in the last years, but nevertheless it still does not seem to be a focus topic. Even though the need and potential for smart services is mentioned, a clear research trend for new approaches to tackle the challenges in SSIM cannot be observed, so far.

Considering key topics identified through our research approach, the central topics mentioned in context of SSI are Big Data Analytics, ICT infrastructure and Service Design. Overarching frameworks for re-designing innovation processes and activities to account for the new nature of smart services, are still not existing. Current concepts indicate that scholars are rather concentrating on showing ways of how smart services can be understood. They consequently remain on a general level. This can also be seen for methods and tools mentioned in context of SSIM. Although, methods and tools to support the smart service innovation process are discussed, these tools rather stem from

to service development in general rather than introducing new dedicated solutions for SSIM. In general, the review of literature reveals that previous studies relating to SSIM mainly focus on single aspects within the smart service innovation process, but no comprehensive approach or framework is found. Accordingly, research needs to account for an overall framework, procedure or tools for the management of smart service innovations.

5 Conclusion and Future Research

Smart services constitute a particular new type of service combining physical, smart and connectivity components. For corporate innovation management it is necessary to account for the specifics of smart services. The goal of this study, therefore, was to generate an understanding of current research on smart service innovation management. Based on a literature review, we identified 27 papers with relevant contribution to the research area. These papers' content was structured along six major categories (Topics, Resources, Knowledge & Information, Processes, Principles and Methods & Tools) in order to summarize pre-existing knowledge on smart service innovation management Our analysis reveals, a lack of practical knowledge on the transformation of innovation activities and processes in organizations necessary to account for the new smart and connective nature of smart services. The relevant challenge will be to define how the three different levels of smart services – physical, smart and connectivity - can be aligned and managed within the smart service innovation process.

Finally, this study not only contributes by summarizing the status quo perspective on innovation management for smart service, but also by identifying starting points for future research in the field of SSIM. However, the literature review is only a first step towards holistically understanding the impact, smart services will have on innovation management. On basis of the overview given within this paper, future research will need to create a more comprehensive understanding of the innovation management of smart services. In particular, it is suggested to conduct several case studies to fully understand the challenges and changes, of the introduction of smart services into a company's solution portfolio.

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