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Making Data Valuable for Smart City Service Systems - A Citizen Journey Map for Data-driven Service Design

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Abstract. Due to the digital transformation of smart cities (SCs), improved access to digital technologies can enable gathering and utilization of data which can serve as key resources for services to improve citizens' quality of life. SCs face challenges making data valuable for the design of such data-driven services. Service literature lacks in providing methods to facilitate the design of these services while addressing the requirements of SCs as smart service systems. This paper presents the Data-driven Citizen Journey Map (DCJM), a method which supports designing data-driven services in collaborative Design Thinking (DT) workshops. Following design science research (DSR), we developed and evaluated our method through five iterations of workshops, interviews, and questionnaires with SC experts and students. Our evaluations indicate that the DCJM, including all promoted constructs, is useful to support data-driven service design in SCs and that it can be combined with existing methods in comprehensive service development processes.

Keywords: Smart City, Data-driven Services, Customer Journey

1 Introduction

Innovative and affordable technologies enable cities to produce and analyze unprecedented amounts of data through various sources, such as smartphones, sensors, and commercial transactions [1]. These data can be used to gain new insights and to enhance innovation by developing data-driven services that can improve the citizens' quality of life and thus contribute to achieve SCs' overall goal [2, 3]. Data-driven services can be defined as services in which value is created through data as a key and necessary resource [4]. Being considered as smart service systems, SCs are focused on the continuous co-creation of data-based value between citizens and a city, with services as the central elements of interaction [5, 6]. Thus, SCs can gain significant value by leveraging service innovation through the development of data-driven services. In this context, the multitude of actors involved in SCs [2, 7] provide various physical and digital touchpoints at which interactions with citizens can take place to

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create and deliver value based on data [8, 9]. Integrating these touchpoints at different service levels to bring together resources, such as data, can lead to a holistic perspective of city services towards a superior citizen experience [10, 11]. The creation of such a holistic experience can enhance citizen-oriented value creation in cities [11].

However, literature recognizes that SCs experience issues in deriving value from data to design data-driven services [12]. Fundamentally, cities may fail to recognize the benefits of data to improve citizens' quality of life [1, 13]. Furthermore, SCs struggle to understand citizens' needs, which is required to transform data into valuable information and services [12]. Researchers have also identified a general lack of cross-sectoral cooperation in the use of technologies [3]. In particular, much of the data in SCs is being produced by commercial companies which, despite some progress, often remain reluctant to share this data due to its high value [13]. Finally, a large part of the information gained from data often remains unused for value creation in SC projects, as SCs are lacking in designing services that efficiently deliver this information to citizens [12]. These challenges could hinder SCs' innovation potential and call for support for the idea creation in data-driven service design.

Little research has provided methods to support collaboration on data-driven service design for service systems, such as SCs. For this purpose, service design methods are considered useful [12]. However, literature lacks in providing collaborative methods that sufficiently address the described challenges to leverage the innovation potential of SCs. Meanwhile, literature provides methods which support the design of services from a service system perspective, these methods do not integrate data as a key resource for value creation [11, 14, 15]. There are some methods available for designing data-driven services [16–18], but they do not sufficiently provide a holistic citizen experience perspective to enhance value co-creation with and for citizens by encouraging the multitude of actors to bring together and use data at different touchpoints and service levels. Thus, smart cities require new methods that incorporate a service system perspective to address SC-specific conditions for data-driven service design. In consequence, this paper aims to answer the following research question:

RQ: *How can SC service systems be supported in designing data-driven services with a useful collaborative method?*

To answer this question, we provide a collaborative method which facilitates the idea creation and supports the design of data-driven services in SCs – the DCJM. As a setting in which our method could be used, we suggest collaborative DT workshops. DT provides principles and processes for creating customer experience-based services in multidisciplinary teams [11, 19, 20]. Our contribution supports SC practitioners in designing data-driven services by proposing a relevant method and combining it with guidelines to use it during the service creation process. Adding on this, we argue that the DCJM can be used in service systems in general, thus contributing to service design research in the contexts of both SCs and service systems.

The following section provides an overview of current research on SC service systems and data-driven services. In section 3, we present our research design. We follow the DSR process provided by Peffers et al. [21] to develop and evaluate our method, as DSR offers a commonly accepted iterative methodology for design-oriented research goals to solve organizational problems. We therefore conduct two evaluation cycles

with five iterative workshops with SC experts and students. In section 4, we derive design requirements for the DCJM and present its underlying ontology as well as its visual representation. Finally, we discuss our evaluation results, our work's implications and limitations and provide an outlook for future research.

2 Related Literature

2.1 Service Systems and Data-driven Services

From the perspective of service science, a service is a set of different activities, as applications of specialized competences, such as knowledge and skills, in a business and formed as a process between the different entities with the aim to support customers' everyday practice [22]. In contrast to traditional product-centered views, the service-dominant logic shifts the perspective from producing and distributing tangible goods to co-creating value with and for customers through services [22]. Thus, service research investigates complex interrelated systems in which services are the fundamental basis of exchange [23]. These service systems are defined as "complex sociotechnical systems that enable value co-creation" [24], and comprise a configuration of a distinct set of interconnected resources, such as actors, information, technology and other service systems [25]. The actors include those involved in the process of interactive value co-creation with their knowledge and skills [22]. Increasingly, service systems evolve towards smart service systems in which value co-creation through service is based on technological assets and the collection, use and computation of data [23, 26]. In this context, data are recognized as a key resource to create services, and in particular enable new types of services, such as "Data-as-a-Service" and "Analytics-as-a-Service" [27, 28]. However, when comparing traditional services, which also rely on data, with data-driven services, there is no specific threshold for reliance on data to distinguish these service types [4]. Thus, as described above, we define services as data-driven if they rely on data as an essential resource to create value [4], meaning the service cannot be offered without relying on data.

2.2 Smart City Service Systems

In the past fifteen years, SC initiatives have emerged as an evolution of earlier efforts to modernize and digitize public services, and urban planning [29]. Although there is no standard definition of SC, theory and practice reveal at least a common basis: sustainably improving citizens' quality of life by using information and communication technologies [3, 30]. To sufficiently achieve these goals, SC initiatives involve manifold stakeholders with often a high degree of citizen participation and structure value creation into inter-disciplinary SC domains, such as energy, mobility, health, education, etc. [3, 12]. To deal with this complexity, literature suggests a holistic approach to SC management and recently proposes to consider the SC as a service system [6]. In this vision, SCs are focused on the co-creation of value, with services being the central element of interaction in a continuous process of collaboration between citizens as well as public and private organizations [5]. In line with this view

and the central role of data for value creation, we consider SCs as smart service systems which have some key characteristics that need to be considered for service design:

SCs experience a shift in value creation towards providing citizens with smart services [9] and the design of these can be understood from the service-dominant logic's perspective [9, 22]. This also entails that citizens are given a central role in value creation and a community's progress [5, 31]. While we sometimes use the terms citizen and customer interchangeably, it is important in the SC context to note that citizens "have all the rights of customers receiving services along with additional rights of access" to information and participation in service design [32, p.50]. In the special context of SCs, one aspect of improving citizens' quality of life is to consider the public value of services, including not only its monetary value, but also its value regarding civic and democratic principles, such as equity, liberty, and participation [33]. This underlines a holistic view of SCs and service systems towards the democratization of all actors' resources for value co-creation and pursuing common goals [5]. Another key characteristic of SCs include the increasing role of digital and connected technology, which serves as an operant resource to support innovation activities in ecosystems composed of manifold stakeholders [1, 2, 34]. In this context, cities are increasingly becoming instrumented through the usage of data from various sensors and (mobile) devices [13] to uncover hidden patterns and new insights and thus to develop valuable services [2, 9]. In SC service systems, a variety of actors can be involved in value creation activities providing different data, skills and knowledge about the citizens' needs which can be integrated to stimulate service innovation [2, 3, 9]. This is further supported by the integration of the different actors' multiple touchpoints. Touchpoints are moments or instances of contact [35] related to a service [36]. They provide the link between a customer and a service provider in the creation and delivery of services [9]. Research has recognized the service innovation potential of touchpoints [8]. In SCs, the multitude of interconnected touchpoints supports the transformation from single service encounters to the creation of a holistic citizen experience in the city [10, 26]. Citizen experience can be viewed as internal and subjective responses to any contact with SC actors, which can create value for the citizen [36].

In recent years, novel methods have emerged which support service design from a service system perspective [11]. For example, the customer journey map involves the customer at the heart through the concept of customer experience, and supports co-creation by considering how a customer experiences services through different touchpoints [37–39]. As an approach towards supporting service design in SCs, existing methods propose stages and related tasks for improving existing or designing new citizen-centric services [14, 40]. However, these methods have not yet been revised by considering data as the key resource to be transferred into value. Emerging literature builds understanding for the value-chain of data-based value creation and calls on research to develop related service design approaches [41]. Existing examples for such approaches include a method for developing data-driven services as a canvas-based documentation of the overall design process [18]. In further studies, methods for developing key activities and describing key elements of data-driven business models [16, 17] were proposed. Meanwhile, these methods promote a customer focus, they do not incorporate the described SC characteristics and the goal to create a superior

customer experience, going beyond the view of single services and linking data-based values for customers. Thus, we present a method which facilitates diverse actors of a network to bring together their data and service contributions at different touchpoints to jointly design data-driven services towards a holistic citizen experience.

2.3 Design Thinking

DT was introduced as an approach to develop problem-solving innovations with an orientation toward the customers, in order to answer the key question of how customers' needs could be identified and implemented in customer-centric solutions [19, 20]. This thinking has developed into a methodology that organizations use to enhance their service design activities [42]. DT can contribute to collaborative SC service design by building upon common values and thus balancing the actor's needs and interests [43].

Schallmo et al. [20] provide DT principles that could be applied when using our method. These principles include 1) humans and their needs as a central source of inspiration for new ideas; 2) using multidisciplinary teams; 3) providing an iterative process characterized by divergent and convergent thinking; and 4) providing a creative and idea-promoting environment. Extant literature also provides different process models for realizing DT, which order design activities into a sequence of iterative phases and activities. We follow Brown's [19] work, which presents a prescriptive model with concrete guiding actions for each phase of the DT process, because it provides an intuitive workflow to apply DT principles without the need for users to have them already internalized [44]. It combines hybrid characteristics of a flexible, iterative DT approach with a sequential, process-type depiction. Brown [19] proposes a process consisting of three phases, 1) inspiration, 2) ideation, 3) implementation. In the inspiration step, a problem or opportunity is identified that motivates and frames the search for solutions including customers and their environments [19]. The ideation phase includes the process of generating, developing and testing ideas for solutions [19]. In order to stimulate customer-oriented ideas and to keep ideas alive, customers are placed in the center of the thought process by describing their journey. The last step characterizes the implementation by elaborating a path to market [19].

3 Research Design

Our research design is based on design science research (DSR), as a suitable research approach to create meaningful and practitioner-oriented artifacts [45], including methods as "a set of steps […] used to perform a task" [46, p.257]. A set of principles, procedures, and guidelines allows DSR to support the design, development, and evaluation of artifacts that fulfill human needs [21, 46] and ensures addressing an organizational problem while integrating the current theoretical body of knowledge [45]. With the goal to build and evaluate an efficient method for designing data-driven services, we chose DSR because of the following reasons in line with Hevner et al. [45]: First, DSR is building on a problem-based view and we identify the problem of designing data-driven services in SCs. Second, DSR is an iterative method and we

improved our methods with distinct iterative evaluations. Third, DSR has a design-oriented approach which fits to our research goal to design a new method for data-driven service design in the context of SC service systems. Our research process is based on Peffers et al.'s [21] commonly applied DSR methodology, which is suitable for the design of artifacts, and includes six steps:

(1) Initially, we identified the research problem and its importance, described in the introduction and theoretical foundations. (2) Secondly, we defined the need for related supportive methods and determined this research's objective as developing a collaborative method to facilitate ideation and support the design of data-driven services in SCs. As a boundary objective, this method should be suitable to be used in DT workshops and therefore positioned within the DT concept, since DT serves as an appropriate foundation to contribute to SC service design (see section 2.3). (3) Thirdly, we designed the DCJM. For this purpose, we derived design requirements from literature to ensure that our method addresses the described challenges of SCs in designing data-driven services (see section 4). (4) In step four, we tested the DCJM within the group of four researchers to challenge and improve our method. We presented the method to colleagues and discussed its applicability which helped us with our further development. (5) In step five, we evaluated our method in two iterative cycles, conducting workshops with varying SC experts, as depicted in table 1. The workshops and evaluations were designed differently according to the respective evaluation goals. The goal of the first cycle was to assess the DCJM's usefulness to give SC actors an orientation in collaboratively creating service ideas and designing data-driven services. Further evaluation goals included the suitability of the DCJM for being used within DT processes, its applicability for SC actors and its user-friendliness. For the first cycle, we conducted two workshops that had to take place virtually due to COVID-19. After an introduction to the research topic and the developed method, we presented the DT principles and process as guidelines to be applied when using our method. Afterwards, the participants were split into two independent groups and were asked to collaboratively test the method. To evaluate the suitability of the DCJM to be integrated into a real-world DT process, which enables iterations that allow service ideas to be refined by looping back through different DT steps and methods (Brown, 2008), we asked the participants to link the DCJM with another method to further describe their service ideas in a next step – the Data Insight Generator (DIG). The DIG has been presented in literature and evaluated in the SC context to support the linkage of value propositions and data as key resources, e.g. by describing how data can be combined and analyzed to be transferred into the pursued value proposition [47]. According to the DT approach, the DCJM can be used to create service ideas in a divergent thought process. The DIG facilitates convergent thinking by selecting one data-driven service idea and examining the service's technical details in more depth. To get valuable insights about the DCJM's general usefulness and applicability for SCs, we invited participants with different backgrounds and levels of practical and theoretical knowledge in the context of SCs. The authors acted as passive observers during the workshops to evaluate the method's user-friendliness and intuitiveness. To provide the participants with input for using the method and to obtain comparable results, we introduced a fictional persona to all participants. We video-recorded the

workshops, took notes, and, in a final group discussion at the end of each workshop, asked for detailed feedback. All the recordings were reviewed, and feedbacks transcribed to identify opportunities to improve the method. We paraphrased and generalized our notes and observations, using the guidelines of structured content analysis [48]. Furthermore, all the participants completed a questionnaire after the workshops. The questions addressed quality criteria which were used to quantitatively evaluate our method according to the evaluation goals. The combination of these data gathering techniques allowed us to conduct a reasonable evaluation. Then, our method was iteratively adjusted based on the evaluation's result after each workshop.

	Number of participants	Participants' background
Cycle 1	6	Heads and employees of a European energy company with years of experience in developing SC solutions
	6	Master students in the fields of information systems and social science with theoretical SC knowledge
Cycle 2	12	Executive directors, managers and experts of municipal housing, utility, mobility and disposal companies, involved in a SC initiative in a medium-sized German city
	9	
	8	

Table 1. Workshop participants

After refining our method, we conducted another evaluation cycle to assess the DCJM's suitability in real SC project scenarios [21]. Therefore, we tested the DCJM in three practice-oriented SC workshops taking place in July 2020 in a medium-sized SC in Germany. In comparison to our first cycle, the workshops' primary goal was to develop real-world digital services for defined cross-sectoral fields of action within the SC initiative, such as mobility and logistics, and social participation. The authors worked as moderators and SC experts within the groups. As this workshop took place physically, the participants were asked to use sticky notes on large, printed versions of the DCJM. Data was collected through the authors' observations of the participants using the DCJM and a final written feedback round, from which the data was processed in the same ways as in the first evaluation cycle. (6) In step six, communication of the method is targeted through the publication of this paper.

4 Data-driven Citizen Journey Map

To structure the development process of the DCJM, we used the design principles provided by Avdiji et al. [49] for methods created to collectively solve complex principles: (1) Framing the problem by developing an ontology describing its main components and their relationships; (2) deriving a concept map from the ontology to serve as a visual representation of an empty problem space; (3) instantiating the visualization to use it as a shared problem space in which solutions can be collectively prototyped by using sticky notes [49]. We also derived content-related requirements for the DCJM to support the design of data-driven services. We therefore built on the design requirements for data-driven innovation problems [18]. As these requirements were not specifically provided for the conditions of SC service systems, we

complemented them with requirements that address the characteristics of SCs described in subsection 2.2. These requirements have been derived based on five considerations to be realized to address the challenges of SCs in making value out of data [12]. In total, we applied the following requirements for designing the DCJM: (1) Applying a service-oriented perspective with the value of the citizen at the center of the innovation process [12, 18]; (2) Taking into account the citizen experience in using data and delivering information through services [12]; (3) Applying a data-oriented perspective on service design using data in each design step [12, 18]; (4) Enabling service design in cross-functional teams and create synergies between stakeholders [12].

We follow a service-oriented perspective by setting citizens at the center of data-driven service design, thus aligning the actors' goals, allowing SCs to uncover citizens' needs and supporting an efficient identification of useful data which are beneficial to create value [12]. A citizen experience-based view on service design can visualize the multitude of potential touchpoints with citizens, where data can be collected, and services can be delivered. Such a view underlines the potential benefits of sharing data and supports cooperation among different actors to achieve service innovation and a holistic citizen experience. Seeing data as the core of service design further uncovers the benefits of using and sharing data across domains to increase service innovation.

Collaboration methods aimed at solving data problems need to reuse familiar visual elements to let users communicate the examined issues easily [18]. Since our goal is to develop a method that contributes to improving the overall citizen experience, the DCJM is based on the customer journey map which is one of the most widely adapted visual methods for service design and linked to the concept of customer experience [38, 39]. It is related to the DT concept [11] and used in various research fields, such as service management, service science [8, 35], and marketing [50]. The customer journey map can be conceptualized as "the process of experiencing service through different touchpoints from the customer point of view" [37, p. 221]. This view reflects the strong citizen-orientation and different interaction points between citizens and the various actors involved in the service process in SCs [31]. The customer journey map serves as an abstract, flow-type visual representation of the sequence of events and touchpoints through which customers might interact with an organization during a service process [51]. This visualization facilitates an understanding of customers' unmet needs and finding ideas to improve the customer experience [52]. While customer journey maps are used to analyze already existing services to identify potentials for improvement [53], we expand this view and provide a method which supports the ideation for both improvements of existing and new data-driven services in SC service systems. Figure 1 shows the developed ontology as the DCJM's basis.

The ontology's goal is to provide a shared understanding of the considered problem by depicting the key concepts and their relationships in the citizen journey [49, 54, 55]. It follows the structure of the addressed DT process stages inspiration and ideation [18]. Citizen Insights, as the result of direct citizen participation or research-based archetypical personas of a targeted group of citizens [56], serve as input to explore the citizen's problems and needs at the inspiration stage. The Timeline adds a temporal structure to the course of the Journey which can be divided into subsequent periods, such as daytimes [55] or the typical pre-purchase, purchase and post-purchase stages of

a customer journey in a buying process [50]. For each period, the citizens' Actions related to the city are the entry point to the journey. Based on these Actions, their Pains and their Wishes and Expectations, which serve as a basis for understanding their needs, can be identified. Value Propositions are derived in the ideation phase to solve citizens' Pains and address their Wishes and Expectations. These Value Propositions represent the citizens' benefits through the delivery of concrete Service Solutions. The citizens and the city interact with one another via City Touchpoints. Not only do they enable Data Ideas, which can be used to provide Value Propositions, but they also represent interaction points, serving as potential sources of Pains and Wishes and Expectations.

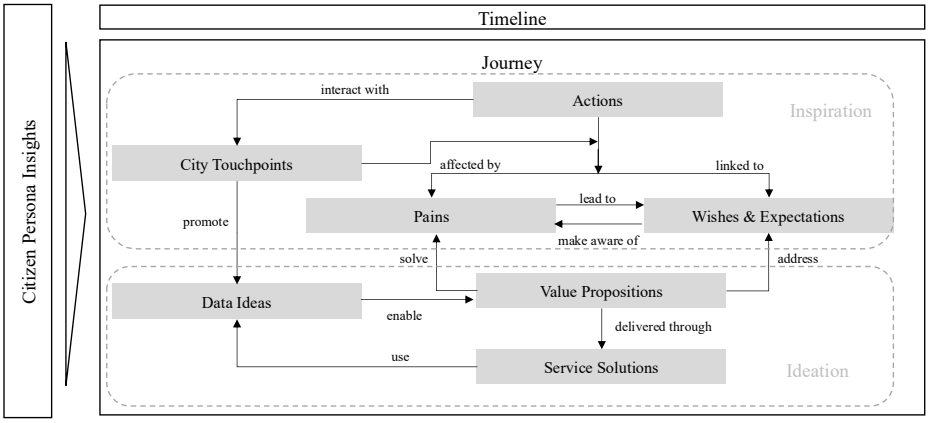

Figure 1. Ontology for the DCJM

The developed ontology is represented in a shared visualization, the DCJM (Figure 2), to ensure that all the participants collaborate on the same problem [49]. The DCJM's horizontal axis depicts a timeline to model the citizen's experience over time [15, 51, 56]. It is modelled by distinct variables from the set of subsequent timeslots [t_1, t_n]. Thus, different temporal scales can be implemented, depending on the considered experience's scope, e.g. covering a day in the citizen's life or a specific service journey [56]. The vertical axis depicts what is happening at each stage [15]. Consequently, the DCJM includes the dimension Citizens' Actions as a starting point to describe what citizens are doing at each stage [15]. These Actions can be accompanied by City Touchpoints through which citizens can receive value from a service or contribute to creating a service by interacting with the city [9], which can result in producing data. City Touchpoints can include ways of communication and ways to deliver services between a city and its citizens [9], e.g. via face-to-face interaction, websites and apps [53, 56]. When users fill out the Pains dimension, they document citizens' problems [57] related to their Actions, as well as to existing and potential City Touchpoints. Wishes and Expectations could include both expected benefits and unexpected gains which the citizens are not aware of while conducting the Actions [57]. Data Ideas describe data that can be used to create a service to address citizens' identified needs. These ideas can include existing data and additional data that could be collected [18].

Value Propositions describe the benefits that can be created for citizens by addressing their specific needs [9]. This dimension represents the result of a thought process on how to match and process the identified Data Ideas in order to gain new information to provide citizens with added value [18, 41, 47]. Service Solutions describe ideas for services which can be offered to deliver the identified value propositions [57].

	t_1	$t_{...}$	t_n
Citizen's Actions What are the citizen's actions in relation to the city during the day?			
City Touchpoints At which touchpoints can the citizen interact with the city to create or receive services?			
Pains What problems does the citizen face?			
Wishes & Expectations What wishes and expectations does the citizen have when carrying out his actions?			
Data Ideas What data could be used to address the wishes and expectations of the citizen?			
Value Propositions What value propositions could be provided for the citizen?			
Service Solutions What services could be offered to deliver the value propositions?			

Figure 2. DCJM

We adapt Schallmo et al.'s [20] DT principles, by providing a collaborative method which facilitates a citizen-centric ideation and service design among multiple SC actors with different expertise, which can be used in creative workshop settings [20]. Based on Brown's [19] DT process, the DCJM supports working collectively on the activities of the inspiration phase (problem identification) and the ideation phase's first iterations (idea generation) [19]. Divergent thinking is enhanced in the first phase of collecting a broad set of citizens' problems and wishes [18]. The latter are channeled into a convergent thought process to derive ideas for concrete value propositions [18]. The next step opens a divergent collection of service ideas, since various service solutions can provide a value proposition [57]. Service ideas can be chosen in a convergent way to be prototyped and tested in the next steps of service design. Thus, the DCJM enables to identify and refine service ideas by iteratively working through its dimensions. Further, it can be combined with other suitable service design methods to prototype, test and further develop services by looping back through the DT steps [19].

5 Evaluation

For the first evaluation cycle, all questions in the questionnaire were designed to gain quantitative answers on a 5-point Likert-scale, ranging from strongly agree (1) to strongly disagree (5), as well as qualitative answers through open textboxes for further explanations. Our questionnaire included qualitative criteria according to the evaluation goals described in section three [45]. Achieving scores of $\leq 2{,}00$ across all criteria in the survey results, we conclude that the DCJM sufficiently contributes to achieve our solution objective. The participants agreed on the DCJM's user-friendliness (2.00) as

well as its applicability and usefulness for the problem space. Explicitly, the method offered a targeted orientation for idea creation and service design based on data (1.43) and was suitable for the SC context (1.50). The method was applicable for different SC actors (1.25) and suitable for working in teams (1.13). The participants further confirmed that the DCJM could be satisfactorily combined with the DIG (1.25) and were satisfied with the workshop's methodical approach (1.63). Thus, we also consider our method's boundary objective, to be suitable for DT workshops, fulfilled and feel confirmed that DT workshops provide a suitable application area for designing services using the DCJM. Our observations and the participants' feedback underline our approach's strengths. The participants provided positive feedback on the usefulness of the DCJM and its suitability for the related DT stages, namely identifying and describing service ideas in iterative steps, based on the transformation of data into value from a citizen experience perspective.

Besides these results, we derived opportunities for improving our method from the qualitative evaluations and classified them according to the usability problem types proposed by van den Haak et al. [38]: (1) layout, which facilitate participants to find particular elements in the methods; (2) terminology, which ensure the participants' correct understanding and use of terms; (3) data entry, which address that participants know where to insert data in the methods; (4) comprehensiveness, which ensure that information relevant for using the methods is provided. For a clearer understanding of the type of information requested in the Value Proposition and Service Solution blocks, the guiding questions were made shorter and more precise to achieve terminology improvements. Participants also perceived redundancies between Value Propositions and Wishes and Expectations. Yet, research indicates that differentiating between these dimensions is reasonable, because there might be differences between citizens' perceived wishes and value propositions that could also address unexpected benefits and user needs [58]. Further, the definition of the City Touchpoints field was adjusted, which was initially divided into touchpoints at already existing services and potentially new services [9]. We observed that the discussions about the existence of touchpoints inhibited the groups' creativity. We also observed some participants having an unstructured brainstorming on value propositions even before problems were identified, which was also triggered by the participants' considerations of potentially new touchpoints. Consequently, as the participants listed potential value propositions in the City Touchpoints blocks, some were unsure about which information to put in the Value Propositions blocks. Thus, we also implemented a data entry improvement by adjusting the dimension City Touchpoints to enhance creativity and a more structured use. In addition, we observed that using sticky notes (or digital markings) of one color for information on the same problem space would be helpful, as the amount of information and ideas filled out in the blocks of the same column increases. We have integrated the described findings into our method, as shown in Figure 2.

After iteratively revising our method, the DCJM was validated in three further workshops in real SC projects. The workshop outputs resulted in concrete service ideas, which are being implemented within the initiative. The participants assessed the method as "comprehensible", "flexible" and "effective". This allowed us to verify the DCJM in terms of its usefulness to design data-driven services in practice.

6 Discussion and Conclusion

The increasing amount of data in SC service systems can be used to enhance innovation by developing data-driven services to improve citizens' quality of life. Due to the lack of research to provide methods which sufficiently address SCs' problems to make data valuable for such services, we applied DSR to design and evaluate the DCJM as a method which supports SC actors to collaborate on the idea creation and design of data-driven services. It can be used in DT workshops to facilitate ideation and can be combined with related methods to further prototype and test the identified service ideas in comprehensive service design processes. Our evaluations were based on five iterative workshops with SC experts and students and data from observations, interviews, and questionnaires. The results indicate that the DCJM is useful to support data-driven service design in real-world SC projects and suitable for DT workshops.

Our work makes the following research contributions: (1) We present a method which supports the design of data-driven services in SCs by considering key characteristics of SCs viewed as smart service systems. In this way, we address the research gap in providing a method that solves SCs' problems in making data valuable for citizens. As the DCJM was designed to address the requirements of SCs considered as smart service systems, we argue that our method is not limited to the application field of SCs and that it can be used in smart service systems in general. (2) We deepen knowledge on data-driven service design in SCs, deriving requirements for service design methods from a service system perspective. Since the research field on data-driven service design is relatively new and solutions for the issues of developing such services in SCs are not well understood yet [12], we promote the role of certain constructs and their relationships, such as the special role of city touchpoints and data ideas.

Despite the practical implication of providing SC actors a method for data-driven service design, our work serves as a basis for the development of further methods to support data-driven service design to create a holistic citizen experience in SCs and smart service systems. Our work is focused on the creation and specification of ideas for data-driven services which can serve as an input to further DT activities, such as prototyping and testing, towards market-ready services [19].

Limitations from a conceptual point of view include, that the underlying DT process could increase the risk of misunderstandings, as its sequential characteristics stands in contrast to the nature of DT emphasizing non-standardized problem-related learning and adaption [44]. However, we observed the used model to be helpful because it provides guidelines and structure to practitioners on the application of DT principles.

Considering future research, our method needs validation in other service systems. In addition, the DCJM was tested using archetypical citizen profiles as input to citizens' needs, which is subject to the limiting assumption that considered touchpoints impact the experience of citizens within one target group in the same way [11]. In contrast, the variety of potential touchpoints between the city and its citizens offers opportunities to develop individualized services based on the use of situational, contextual and behavioral data about citizens. Future research should apply the method integrating direct citizen participation and examine the DCJM and other approaches for SC services according to their potential to create personalized experiences.

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