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EMPIRICAL ARTICLE

Multi-factor service design: identification and consideration of multiple factors of the service in its design process

Chiehyeon Lim[1] · Ki-Hun Kim[2] · Min-Jun Kim[3] · Kwang-Jae Kim[2]

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Abstract Service design is a multidisciplinary area that helps innovate services by bringing new ideas to customers through a design-thinking approach. Services are affected by multiple factors, which should be considered in designing services. In this paper, we propose the multi-factor service design (MFSD) method, which helps consider the multi-factor nature of service in the service design process. The MFSD method has been developed through and used in five service design studies with industry and government. The method addresses the multi-factor nature of service for systematic service design by providing the following guidelines: (1) identify key factors that affect the customer value creation of the service in question (in short, value creation factors), (2) define the design space of the service based on the value creation factors, and (3) design services and represent them based on the factors. We provide real stories and examples from the five service design studies to illustrate the MFSD method and demonstrate its utility. This study will contribute to the design of modern complex services that are affected by varied factors.

Keywords Service design · Multiple factors · Value creation · Design space · Service representation

✉ Chiehyeon Lim
chlim@unist.ac.kr

[1] School of Management Engineering and School of Business Administration, Ulsan National Institute of Science and Technology, 50 Unist-gil, Eonyang-eup, Ulju-gun, Ulsan 44919, Republic of Korea

[2] Department of Industrial and Management Engineering, Pohang University of Science and Technology, San 31, Hyoja-dong, Nam-gu, Pohang, Gyeongbuk 790-784, Republic of Korea

[3] Samsung Electronics, 33, Seongchon-gil, Seocho-gu, Seoul 06765, Republic of Korea

1 Introduction

A factor is "one of the things that affects an event, decision, or situation" (Collins Cobuild 2009), and understanding key factors that affect the system in question is a prerequisite to its analysis and design (Lim et al. 2018b). Service has a multi-factor nature, that is, the nature that involves multiple and interdependent factors (Lee 2017; Lüftenegger et al. 2017). For example, a service business model can be described based on multiple factors, such as its value proposition, delivery channel, resources, and activities (Osterwalder and Pigneu 2010). The delivery channel factor can be further decomposed into sub-factors such as technology mediation in delivery, delivery by front-office, and delivery by back-office (Bettencourt 2010). The multi-factor nature is inherent in any service because services are systems of different components (e.g., people, information, organizations, and technologies) that operate together to create value (Maglio et al. 2009; Lim et al. 2012; Frost and Lyons 2017; Lim and Maglio 2018). Describing a specific service with a fixed set of factors is useful (Mont and Plepys 2003; Lim and Kim 2014) but difficult because of the fuzziness of service description; people find different factors in describing the same service because of their different experiences and references (Glushko 2013). Nonetheless, we need to be anchored in multiple factors in describing (Sampson 2012), evaluating (Kim et al. 2016), and designing any type of service (Osterwalder and Pigneur 2010).

Service design is a multidisciplinary area that contributes to innovations in the services by bringing new ideas to customers through design thinking (Ostrom et al. 2010; Lim et al. 2018a). Service design has received research priority as an actual means to create customer value (Ostrom et al. 2015; Lüftenegger et al. 2017). Developing knowledge or specific methods for service design is a research area that aims to facilitate customer value creation and service innovation (Patrício et al. 2011; Cavalieri and Pezzotta 2012; Lim et al. 2018a). The multi-factor nature of service has been discussed in the service design literature frequently but implicitly, although the term "multi-factor nature" is not applied. For example, researchers have investigated multiple factors related to the experience-centric service design (Zomerdijk and Voss 2010; Ponsignon et al. 2017), product–service system design (Kim et al. 2012; Lim et al. 2012), information-intensive service design (Lim et al. 2018b), smart service design (Geum et al. 2016; Maglio and Lim 2016), and service delivery process design (Bettencourt 2010; Lim and Kim 2014). This is attributed to that dividing blocks (factors) among the objects is useful to see certain functional work of the service (Osterwalder and Pigneur 2010; Lim et al. 2018b). However, it is not clear how factors of the service in question can be considered in its design process although the consideration is significant for systematic and solid service design.

The present study aims to etch the multi-factor nature of service in the service design literature explicitly. This paper proposes the multi-factor service design (MFSD) method that helps to consider the multiple factors of the service in question systematically in its design. In the MFSD method, the factors of a service refer to the factors that affect the *value creation* for customers in service. The method addresses the multi-factor nature of service for systematic service design by

providing the following guidelines: (1) identify key factors that affect the customer value creation of the service in question (in short, value creation factors), (2) define the design space of the service based on the value creation factors, and (3) design services and represent them based on the factors. The MFSD method has been developed through and used in our action research (Avison et al. 1999) of five studies with industry and government on the design of services in automobile, transportation, healthcare, and telecommunications industries. Designing a new service is fundamentally about change in organizations (Lim et al. 2018a). Action research through intensive collaboration between researchers and practitioners is useful to scrutinize issues in the change in question and to make academic research relevant to practice (Avison et al. 1999; Coughlan and Coghlan 2002). Thus, in this paper, we demonstrate the application and utility of the MFSD method with real examples from the varied service design studies.

Various service design methods exist, such as the service design method based on the theory of inventive problem solving (Russian acronym: TRIZ) (Chai et al. 2005), multi-level service design method (Patrício et al. 2011), casebook-based service design method (Kim et al. 2012), and sensor data-based service design method (Lim et al. 2015, 2018a). However, a service design method that helps consider the multiple factors affecting customer value creation is not well known, although such consideration is the key to designing services that aim to create customer value (Lim et al. 2018b). Our work proposes the MFSD method that synthesizes contributions from existing works related to the multi-factor nature of service for systematic service design, building upon varied case studies on service design from a customer perspective. Our work demonstrates the utility of the proposed method through several case studies. Our work could complement the existing body of service design literature (e.g., Kim and Meiren 2010; Patrício et al. 2011; Cavalieri and Pezzotta 2012; Papastathopoulou and Hultink 2012; Lim et al. 2018a) by showing the value of considering the multiple factors of the service in question in its design process.

This paper is organized as follows: Sect. 2 reviews studies related to the multi-factor nature of service and service design; Sect. 3 proposes the MFSD method; Sect. 4 illustrates the proposed method with five case studies; Sect. 5 discusses the use of the proposed method; and Sect. 6 concludes with future research issues.

2 Literature review

2.1 Multi-factor nature of service

The multi-factor nature discussed in the service design literature can be classified into three categories: the multi-factor nature of (1) customer value creation, (2) service offering, and (3) service representation. First, researchers have found multiple factors in describing and analyzing customer value creation in a service. Zomerdijk and Voss (2010) described the value creation in experience-centric services based on several factors, such as customer journey, touchpoints, physical environment, frontline employees, and fellow customers. They suggested that these

factors are critical in the design of experience-centric services. Lim et al. (2012) described the value creation mechanism of product–service systems based on the following five factors: customers' goal achievement process, product, service, dedicated infrastructure, and provider network. They also indicated that the design of such systems should consider the five factors. Lim and Maglio (2018) identified five factors of smart service systems, called the "5Cs" (connection, collection, computation, and communications for co-creation), from text mining of 5378 scientific articles on such systems. Bettencourt (2010) focused on the process factor that affects customer value creation. He highlighted that the utility of decomposing the customer value creation process into multiple steps in service design, such as defining their goals of value creation and monitoring whether the value creation process is being executed successfully. Patrício et al. (2011) showed the utility of analyzing the network factor that affects customer value creation and demonstrated the importance of the notion of customer value constellation, which represents the customer value creation mechanism enabled by a network of multiple actors and their interdependent relationships (Normann and Ramirez 1993; Polese et al. 2017), in positioning the service that needs to be designed. Lüftenegger et al. (2017) developed a design canvas to design services for customer value creation.

Second, multiple factors should be considered in describing, analyzing, and designing a service offering. Osterwalder and Pigneur (2010) developed the Business Model Canvas, which defines nine building blocks to describe and design business models. These building blocks are customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure. Notably, the Business Model Canvas was developed by incorporating different management tools, such as the Balanced Scorecard, to categorize and clarify factors that should be considered in a business model. Dijkman et al. (2015) used these nine blocks to decompose existing service offerings systematically and to create a new service offering based on information from existing ones. Geum et al. (2016) examined the five factors of service (the user, spatial, temporal, eventual, and value factors of service) and the three factors of technology (the input, process, and benefit factors of technology) to derive ideas of new smart service offerings. Lim et al. (2018b) identified nine key factors that characterize information-intensive service offerings: (1) data source, (2) data collection, (3) data, (4) data analysis, (5) information on the data source, (6) information delivery, (7) customer (information user), (8) value in information use, and (9) provider network.

Third, a representation of service inherently involves the consideration of multiple factors because services are complex configurations of multiple elements, such as people, information, and technologies (Maglio et al. 2009). Representation (or visualization) is the external realization of an object, and a representation helps people to build and use their mental models to understand, describe, analyze, and design an object (Crapo et al. 2000). Visible pictures of service enhance dialogues between the people involved in discussion, which enable them to achieve joint understanding more efficiently and effectively. Thus, to address the complexity of service in its analysis and design, researchers have represented services with an emphasis on specific factors that characterize the services in question (Lim et al.

2012, 2018b; Lim and Kim 2014). These specific factors include customer action and employee visibility in service (Bitner et al. 2008); interactions among players involved in service (Morelli 2006); information exchange in service (Lim and Kim 2014); information production in service (Lim and Kim 2015); data analytics in service (Lim et al. 2018b); relational network of service elements (van Halen et al. 2005); multi-channel nature of service (Patrício et al. 2008); product utilization in service (Hara et al. 2009); customer goal achievement process in service (Lim et al. 2012); and customer requirements fulfillment mechanism (Teixeira et al. 2012).

In fact, the three types of multi-factor nature of service (i.e., the multi-factor nature of customer value creation, service offering, and service representation) are interdependent. For example, factors that affect guest value creation (e.g., physical environment and frontline employees) may need to be considered in hotel service representation. A limitation in the current service design literature is the lack of method to consider the three types of multi-factor nature of service coherently and holistically in the design process. The proposed MFSD method corresponds to this research necessity.

2.2 Service design and development

Service design is a process to create or improve services to customer value (Zomerdijk and Voss 2010; Patrício et al. 2011; Lüftenegger et al. 2017; Lim et al. 2018a). Recently, Ostrom et al. (2015) identified and evaluated service research priorities through roundtable discussions and surveys with service researchers around the world. Among the 12 research priorities deemed important, their study determined that *leveraging service design* is a priority, where a significant gap was observed between the importance and current knowledge of the field.

To leverage service design, researchers have developed specific methods that support the human processes of designing services. Patrício et al. (2011) focused on the multi-level structure of service design. They proposed a service design method that enables the integrated development of a service offering at three hierarchical levels: service concept, system, and encounter. Chai et al. (2005) proposed a problem-solving model for service design based on TRIZ. Kim et al. (2012) established a method for the design of product–service system concepts that include a list of general customer needs, a list of design models, the concept generation support matrix, and a casebook. Lim et al. (2012) focuses on the process of product–service system design from the perspective of value proposition. Lim et al. (2015) showed how to design services based on analysis of emerging sensor data, such as customers' driving records, while Lim et al. (2018a) empirically identified eleven managerial issues that should be considered in designing services with such data. Bettencourt (2010) defined service innovation as "the process of devising a new or improved service concept that satisfies customer's unmet needs," and proposed a service design method that helps to identify customers' unmet needs and devise new service concepts that address these needs.

From the perspective of the new service development (NSD) literature (Kim and Meiren 2010; Papastathopoulou and Hultink 2012), the scope of service design in this paper corresponds to the concept and process design in the NSD process. A

service concept includes specific features of the service (Kim and Meiren 2010), indicates the benefits that the service is expected to offer to customers and how to offer it (Edvardsson et al. 2000), and mediates between the customer needs and the strategic intent of the company (Goldstein et al. 2002). Instead of viewing the service concept as the structure and content of a service operation from the service provider perspective, Patrício et al. (2011) focused on the customer side and suggested the service concept to be viewed as a service provider's strategic positioning in the value constellation network that characterizes the provider's value proposition to customers within the network. A service process describes the process through which the service is produced (Fließ and Kleinaltenkamp 2004) and delivered to a target customer (Bitner et al. 2008). In the service process design, the details associated with the service process are determined, such as the interactions between customers and employees, sequence of operational tasks and their interactions, the input and output of each task, and the responsibility of service personnel and technologies (Kim and Meiren 2010).

These works on service design and NSD have contributed to the effective and efficient development of multiple hierarchies of service design outcomes, such as service ideas, concepts, delivery processes, and business models. However, these works address the multi-factor nature involved in each hierarchical level in a limited manner. The proposed MFSD method aims to complement existing studies and expand the service design literature by showing the utility of considering the multi-factor nature in each hierarchical level. The morphological analysis, a well-known approach for structured system analysis and design, predefines key factors of the system in question and uses them for its analysis and design (Geum et al. 2016). This approach has been applied to the service context recently (e.g., Meier and Boßlau 2013; Geum et al. 2016). However, how this approach can be used in the key tasks of service design process, such as customer understanding and service concept design, is not well known. The proposed MFSD method could contribute to bring the knowhow from morphological analysis studies in varied fields into the service design research field.

3 Multi-factor service design method

The MFSD method consists of the following three steps: (1) preliminary investigation and customer understanding, (2) service idea generation and refinement, and (3) service concept and delivery process design. The three steps were identified and defined based on the service design and NSD literature (e.g., studies reviewed in Sect. 2.2). The MFSD method suggests its own approach in performing the three steps to address the three types of multi-factor nature of service (i.e., the multi-factor nature of customer value creation, service offering, and service representation). In the respective steps, the MFSD method involves (1) identifying multiple factors that affect customer value creation (in short, value creation factors), (2) identifying multiple choices for service offerings and defining the design space of the service in question based on the value creation factors, and (3) devising the templates for representing the services based on the value creation factors and

Table 1 Multi-factor service design method and its applications

MASD process	MASD approach in each step	Case study 1: health-related data utilization service design	Case study 2: car infotainment service design
Step 1. Preliminary investigation and customer understanding	Visualize and analyze the customer value creation mechanism of the service to be designed. The mechanism should involve key factors that affect the value creation	Investigated existing cases of ICT-based and health-related data utilization service Defined the value creation mechanism of health-related data utilization services Understood issues of health-related stakeholders through interviews with experts Identified the key factors of health-related data utilization services	Investigated existing cases of car infotainment service Defined the driver value creation mechanism of car infotainment services Analyzed vehicle operations and condition big data from the perspective of driver value creation Identified the key factors of car infotainment services
Step 2. Service idea generation and refinement	Represent the service design space to organize the generated service ideas. The design space should show key factors of the service to be designed	Generated ideas of health-related data utilization service and evaluated the ideas through the interviews with experts Identified the design space of health-related data utilization service	Generated ideas of car infotainment service and evaluated the ideas through discussions with managers Identified the design space of car infotainment service
Step 3. Service concept and delivery process design	Design service concepts and delivery processes based on the service design space Devise and use customized service representation templates not to miss any important points of the service in its design	Designed eight health-related data utilization service concepts based on the service design space Defined a service concept description template for ICT-based healthcare-related service Used the template to represent the designed services	Designed four car infotainment services based on the service design space Defined a service concept description template and a service blueprinting template for car infotainment service Used the templates to represent the designed services

designing services onto the templates. Although the procedure in Table 1 is shown in a linear form, the MASD method involves iterations between the steps (e.g., iterations between customer understanding and service idea generation). The applications of MFSD are given in the next section.

The proposed MFSD method was developed based on our action research of service design projects. Action research is "an orientation to knowledge creation that arises in a context of practice and requires researchers to work with practitioners" (Huang 2010). This particular qualitative research method "is unique

in the way it associates research and practice, so research informs practice and practice informs research synergistically" (Avison et al. 1999). Action research is appropriate to achieve our objective because (1) action research is concerned with bringing about change in organizations (Shani and Pasmore 1985), and our study is concerned with change (i.e., design of a new service); (2) action research aims at developing holistic understanding (Coughlan and Coghlan 2002), and our study explores a complete service design process that considers multiple factors of the service in question; and (3) notably, the research topic of service design fundamentally requires an understanding of real service design practices, and we concur with the view of Huang (2010) that only through action (i.e., active participation of the researchers in the reality) close observation is possible and legitimate understanding can be developed. Service design is really about practice to create value, and our study aims to scrutinize and help improve practice by offering specific actionable knowledge to practitioners (i.e., service designers).

Maintaining objectivity in action research is important because the researchers (i.e., the authors) participate in the problem-solving process in the project. Thus, we conducted our service design projects following some key action research references (e.g., Avison et al., 1999; Iversen et al., 2004; Mathiassen et al., 2012; Lüftenegger et al., 2017). In addition, to develop a neutral method, we conducted a comprehensive review in each project and in developing the MFSD method (e.g., studies reviewed in Sect. 2). We now describe each step of the MFSD method in turn.

The preliminary investigation and customer understanding step includes market investigation, analysis of data about customers, and expert interviews to understand the customers in question. In this step, the MFSD method suggests an identification of the key *factors that affect customer value creation* in service. On the basis of the studies reviewed in Sect. 2.2, the MFSD method defines the service to be designed as "what and how to offer a service to customers and create their value." Thus, the MFSD method views the factors of the service to be designed from the perspective of customer value. Identifying the value creation factors requires multiple considerations, such as the fundamental goal of customers, their process to achieve the goal, current, and potential problems of customers, how current or relevant service cases address the goal and problems, how customers perform their actions in service, and what kinds of players are involved in customer value creation. A useful approach in this step is to visualize a value creation mechanism, which is a set of factors (e.g., activities and resources) used by the service customer and the provider to jointly perform particular functions (Payne et al. 2008; Lim et al. 2012, 2018b). The mechanism visualization naturally involves the identification of value creation factors and requires the abovementioned considerations. Figure 1 in Sect. 4 shows an example of the mechanism visualization. All subsequent steps of the MFSD process (i.e., service idea generation and service concept and process design) should be organized coherently based on such considerations to enhance focal customer value.

The service idea generation and refinement step includes derivation of service ideas and design of service contents for customers on the basis of the learning from the previous step. In this step, the MFSD method suggests defining the service

design space beyond simple idea generation, that is, the space that consists of key factors of the service to be designed and the corresponding design choices of each factor. While the definition of customer value creation mechanism in the previous step helps develop an understanding of the problem space of service design, the definition of service design space helps articulate the solution space. Once customer understanding is achieved in the previous step, service idea generation through brainstorming occurs naturally. Here, the designer may use existing brainstorming methods in the literature, such as outcome-driven method (Bettencourt 2010) and casebook-based method (Kim et al. 2012). What the MFSD method uniquely suggests is to organize and refine the generated service ideas in a systematic manner, that is, analyzing the similar and different aspects of ideas based on the value creation factors during and after the idea generation continuously and iteratively. This way, service designers can identify multiple options for service offerings and understand the design space. Attempting to represent the design space considering the identified factors is useful. Figures 2 and 4 in Sect. 4 show examples of the service design space illustration. As shown, the designer can place and refine the generated service ideas according to the identified factors. The systematic definition of design space in this step contributes to the examination of the ideas under a coherent framework, creation of synergy between the ideas, and derivation of additional ideas based on the framework.

The service concept and delivery process design step incorporates the design of service concepts and their delivery processes. Once a design space is defined, a combination of the choices of multiple factors (i.e., creating synergies among the ideas) results in a service concept. Figures 2 and 4 in Sect. 4 illustrate the service concept formation based on the design space. As shown in these figures, the definition of design space enables a full exploitation of original ideas to come up with service concepts. In this respect, the service design space can be described as "a collection of refined materials for forming service concepts." The combination of ideas should be natural from the perspective of the customer value creation mechanism visualized in the previous step. The visualized mechanism should show a relationship between the factors, thus aiding in assessing the fitness and synergy between different ideas. In addition, other information gained in the previous investigation step (e.g., the current market information and the company's strategies) can be considered in the combination.

In the service concept and process design step, the MFSD method suggests to devise and use service representation templates not to miss any important factors of the service in its design. Figures 3, 5, and 6 in Sect. 4 show examples of the service concept and process representation, respectively. Researchers have developed templates for service representation, such as Service Blueprint (Bitner et al. 2008) and Process Chain Network (Sampson 2012). What the MFSD method suggests is devising and using the *templates customized to* the multi-factor nature of service in question, not merely adopting existing templates. A service representation should show the essential aspects of the service in question because the picture serves as a basis for the design, analysis, and improvement of the service; meanwhile, each type of service has a different nature. In other words, the factors that should be addressed in service representation differ according to service type. This issue has been the

underlying driver of researchers who developed a new and specialized template for representing the service type they are interested in, such as the different styles of service blueprinting templates for representing different aspects of services; examples include Service Experience Blueprint (Patrício et al. 2008), Extended Service Blueprint (Hara et al. 2009), and Information Service Blueprint (Lim and Kim 2014). Through the case studies in Sect. 4, we found that the use of a customized service representation template is helpful in creating new services with consideration of the specific multi-factor nature of service in question.

4 Case studies

The proposed MFSD method has been applied through five service design studies with industry and government. Each of the authors participated in two to five studies of the five and observed the other studies. Studies 1 and 3 concern mainly services of the health industry, whereas Studies 2 and 4 designed services in the automobile and transportation industries. Study 5 is highly relevant for both the telecommunications and IT industries. The main objective of the current study is to enhance understanding on a service design that focuses on the multi-factor nature of service. Thus, this section focuses on the application of MFSD in each case study, rather than providing detailed information. For further information on these studies, see Lim et al. (2015) for Studies 2 and 4; Lim and Kim (2015) for Study 5; and Lim et al. (2018a) for Studies 1 to 4. Sections 4.1 and 4.2 explain the application of MFSD in Studies 1 and 2, respectively. Appendix discusses the application of MFSD in the other three studies briefly due to lack of space. The motivation, process, and outcomes of each case study can be utilized as useful references for similar studies in the future.

4.1 Case study 1: health-related data utilization service design

Study 1 designed health-related data utilization services for health-related stakeholders. The study was conducted with the National Health Insurance Service (NHIS) of the South Korean government that operates the public health insurance

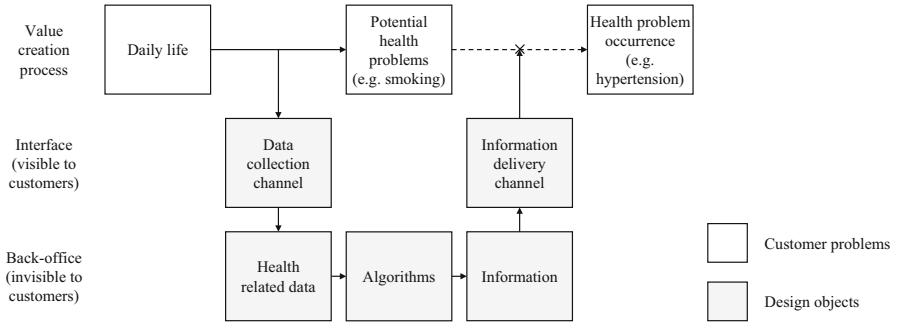

Fig. 1 Customer value creation mechanism visualized in Study 1

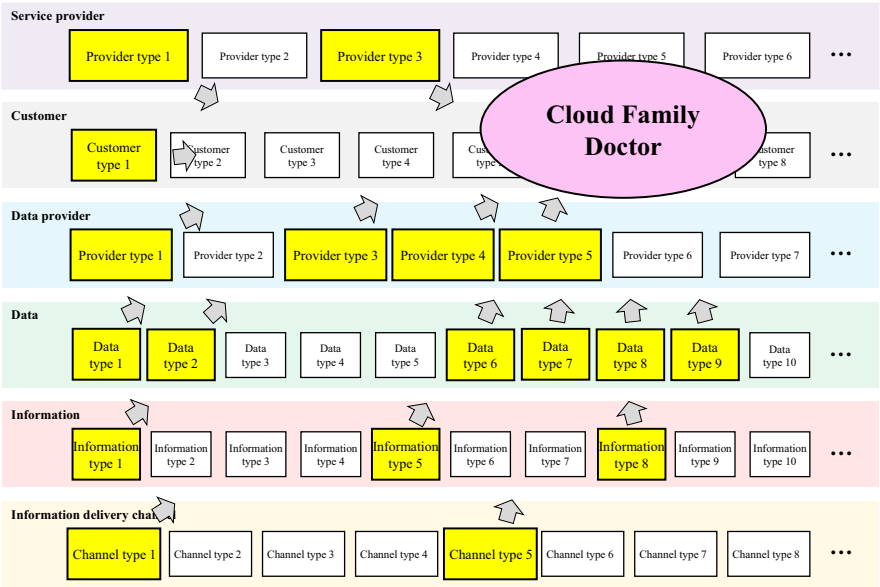

Fig. 2 Design space of health-related data utilization service

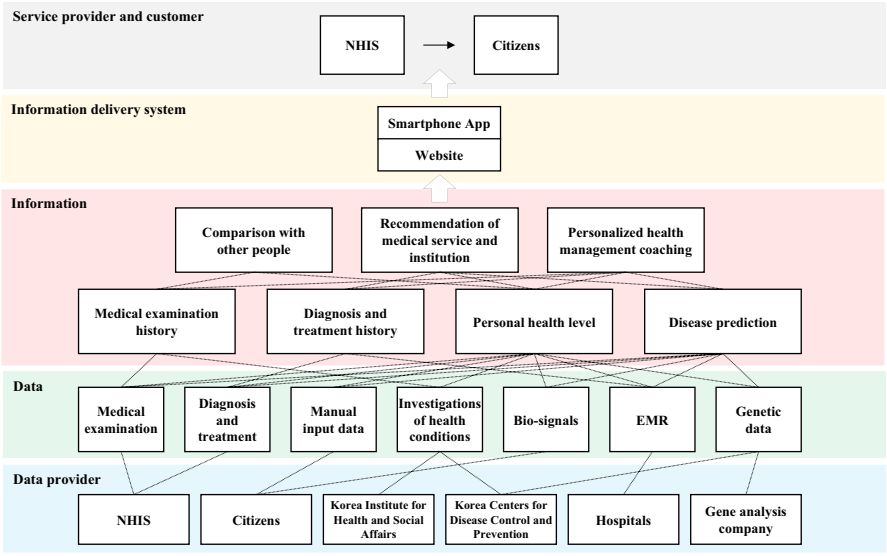

Fig. 3 Example of representation of service concepts: cloud family doctor

system. The organization collected various types of health-related data, including insurance, diagnosis, treatment, and medical examination data of citizens. The organization aimed to design service concepts that will serve as bases for service innovations in the health industry of South Korea. Thus, the objective of Study 1

was to develop service concepts that utilize a wide variety of health-related data including the government data. The study was conducted through interviews with 34 experts from different fields including doctors, public health scientists, data analytics experts, and managers and executives in the health industry and the government. As a result, eight new service concepts were developed for citizens and other stakeholders (e.g., doctors and local governments) in the health industry based on the generation and evaluation of 138 service ideas. The eight concepts were evaluated through surveys with experts and citizens. Table 1 shows a summary of the application of MFSD method in Study 1. The succeeding paragraphs describe in detail how the method contributed to Study 1.

In the preliminary investigation and customer understanding step, existing studies on ICT (information and communications technology) and data utilization for service value creation in the health industry and relevant cases of health-related data utilization service were investigated. Furthermore, we conducted focus group interviews with 14 experts affiliated with medical institutions, public institutions, IT companies, and universities to understand the factors of the value creation in health-related data utilization services. We selected experts who represent diverse areas of expertise (e.g., medical science, health science, and data mining). Through the interviews, we could define value creation mechanisms of health-related data utilization service and understand multiple issues of health-related stakeholders. We defined several factors that are useful for organizing and integrating the insights from the experts. As a result, we identified the six value creation factors of health-related data utilization services, namely, (i) service provider, (ii) customer, (iii) data owner, (iv) data, (v) information, and (vi) information delivery channel. To create value, the service provider integrates different types of data from different data owners, analyzes data to create useful information for customers (e.g., information for hypertension prevention), and delivers the information to customers. Value is created as the customer uses the received information for a specific purpose. Figure 1 shows the customer value creation mechanism visualized in Study 1. We focused on the design of information and information delivery channel considering available health-related data, although the design of data collection channels and data analytics algorithms is also important in this work.

Second, we generated various service ideas that create value for health-related stakeholders. In this study, a "service idea" was defined as a function or information that can be provided to a health-related stakeholder based on a set of health-related data. We considered service ideas for multiple stakeholders besides patients, such as healthy people, hospitals, and government organizations. Such consideration was taken because the services for other stakeholders also create value for (potential) patients eventually (e.g., preventing chronic disease onsets of local people through a service to local governments and improving healthcare quality through a service to hospitals). Our aim was to consider a comprehensive set of factors that affect the value creation of health-related data utilization service. We conducted multiple brainstorming sessions to generate service ideas based on the findings from the previous step. As a result, we generated 138 service ideas, including personal health scoring, hospital search, medical equipment sharing, and regional health statistics services. We also evaluated the 138 ideas through new focus group interviews with

20 experts who were asked to assess these ideas based on their expertise. The idea assessment sessions helped us understand the various aspects of the 138 ideas and the interdependent relationships among the ideas.

Based on the generated service ideas and learning from idea evaluation sessions, we defined the service design space to exploit fully the 138 ideas in devising service concepts and to facilitate communication among project participants. Figure 2 illustrates the design space. Detailed information is confidential because of the project agreement and is thus simplified in this article. We developed an MS Excel sheet that contains full information on the design space. As shown in Fig. 2, the design space consists of six factors and the corresponding design choices of each factor. We integrated all information gained from the previous step, the 138 ideas, and experts according to the six key factors by decomposing and combining information. Through the analysis of the design space, the 138 ideas were examined and refined as useful ingredients in developing the service concepts in the next step.

The third step aimed to transform the information, knowledge, and insights gained from the previous steps into several service concepts that will serve as bases for data-based service innovation in the health industry. Through multiple brainstorming sessions based on the design space, we formed eight new service concepts, as follows: (i) "cloud family doctor," (ii) "PAY care," (iii) "hospital QA," (iv) "my PHR market," (v) "local health-nostics," (vi) "medical expense analytics," (vii) "NHIS budget firewall," and (viii) "insurant relationship management services." Figure 2 illustrates how a service concept (cloud family doctor) was generated based on the design space. Different ideas were combined by considering the customer value creation mechanism related to the ideas, the synergetic and conflicting relationship between the ideas, and discussions between the authors and the project client. For example, the idea assessment sessions with 20 experts were helpful to understand the synergetic and conflicting relationship between different ideas.

The "cloud family doctor" service provides healthcare-related information based on data analysis authorized by the customer. Customers can access this service via smartphones and computers. Another objective is to support doctors in efficiently accessing and utilizing patient data. "PAY care" is an abbreviation for "pay as you care." This service provides discounted insurance fees based on the degree of health improvement and the degree of efforts for improvement. This service is similar to the PAYD (pay as you drive) concept in the vehicle insurance industry. "Hospital QA" is an abbreviation for "hospital quality assessor." This service evaluates the service quality of tertiary hospitals and provides this information to patients to assist them in decision-making. Another objective of this service is to lead benchmarking among hospitals. The "my PHR market" service mediates between patients and health-related organizations, such as hospitals and research institutions, and supports them in selling and obtaining personal health records (PHR). The organizations provide derived information to patients.

Whereas the main objective of service concepts (i)–(iii) is to support citizens, the other service concepts mainly aim to support private (iv) and public organizations (v–viii) in the health industry. "Local health-nostics" is an abbreviation for "local health diagnostics and prognostics." This service provides diagnostic and

prognostic health information, such as disease maps and local health statistics to local governments. The "medical expense analytics" service focuses on analyzing health-related data from health-related spending and supports the national policy and regulation development of the government. The "NHIS budget firewall" service identifies cases that negatively affect the budget of NHIS based on the analysis of national health insurance-related data. "IR management" is an abbreviation for "insurant relationship management." This service analyzes complaints on public health-related services and manages the relationship between citizens and the government in terms of health welfare.

Because of the lack of space, this paper provides only a representation of the cloud family doctor service concept in Fig. 3, which is based on the following six factors predefined in the design space representation: (i) service provider, (ii) customer, (iii) data owner, (iv) data, (v) information, and (vi) information delivery channel. The representation method can illustrate the process of data transformation into information for customers in a service concept. For example, a cloud family doctor connects various types of data, such as medical examination and investigations of health conditions, from data owners. The information produced from the data includes personal health and recommendations of medical service and institution. This information is delivered to citizens via a smartphone application and the public health insurance service website.

4.2 Case study 2: car infotainment service design

Study 2 designed car infotainment services with a major automobile manufacturer. The automobile manufacturer gathered data on vehicle operations and conditions through a telematics system and constructed a database called, the vehicle relationship management database (VRM DB). The manufacturer aimed to develop new car infotainment services by analyzing this database and using insight from the data. The study involved a market investigation and an analysis of VRM DB; identification of 35 service ideas based on the data analysis and market investigation; as well as development of four car infotainment service concepts. Table 1 shows a summary of the application of the MFSD method in Study 2. The next paragraphs contain a detailed presentation of how the method contributed to Study 2.

First, we investigated existing car infotainment service cases and analyzed the driver (customer) value creation mechanism of car infotainment services in the preliminary investigation and customer understanding step. The driver value creation mechanism involves the use of vehicle condition and operations data and the delivery of vehicle health management (VHM) and vehicle operations management (VOM) services. Through the use of such data, VHM services predict and prevent vehicle condition problems (e.g., stalling), while VOM services identify nonstandard customers and provide intervention to the customers to prevent operations problems (e.g., accident). The problem prevention contributes to creating value.

Once the driver value mechanism of car infotainment service was investigated, we analyzed VRM DB. We analyzed 7.6 million trip data on the driving of 18,943

vehicles (19,063 customers) in 2011 (vehicle operations data). In addition, 3662 cases of warning code occurrences from 2009 to 2012 (vehicle condition data) were also analyzed. The results of the data analysis included descriptive statistics of the driving patterns of customers, key variables that determine driving characteristics, as well as the relationships among warning codes. Through these works for customer understanding, we identified the four key factors that affect driver value creation, namely, (i) driving context, (ii) infotainment service content, (iii) content delivery channel, and (iv) content production support system. In Study 2, the understanding of these factors served as a basis for identifying the utility of available data for driver value creation, and performing data analytics to understand the potential problems of drivers, and identifying information useful to drivers for managing and improving their driving (i.e., value creation) processes.

Second, we generated service ideas. We defined service idea in Study 2 as things that address customer needs during vehicle-related activities such as vehicle purchase, driving, and maintenance. The generated ideas include consultation for new vehicle purchase (for the vehicle purchase activity) and provision of vehicle operations and health history review report (for the vehicle driving activity). The results of the data analysis provided cues for service ideas. For example, the distribution of total mileage in a trip follows the Pareto principle, and the data show that 80% of the customers drive for < 22 km during a trip. Thus, when designing products and services, the automobile manufacturer should note that most driving experiences are short trips. In addition, services that support short and long trips should be differentiated. The relationship between car stalling and warning code occurrences provided some important information to predict and prevent sudden stalling. For example, stalling frequently occurs during winter. Prior to this event, a specific warning code was frequently triggered.

We also analyzed existing service cases and customer complaints to generate a variety of service ideas. As a result, we generated 35 service ideas, including safe driving guidance, driving school services, city/highway and winter driving guidance, customized car selection support, mileage-based insurance, traveling support, and entertainment content delivery services. The 35 ideas are organized in the design space in Fig. 4 based on the four key factors. Detailed information of the ideas is confidential because of the project agreement and is thus simplified in this article. Through visualization and analysis of the design space, the similarities and differences among 35 ideas were examined to seek synergies among the ideas and sublimate the rich information in ideas into several service concepts in the next step.

The four service concepts designed in the third step are services for fuel-efficiency improvement, driving safety enhancement, consumable replacement support, and prognostic maintenance support. Services for fuel-efficiency improvement and driving safety enhancement review the driving patterns of drivers and guide them from the perspectives of mileage and driving safety, respectively. Consumable replacement support service manages the life cycle of consumables customized to the driving patterns of drivers, such as engine oil, tires, and batteries. Prognostic maintenance supports service monitors vehicle health to predict and prevent sudden breakdown of vehicles. Figure 4 illustrates how a service concept (fuel-efficiency improvement service) was generated based on the design space.

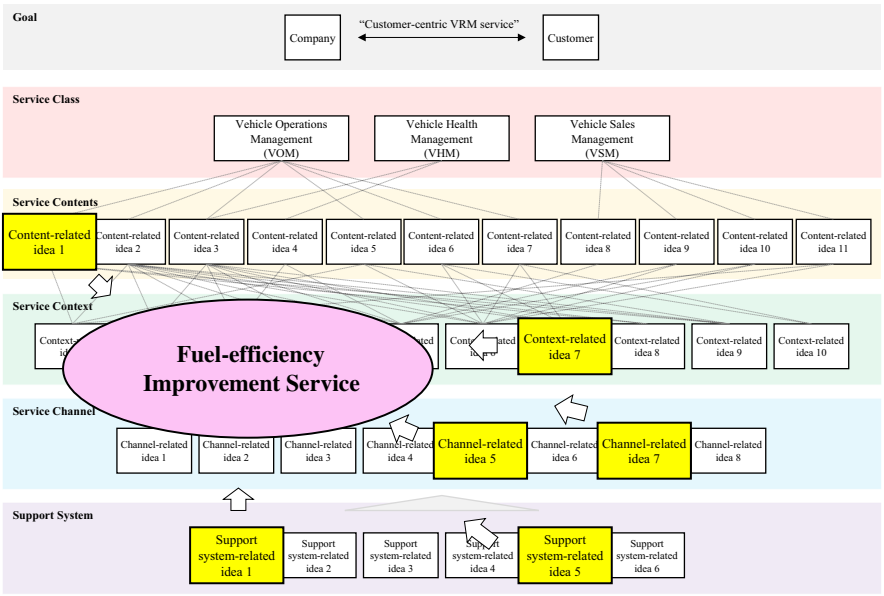

Fig. 4 Design space of car infotainment services

Similar to the Study 2 case, we assessed the synergetic and conflicting relationship between different ideas to form service concepts. For example, the service content idea 1 (fuel-efficiency prediction) may create synergy with the service context idea 7 (traveling context), while the channel idea 5 (smartphone application to be synchronized with the onboard device) is highly relevant to the channel idea 7 (game application for driving capability enhancement).

Figure 5 shows the main characteristics of the four service concepts according to four factors, namely, information content, information delivery channel, information production system, and partner companies. As shown in the figure, the set of four key factors is useful in specifying and describing the designed service concepts. Figure 6 shows the blueprint of the designed fuel-efficiency improvement service process. The service process representation template shown in Fig. 6 served as a basis for forming new service concepts to enhance customer driving experience. This blueprint was useful in combining and integrating different ideas in the design space (Fig. 4) into one template. The seven rows, which are based on the four factors, served as lenses to view the key design areas and made the discussion among project participants efficient because it served as a visual basis to share and develop thoughts.

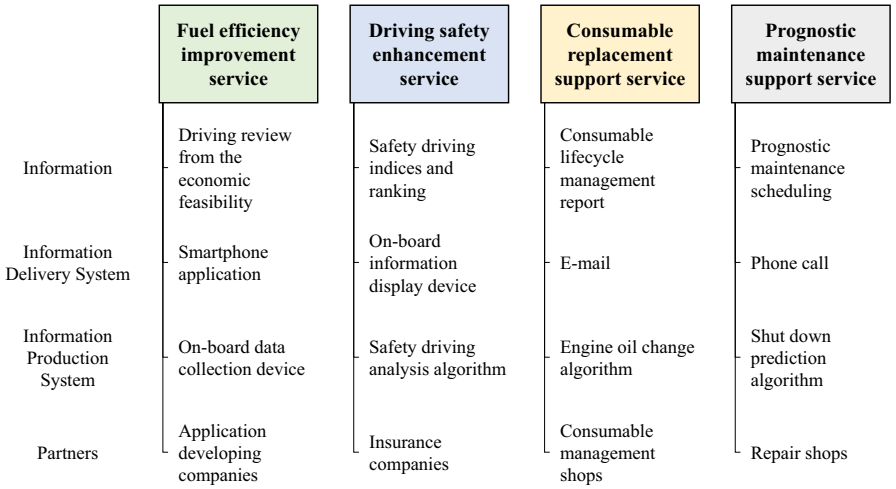

Fig. 5 Main characteristics of the four car infotainment service concepts

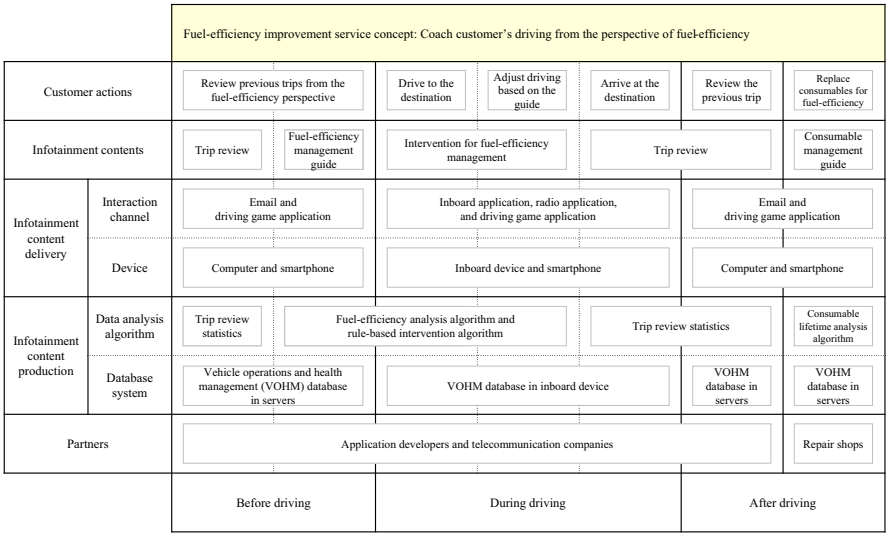

Fig. 6 Example of representation of service processes: fuel-efficiency improvement service

5 Discussion

5.1 Utility of the proposed multi-factor service design method

A prerequisite to improving existing services or designing new services for customers is obtaining a fundamental understanding of the customer value creation mechanism in the context of the specific service in question (Bettencourt 2010; Lim

et al. 2012, 2018b). As the case studies demonstrate, attempts to identify multiple factors of the service's customer value creation mechanism contribute to a service design that is oriented toward customers. For example, an understanding of the data-based driver (customer) value creation in Study 2 served as a basis for the data analytics for customer value creation, design of information content for the customers, and design of the process of data transformation to information and information delivery to the customers. As Study 1 shows, understanding the value creation factors also facilitates the integration of the roles of customers, technology, and other resources for value creation and can contribute to coordinating the multiple stakeholders, their network, and collaborative contexts involved in the customer value creation mechanism.

A service concept is a description of what needs to be done for the customer and how this is to be done (Edvardsson and Olsson 1996). Thus, designing service concepts requires understanding of the things that constitute the *whats* and *hows* of service. A difficulty of service design is that the design space is wide and complex because candidates for the whats and hows are comprehensive. The case studies show that a representation of design space contributes to the decomposition of the complex design space, which allows for the efficient exploration of the space. The identification of design space is useful in integrating, organizing, and exploiting existing information on the service in question (e.g., information of existing service cases from the perspective of defined factors) in the design of new services. The design space can also serve as a tool that triggers more ideas (i.e., exploring unknown information from the perspective of defined factors).

Services are intangible (Fisk et al. 1993) and fuzzy (Glushko 2013). Hence, attempts to represent the concepts and processes of services during their design can help people build and use mental models to better understand, describe, and analyze the services in question, eventually contributing to the improvement of the design outcomes. The representation of service concepts and processes serves as a basis for capturing the big picture of the designed service and seeing the relationships within the service. We found that the MFSD method is useful in designing concepts of new and relatively unknown types of service because the core of the MFSD method is to identify the structure of service operationally and represent the structure. All five case studies concerned the type of service in which the use of (big) data significantly affects customer value creation. This type of service was not well known in the literature during the period that the studies were conducted (2011–2014). Furthermore, the next step in service design is the full development of a designed service to bring it to the market; holistic consideration of multiple factors of service in its concept and process design step contributes to the devising of a more valid service for full development.

In summary, service design is a creative job that should be performed not only by a bottom-up approach, but also under a top-down approach. The explicit identification and use of multiple factors of the service in its design process help service designers execute the process systematically and coherently under the framework of the factors. In particular, the factor identification from a customer value perspective facilitates the service design toward customer value creation.

Whereas the above paragraphs discuss the methodological utility of MFSD method, the organizational utility of MFSD method is in its ability to address the interdisciplinary nature of service design and innovation (Lim et al. 2018a). Service design is, by nature, a "soft" task that combines human activities (Ostrom et al. 2015). As in any interdisciplinary project, service design projects require a cross-functional team with members from various functional units, including planning, design, engineering, IT, and marketing; all the five studies involved various types of experts. The MFSD method is useful in such an interdisciplinary environment to ensure an integrative design of modern complex service systems (Frost and Lyons 2017; Lim and Maglio 2018). The MFSD method is useful for synthesizing contributions from different fields from the perspective of key factors of the service in question, allowing integrated design of service idea, concept, and process, starting from the solid consideration of customer value creation mechanism. In short, a set of factors serves as a framework for service design (Lim et al. 2018b). For example, in Study 1, we could effectively organize the experts' insights on the data-based customer value creation in the health industry based on the six key factors of health-related data-based services. In addition, the MFSD method is useful in enhancing the dialogue between project participants because systematic service representation supports the development of collective reference points and shared language to achieve joint understanding and create team-wide understanding across the entire project. We have observed that this benefit significantly improves communication, thereby ensuring effective and efficient service design.

5.2 Further guidelines for using the multi-factor service design method

We have identified further guidelines for the use of the proposed MFSD method through its multiple applications. First, categorizing existing cases of the service in question is useful in identifying key factors of the service. Categorization of service cases has contributed to understanding similarities and differences between services (e.g., Lovelock 1983), gaining managerial insights on services (e.g., Frei 2006), and identifying archetypes (i.e., design models) of services for service design (e.g., Glushko 2010). Identifying the key factors of services in question is a prerequisite for service categorization. For example, studies on service categorizations have considered varied factors of services, such as the direct recipient of the service, tangibility of the service actions (Lovelock 1983), separability of service production and consumption, type of service benefit (Berry et al. 2006), quality of service experience, and cost of service (Frei 2006). We have observed that service design project participants can naturally obtain insights on the multi-factor nature of service in question through repetitions to categorizing relevant service cases. For example, we classified existing cases of ICT-based healthcare services and car infotainment services into several classification matrices in Studies 1 and 2, respectively, to identify key factors that constitute the services.

Second, the MFSD method can create synergy with a cross-functional team for service design because consideration of multiple factors is the key in an interdisciplinary project environment. Whereas the first guideline concern the methodological issue in service design, this guideline addresses the organizational

and cultural issue. We have confirmed from the five studies that service design projects require multidisciplinary human activities of a cross-functional team. We performed Study 1 with doctors, public health scientists, data scientists, business experts, and government employees; Study 2 with managers with diverse backgrounds from the manufacturer as well as automobile experts; Study 3 with chronic disease experts and statisticians; Study 4 with transportation and mechanical experts; and Study 5 with IT, telecommunications, and business experts. We believe the art of service design is to integrate the expertise of different professionals into a set of knowledge for the service in question and to sublimate the expertise into innovative service concepts. As discussed in Sect. 5.1, the proposed MFSD method is useful as a guide for the entire team to work effectively and efficiently, and the identified factors of service to be designed are useful for connecting insights from different professionals.

6 Concluding remarks

Analysis and design of a service should involve an examination of its multiple factors, such as target customers, service delivery method, and partnership. The consideration of the multi-factor nature of service is particularly essential in the design of modern complex service systems. This paper extends the service design literature by providing specific knowledge to systematically consider the multi-factor nature of service in service design. The proposed MFSD method suggests focusing on the multiple factors of customer value creation, design space, and representation in service design. The holistic and integrative consideration of multiple factors of the service in question enables a systematic service design process that produces rich and structured design outcomes. The multi-factor nature of service has been frequently but implicitly discussed in the service literature. However, it has not been considered in the current service design methodology explicitly despite its utility in addressing the complexity of service design. The academic contribution of this paper is to connect literature related to the multi-factor nature of service and service design and to propose a new relevant service design method. The five case studies demonstrate the practical utility of the proposed MFSD method. Although this paper focuses on the service design context, the multi-factor nature of service should be investigated in more contexts such as service evaluation and strategy development.

Future research could address several issues to enhance the application of the MFSD method. First, a methodology to identify the key factors of the specific service in question is necessary. The identification task involves considerable research and is time-consuming. A scientific methodology to alleviate the load would be useful to practitioners. For example, as shown by Lim and Maglio (2018), a text mining approach would contribute to easing the task of collecting and analyzing keywords related to the service in question to classify them into several terms that represent the key factors of service. Second, key factors of emerging types of service should be investigated. The design targets of all the five case studies in this paper can be classified as data-based service, in which the use of (big) data

contributes significantly to value creation for customers. The five studies during the period from 2011 to 2014 were challenging because this new type of service was not well known at the period. Through the five studies on designing data-based services with industry and government, we found that identifying the key factors that describe the value creation of data-based service in question is useful in the analysis and design of the service (Lim et al. 2018b). Generic factors of data-based services can be useful to apply the MFSD method to analyze and design such services in the future. Finally, implementing the MFSD method using a user-friendly software system can be helpful for practitioners. For example, a software system to visualize the multi-factor design space of service and combine the design options would be very useful in service design projects.

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Appendix

The proposed MFSD has been used in other case studies as well. Study 3 designed a hypertension patient management service with a government organization. The government was alarmed with the costs associated with hypertension treatment and wanted to provide data-based hypertension management services to citizens using data from the public health insurance system introduced in Sect. 4.1. A data-based hypertension management service is a new type of ICT-based healthcare service. Thus, we attempted to exploit useful information of existing cases of ICT-based healthcare service to design this service. We collected 46 cases of ICT-based healthcare services, including health-related information provision (e.g., health news), self-healthcare (e.g., medication support application), professional healthcare (e.g., remote medical diagnosis), and genetic data analysis (e.g., ancestry analysis) services. Then, we identified four key factors of such services, namely, target customer, service content, service channel, and service algorithm. The four factors were used to generate and organize varied service ideas for hypertension management and used to represent the design space for service concept design.

Study 4 designed a driving safety enhancement service with a government transportation safety institute. The institute is in charge of ensuring the driving

safety of commercial vehicle drivers (i.e., bus, taxi, and truck drivers), and collects vehicle operations data from vehicles using digital tachograph (DTG) devices. The institute wanted to develop data-based services to manage the drivers and transportation companies in terms of driving safety (Kim et al. 2018). The service design process in Study 4 is very similar with that in Study 2. We first analyzed the data, including DTG (e.g., velocity, GPS, brake on/off, and RPM), driver (e.g., driver name, driving date, and car plate number), and accident (e.g., accident type, time, and place) data. Based on the results of the data analysis, literature review on safe driving, and investigation of relevant service cases, we identified four key factors of driving safety enhancement service, namely, target customer, service content, timing of service, and service channel. Similar to the other studies, the four factors were used to organize generated service ideas into a visual design space for service concept generation.

Study 5 designed a data platform service that facilitates data and information exchange among various players (data provider, administrator, analyst, information deliverer, and consumer) with a telecommunications company. In designing the data platform service concept, we represented the service concept from the perspective of its two factors, namely, value creation network and process. Such representations were useful in identifying the multiple requirements of data platform service across the process, such as the anonymization, quality, and openness of the data to be used in the platform.

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