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Customer Experience Design for Smart Product-Service Systems Based on the Iterations of Experience–Evaluate–Engage Using Customer Experience Data

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Abstract: Data about customer experiences are important in smart product-service systems. It is desired to establish a framework for customer experience data so that smart customer experiences can be designed based on customer data. Particularly such a framework should support determining what kinds of customer data are needed and how these data are effectively acquired. This paper presents such a framework where rich and structured customer experience data can be defined and customer experience evaluation data are obtained in real time together with context data. Some representative service units for smart experience design using customer experience data are also presented. Two illustrative cases are provided to demonstrate the validity of the framework of customer experience data. The validity of the framework is discussed considering both the consistency and flexibility of the framework demonstrated by the cases.

Keywords: product-service systems; smart experience design; data-driven design; customer experience data; zero-party data

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1. Introduction

A Product-Service System (PSS) is a system of products, services, supporting networks and infrastructure that is designed to satisfy customer needs and generate values [1–4]. Ecological values have been addressed in many PSS development efforts [5,6]. Efforts are being made to accommodate experience issues as primary design goals in PSS design by reflecting characteristics of customer experiences in human-centered design approaches [7–9]. Customization and personalization issues are also addressed [10–12]. Digitalization supports servitization. Specific digital capabilities relevant to servitization functions include user and product identification, condition monitoring and usage monitoring [13]. *Smart* PSS, which are characterized by context-awareness and specificity, strong human centration, reconfigurable product and service elements and co-creative value provision of ecosystem stakeholders, is receiving a lot of attention in PSS research [7,14–16].

Along with digitalization in servitization, the paradigm of data-driven design is emerging rapidly [17]. A conceptual framework of the data-driven design was proposed addressing the activities of the actors, including designers, producers and users, customers and stakeholders, on the artefacts, including products, services and business models. By adding data classified broadly as demand-side data and supply-side data progressively, the proposed framework of data-driven design [17] addresses the expanded activities of actors, with the addition of data analysts who interact with designers and producers by interpreting data generated by artefacts and processed with data analytics tools. Design methods are also added so that multiple versions of artefacts are effectively designed exploiting data. Most active research and industry efforts in current data-driven design are properly addressed by the framework. For data-driven smart PSS, additional types of data such as user-generated content and internet information data can be used beyond artefact-generated data [18]. Online content posted by users on social media and forums are specifically referred to as user-generated contents in [18].

While the literature on data-driven design deals with artefact-generated data mainly, data generated by users and customers are increasing in the era of digital transformation. The digital revolution is changing customer behaviors. Customers can communicate easily with other consumers and with product/service providers [19]. More and more customers are willing to make their own participation and involvement to get better benefits [20]. Particularly, data about customer experiences would contribute in designing smart PSS where the experiences of users and customers are getting critical. Customer experiences are evolutionary and dynamic [21]. The customer experience process is iterative and customer participation is critical in customer experience [22,23] along the customer journey composed of discovery, exploration, purchase, use, asking, and engagement.

Thus customer experience data would be critical in PSS. The service aspects tightly integrated with the experiences of diverse actors would become key value drivers in smart PSS. As customer experiences evolve with previous experiences and their reflections, experience evaluation and management in digital forms together with the use data generated by artefacts would play critical roles in digital transformation. That is, customer experiences evolve as customers iteratively *experience*, *evaluate* their experiences and *engage* with others and themselves. Integrated customer experience design of customer-led *experience–evaluate–engage* iterations, which is to be referred to as *3E iterations*, should now be emphasized in designing smart PSS. Note that design thinking is explained using the framework of visual thinking [24] composed of interactive iterations of *seeing–imagining–drawing* [25]. As interactive iterations of *seeing–imagining–drawing* are essential in design thinking, 3E iterations of *experience–evaluate–engage* are important in user experience and play important contribution in designing experiences.

Diverse kinds of customer data are collected to improve customer experiences [26]. First-party data are the information a company collects directly from its customers including their transaction data as well as off-line survey data. User-generated content [18] is included in first-party data. Second-party data are those obtained from first-party data of other companies through collaboration or purchase. Third-party data are those purchased from data companies. Enterprises have been trying to improve customer experiences by collecting these kinds of data, and analyzing and interpreting them. However, many earlier efforts revealed difficulties. Data privacy issues are getting critical and data tracked and collected (with or without the customer's awareness) are sometimes incorrectly interpreted. *Zero-party data*, which a customer intentionally and proactively provides for better benefits, draw a lot of attention lately [27,28]. Instead of inferring what customers want or need from transactional data, companies can ask customers to share their personal data, such as purchase intentions and preferences [29]. Current efforts in acquiring zero-party data include questionnaires, polls and quizzes.

Note that zero-party data are owned by customers as the customer experiences are solely made by customers. More desirable kinds of zero-party data should be acquired reflecting diverse context information. Furthermore, zero-party data should be obtained and accumulated so that sustainable services can be evolutionarily devised. The challenges are now to determine what kinds of zero-party customer data need to be defined and how these are collected. The research question of this paper is thus how to establish a framework for customer experience data so that customer experiences can be designed based on the customer data. Particularly such a framework should support determining what kinds of customer data are needed and how these data are effectively acquired.

This paper presents a framework for customer experience data and a method to design customer experiences for PSS based on zero-party data of customer experience evaluation obtained in real time and accumulated together with context data. In response to the question of what kind of customer zero-party data need to be obtained for customer experience design, the *Context-Based Activity Modeling* (CBAM) method which systematically represents experience activities together with rich and structured context information [30,31] is presented as the schema in defining customer data. The *Context-specific Experience Sampling and Analysis* (CESA) method, where a customer provides subjective evaluations of experi-

ences in real time with context information specifically associated, is then utilized [32–34] in response to the question of how zero-party customer data can be collected. Two illustrative cases of smart PSS design are provided to demonstrate how CBAM and CESA methods address the challenges of what kind of zero-party customer data are needed and of how these are collected as well.

It is anticipated that diverse customer experience design for PSS could be devised utilizing the framework of customer experience data based on CBAM and CESA. Through the customer 3E iterations of *experience–evaluate–engage* where customers subjectively *evaluate* and then *reflect* and *engage* utilizing experience evaluation information, customers create customer experiences with their initiation and control so that personal needs and context varieties are accommodated. The paper is concluded with a discussion of the contributions of the paper for data-driven customer experience design for smart PSS.

2. Methodology

The method of the paper to address the research question is to draw specific methods developed earlier and to demonstrate the validity and reliability [35] with multiple cases where those methods provide the desired abilities in a consistent manner. Based on critical aspects of customer experiences, the experience data are represented using the schema of CBAM, which has been designed to represent stakeholder activities for service design [30,31]. The experience evaluation method of CESA [32] is used to collect customer experience evaluation data together with context data. Note that the CESA method's abilities for real time acquisition of experience evaluation from users and for an association of context data from various artefacts have been registered for US patents [33,34]. Note that the two cases of Shower Equipment Smart PSS and Smart Light Customization PSS serve as illustrative demonstrations of the validity and reliability of the CBAM method and the CESA method as meaningful foundations of a framework for customer experience data while the descriptions of the cases are given briefly in the paper.

3. Framework for Customer Experience Data

3.1. Context-Based Activity Modeling

Customer experiences and experience activities are influenced by contexts. Contexts include physical environment such as place and time as well as actors [36,37]. Contexts are dynamic [22,23]. Rich and structured handling of contexts has been used to model activities in a specific and formal manner in CBAM [30]. CBAM was developed as schema for designing of services in a specific and detailed manner [31] as services are basically activities performed for values for others [38]. In CBAM, an activity is modeled with the activity elements of the *actors*, the *object*, the *tool* and the *action verb* as well as the *context*. The context is then specified with four context elements of the *goal*, the *relevant structure*, the *physical context* and the *psychological context* [30,31].

To help understanding the detail of the CBAM method, the CBAM representation of the activity to take a shower, which is a core activity of the shower equipment PSS case to be given as a case of experience personalization service, is now explained (Figure 1). In this PSS, the capsule shower experiences providing various scents and therapies are addressed reflecting emerging trends related to showering [12]. A consumer (*active actor*) takes (*action verb*) a shower (*object*) using shower equipment (*tool*). The showering activity is detailed with context information. The *goal context* is specified with cleaning and the showering theme of healing. The *relevant structure context* refers to soap, shampoo and particularly in this case the shower capsule used. These relevant structures can be represented in detail including the brand and specific capsule information. The *physical context* includes date, time, location, temperature, humidity and weather information. The *psychological context* includes social context, emotional context, motivational context, etc. In this specific activity of Figure 1, the social context of the private context, the occupant context of alone, and the experience evaluation levels for the experience evaluation criteria, reflecting the showering theme of healing such as tired, relaxed, cozy and vivid, have been included. Overall the

activity is described such that "the active actor does the action on the object (using the tool) under the context composed of the goal, the relevant structure, the physical context and the psychological context". Note that this rich representation of activities plays the role of schema in service design thinking in experience design [31].

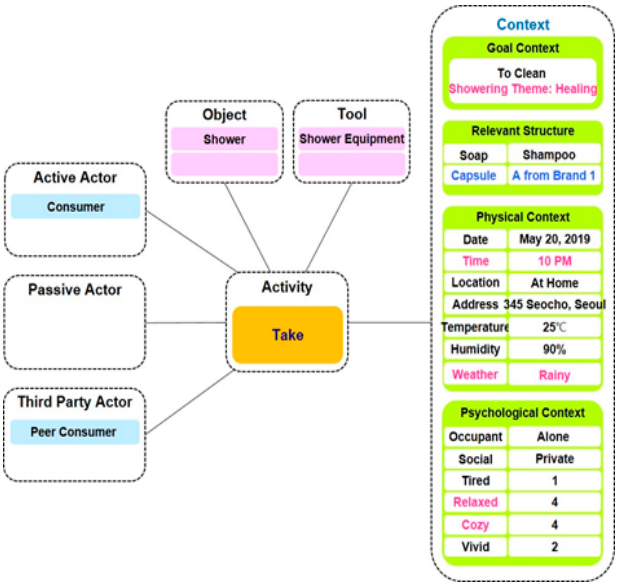

Figure 1. Context-Based Activity Modeling of the Activity *to Take a Shower* [12].

Note that the activity modeling can be handled with a systematic structure as well as rich and easy-to-specify capacity. The CBAM structure is a hierarchical data structure. Actor information can be specified with both static and dynamic characteristics of actors. A very fine level of actor information could be accommodated as in the case of a learner model in intelligent learning support systems if needed. For simplicity, more typical customer characteristics as in most retail marketing could be handled if that level is proper. Note that both the object and the tool would take the form of a product-service system with product elements and service elements. Functions, behaviors and structures can be specified if that much information is desired. The context element composed of goal, relevant structure, and physical and psychological contexts particularly support both richness and structure. Note that each context element can be defined recursively and those can be stored, retrieved and revised flexibly. If needed, customers may be given control in defining and specifying detail levels. In this way, CBAM would properly provide the role of a schema for zero-party customer experience data.

3.2. Context-Specific Experience Sampling and Analysis

To understand the experiences of customers and to evaluate experience services, customer experiences need to be measured. Outcome, moments of truth, and peace of mind can be evaluated using various forms of surveys [39]. Experience measurement methods include questionnaires, interviews, surveys, observation and many others [40]. Experiences are such that they are elucidated as they occur and thus after-the-fact surveys cannot match the real experiences. The experience sampling method of anecdotal self-report [41] has been known as a meaningful method for experience measurement overcoming typical drawbacks of surveys and questionnaires outlined in [29]. General experience sampling suffers from the problem that context information is obtained only by user descriptions without objective methods. The experience sampling method has been improved by systematically associating context information in the CESA method [32]. Using CESA, human subjective experience evaluations are associated with physical context information [42]. Note that customer experiences are evaluated, stored and accumulated in digital forms so that customer experiences can be customized utilizing the experience evaluation data.

The CESA method is composed of the following procedures. A customer journey map is constructed including the use phase as well as pre- and post-use phases. Evaluation keywords of experience value themes [43] are determined along the touchpoints of the journey through empathy with customers. The customer's subjective evaluation of experiences is acquired in real time at critical touchpoints using the corresponding evaluation keywords. Evaluation acquisition can be carried out using the touch screen of smartphones and/or voice interfaces can be used. This procedure is illustrated in Figure 2 with an exemplary journey map composed with 12 touchpoints. Note that 5 touchpoints circled in red, T2, T5, T7, T9, T11 and T12, are critical and corresponding value themes at each of those touchpoints are highlighted in red as shown in the value tree at each touchpoint. A customer can make subjective evaluations of her experiences using those specific and relevant value themes with her smart devices as she goes through her experience journey. For example, a customer can evaluate her experiences in real time as she enjoys her shopping experiences. For whatever reason, she could not make her evaluation if she chose not to, for example at touchpoint 9 as she is the one who leads the experience evaluation process. Note that CESA provides ways for a customer may insert a new value theme if she desires.

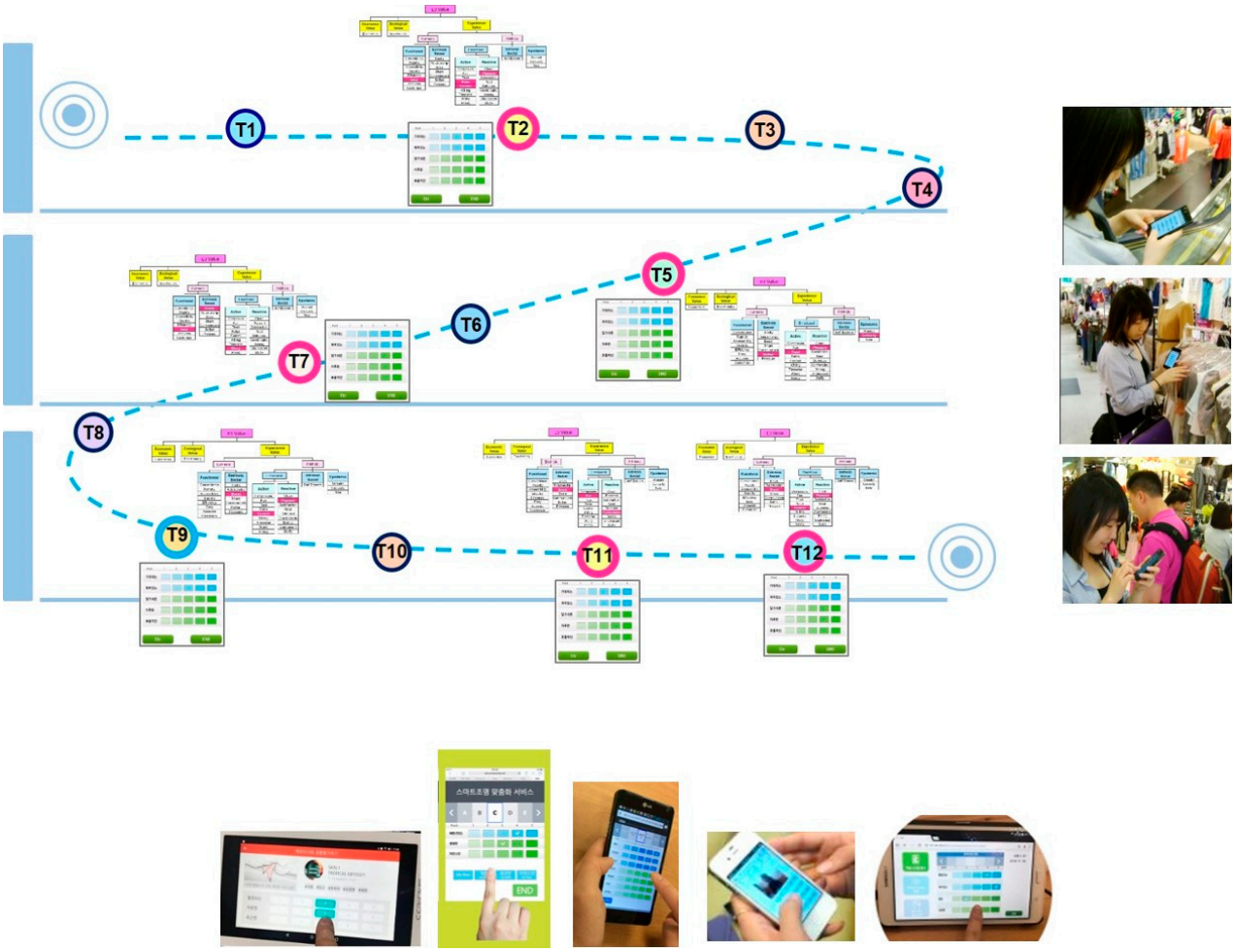

Figure 2. Context-specific Experience Sampling and Analysis.

Synchronized with subjective experience evaluation acquisition, context data are acquired using various record devices including IoT sensors embedded in some product elements and they are associated with real-time evaluation data. Specific context data can be determined based on the context elements of the CBAM method. For example, in the case of Figure 1, the goal context information can be input from the user and the capsule information of the relevant structure context can be automatically acquired through

a sensor as the user inserts the capsule. The physical context such as time and temperature can also be acquired automatically through associated smart devices at the very moment of customer experience evaluation during capsule showering. The emotional context of the psychological context is acquired as the user subjectively evaluates her experience based on the evaluation keywords corresponding to the shower theme.

While the term zero-party data has been coined very recently [27], self-report experience evaluation information as used in CESA is in fact a specific kind of zero-party customer data and it has been used for a while. The CESA method is a structured method of zero-party customer data acquisition of customer experience together with rich and specific context data. Note that CESA does not suffer from data privacy issues as data is collected through user-initiated experience evaluation only. Customers can control the evaluation level of detail, for example, the frequency of evaluation with customer-controlled specifications of evaluation settings.

4. Experience Design Based on Customer Experience Data

4.1. Service Concepts for Experience–Evaluate–Engage

Customer experiences evolve with previous experiences and their reflections. Customer experiences evolve as a customer *experiences*, *evaluates* her experiences and *reflects* herself and/or *engages* with others iteratively. Customer experience design of customer-led *experience–evaluate–engage* iterations based on experience evaluation data constitutes the foundation of designing smart PSS. In this section, some representative service units for experience design in smart PSS are presented.

4.1.1. Real-Time Experience Evaluation Service Unit

A service unit for experience evaluation needs to be designed. It is critical that experience evaluations are conducted in real time as a customer use product elements and/or service elements of a PSS without hampering her experiences. The experience evaluation not only improves customer experiences enabling the *experience–evaluate–engage* iterations, but acquires critical customer experience data. Experience evaluation information is essential in understanding customer experiences. It can also drive the customization of various functions of a PSS for smart solutions. This unit would include customer specification functions so that how often and when evaluations are to be made can be determined by customers with their initiation.

4.1.2. Association of Experience Data and Context Data

A service unit to associate experience evaluation data and context data should be devised. This unit utilizes the framework of the customer data scheme of CBAM. Diverse data obtained from various artefacts are available. However, identifying critical data for customer experience improvement is a big challenge in the data-driven design of customer experiences for PSS. Associating experience evaluation data to such artefact-generated data is like putting life to those data. This unit is tightly related to determining what kinds of customer experience services are to be designed, which is in turn relaying identification of critical experience values. This unit would include customer specification functions so that customer intentions and choices can be reflected. Technical operations of associating these data are very well supported by diverse implementation tools in digital technology these days.

4.1.3. Experience Data Provision Service Unit

Experience data are to be provided to customization and personalization service functions, to reflection and engagement service units and most importantly to customers. At the core of this unit is the underlying representation of customer experience activities, CBAM. Diverse interface options would be needed especially for direct provision to customers. Some functions for customers to control the level of data provisions would also be needed for information provision services for external stakeholders of the ecosystem of a PSS.

Note that this service would play a key role in integrating the efforts of various ecosystem stakeholders as critical in smart PSS in the era of digital transformation [44].

4.1.4. Reflection and Engagement Service Unit

Reflection and engagement are critical for experience evolution of *experience–evaluate–engage* iterations. Customer experiences evolve dynamically for better experience value provision based on accumulated experience evaluations and reflections. This follows John Dewey's view on reflections of experience [45]. Diverse engagements with peer customers and the potential customer are also critical in elucidating experience values. These can be related to the customer behavior change and customer ability enhancement, for example as needed in sustainable experience design [46]. The more frequent reflection and engagement interactions occur, the better chances for customer experience enhancement come. Still, control should be given to customers to choose when and how often engagements are to be made.

5. Demonstrative Cases

5.1. Case 1: Shower Equipment Smart PSS

A smart PSS was devised for the servitization of shower equipment SME [12,44]. Shower users look for experience values such as *healing*, *beauty* and *health*. While shower soap cocktails are used and soap companies produce soaps with many different scents, shower capsules with various fragrances and therapies have recently been introduced. In the near future, it is expected that many different shower capsules would be produced so that variety of capsules would be produced by many different companies to meet diverse personalized preferences and context varieties. Premium customers in the era of digital transformation would characterize those who willingly provide their zero-party experience data for better benefits. They would actively care about their showering experiences with different shower capsules to improve their showering experiences.

Experiences of capsule showering should be evaluated in real time as showering is taking place, and associated context data should also be obtained simultaneously. Thus the *In-Shower Experience Evaluation* service has been designed. A capsule shower user evaluates experiences of showering with a particular perfume capsule so that experience evaluation data are acquired and accumulated together with context data as briefly introduced in an earlier section of CBAM. The *Information Provision* service for personalized customization has been devised to enhance customers' experience values of healing, health and beauty as well as customer's ability to select right perfume shower capsules for diverse contexts. Service interaction should be controlled by the customer with her intent and initiation [47]. The experiences are dynamic and evolutionary so their future experiences would be better as experience evaluation data are accumulated together with context information. If a customer wants to choose a capsule based on accumulated experience evaluations, the capsule information would need to be controllable while some contexts such as the shower theme, time and weather would be used as constraining contexts [12]. A new product element of *Capsule Shower Device* has been designed to accommodate capsules of different sizes from diverse companies in connecting to the shower equipment. This capsule-connecting device identifies the kinds and brands of perfume capsules. As a user conducts capsule showering with a specific capsule, she can evaluate in real time her capsule shower experiences using the touch screen of a tablet installed in her shower booth. Evaluation keywords are selectively used according to showering themes of her choice that can be specified as goal context information. The reflection and engagement service unit of *In-Shower Healing Diary* service has been designed so that users can make diary comments to reflect and share their experiences. This service helps customers build up reflection and sharing habits and behaviors by providing their accumulated experience data with all the relevant context data. Users can retrieve their showering experience data and make their diary remarks using their own smartphone. This service would contribute in changing and forming behavioral habits of the customers with customer initiation. Note

that this PSS design case has been explained as a case of creative digital transformation with contributions of the Capsule Shower Device product element and the In-Shower Experience Evaluation service [44].

To illustrate how zero-party experience data are used for personalized service, the example in Figure 1 is explained further. If the user would like to experience *relaxed* and *cozy* healing shower on a rainy night, the most suitable shower capsule can be recommended based on her accumulated experience evaluation data. Using CESA, the capsule information as relevant structure context is acquired from the sensor of the capsule shower device, together with the shower theme specified by the user. The real-time experience evaluation service unit with its product elements is shown on the left part of Figure 3, where new product elements devised to connect perfume capsules with different sizes and to identify the capsule with sensors is shown together with an experience evaluation interface tablet. Physical context information such as time and weather can be acquired from the evaluation tablet installed in the shower booth. A personalized recommendation can be made based on accumulated experience evaluation data with the keyword of *relaxed* and *cozy*. Through the reflection/engagement service unit shown in the right part of Figure 3, the customer experience iterations of *experience–evaluate–engage* are now enabled as shown in Figure 4.

Figure 3. Shower Equipment Smart PSS.

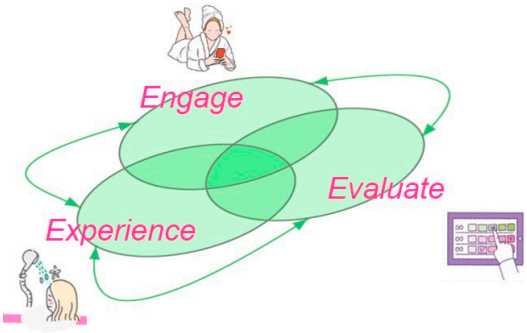

Figure 4. Iterations of Experience–Evaluate–Engage in Shower Equipment Smart PSS.

5.2. Case 2: Smart Lighting Customization PSS

Smart Lighting Customization PSS has been devised for a LED light manufacturing company. Different people may get different values from their activities. Particularly emotional experiences are elucidated differently depending on actors, activities and contexts. With the same lighting condition, different persons may get different kinds of emotional experiences. On the other hand, the most preferred lighting for a specific activity for an actor could be different from the most preferred lighting for the same activity for a different actor. Such diverse preferences of customers are to be taken care of by personalized customization services.

As a user conducts a specific activity under a specific lighting condition, the user subjectively evaluates her own experiences. The activity of taking a selfie shot is shown in Figure 5 as conducted in two different lighting conditions. While she does not know

any specific lighting condition parameters in those cases, she can subjectively evaluate her activity experience of taking a selfie shot using some evaluation criteria such as how pretty she looks and how young she looks as shown in those images of a smart tablet some evaluations shown in 5 points scale in Figure 5. As she makes such evaluations, the corresponding light conditions such as light brightness and color temperature are captured from the system and stored together with experience evaluation. In this way, zero-party data of her subjective experience evaluation and associated context data are acquired. The evaluation results are stored with the specific activity information and the specific lighting condition using the CESA method. As the experience evaluation data accumulate, if the user wants to have the best lighting condition among those she has experienced for the specific activity, the system retrieves and provides that lighting condition. This service unit is the key service concept and it is typical customization based on cultivated relations through interactions between the user and the service system [47]. If she wants to take a selfie where she looks pretty, she can try taking selfie shots under many different lighting conditions with her zero-party data accumulated, then she can ask the system to choose the lighting condition among those when her evaluation is best.

Figure 5. LED Lighting Smart PSS.

If the customer desired to find the most preferred lighting condition for a different activity, she can find the most preferred lighting for that activity in this way with accumulated zero-party data. Note that the range of context data can be modified as relevant to any specific activity as long as those data can be acquired simultaneously with evaluation data as various data definitions can be made as guided by the schema of CBAM.

To promote more user-initiated behavior of doing activities under the most desirable lighting conditions and evaluating experiences, a service unit for self-reflection and engagements has also been introduced. Thus a user improves her experiences through evolutionary iterations of *experience–evaluate–engage* with experience data accumulated. More information on the smart lighting Customization PSS can be found in [48] where the collaborative PSS design process has been represented and explained using a service blueprint-like representation of PSS design activities of various stakeholders.

6. Discussions and Conclusions

In this paper, customer experience design for PSS based on customer experience data has been presented in association with zero-party customer data. A framework for customer experience data composed of the CBAM and the CESA methods has been introduced in response to the challenge of what kinds of zero-party customer data need to be defined and how these are to be collected. Note that CBAM plays the role of schema in defining customer experience data with rich and structured context data including evaluation criteria as parts of psychological context data. The CESA method provides an overall experience evaluation framework where journey maps and critical touchpoints are accommodated as well as evaluation criteria as those critical value themes for respective touchpoints. Foremost, CESA enables the acquisition of real-time zero-party experience evaluation data in an ecologically valid manner, and at the same time associates context data specifically relevant to the experience activities based on CBAM. Potential drawbacks of zero-party

data discussed regarding those of surveys and questionnaires [29] have been overcome with experience sampling methods [41,49].

Typical service units for smart experience design have been presented. These are for real-time experience evaluation, an association of experience evaluation data and context data, experience data provision and reflection and engagement service. Two specific smart PSS design cases have been presented where the framework of CBAM and CESA has played the foundation role. Both cases show how customer-led smart experiences service can be devised so that customer experiences evolutionarily improve as zero-party customer data are accumulated with the iterations of *experience–evaluate–engage*. These show how smart experience design can be developed using zero-party data in the coming days of digital transformation.

As experiences are basically co-created or constructed by customers [50], experiences can give more value when customers initiate and engage more [22,51]. Thus, when a customer is more willingly involved and provides zero-party customer data, her experiences can be better. Due to the dynamic and evolutionary aspect of experiences, the customer initiation of accumulated experience evaluations is a very desirable component of the experience design method as experience values increase with continued customer engagement to build up experience behaviors.

The customer experience design method based on customer experience data can be discussed using the design reasoning model [52] developed to model visual thinking iterations *of seeing–imagining–drawing* [24] with cognitive activities as well as knowledge and schema. Customer experience evaluation data are acquired and accumulated using the CESA method as a customer conducts experiences. This corresponds to knowledge construction involving *drawing* and *seeing* if viewed from the design reasoning model. Note that *drawing* accommodates experiencing and *seeing* corresponds to evaluation where customers are involved. In this way, knowledge about structured customer experiences is constructed with customers involved in a very personalized manner. Additionally, the knowledge constructed and accumulated with customer involvement including zero-party data is then utilized to provide personalization service. The personalization service method using constraining and controllable contexts can be regarded as the construction of a new schema for customer experience personalization service based on the schema of CBAM. Note that this schema of customer experience design can now be utilized in devising many other customer experience services.

Customer experiences are created by customers. Customers initiate, *experience*, *evaluate* subjectively, *engage* with self-reflection and communication with peers iteratively. In this way, customer experiences evolve dynamically. Values are elucidated by experiences customers make using artefacts in collaboration with other stakeholders of the ecosystem, rather than directly from artefacts. Different types of data have been addressed for data-driven design in [17]. The figure for the data-driven design scenario of [17] has been reproduced as a little simpler version in Figure 6a. However, data provided by users, consumers and customers such as zero-party customer experience data have not been addressed in [17], and neither in Figure 6a. Data coming from various artefacts only were addressed in [17], and in Figure 6a. In contrast, this paper contributes by identifying important data types of customer data such as zero-party customer experience data and addressing customer experience design based on such data. The data-driven experience design scenario proposed in this paper is depicted in Figure 6b with zero-party experience data provided by a user/customer is shown in pink. Note that the most important recipient of customer experience data with zero-party data and associated context data would be the user/customer, as shown in purple, in a human-centered design with an experience economy [53] perspective unlike artefact-centered design with artefact economy perspective.

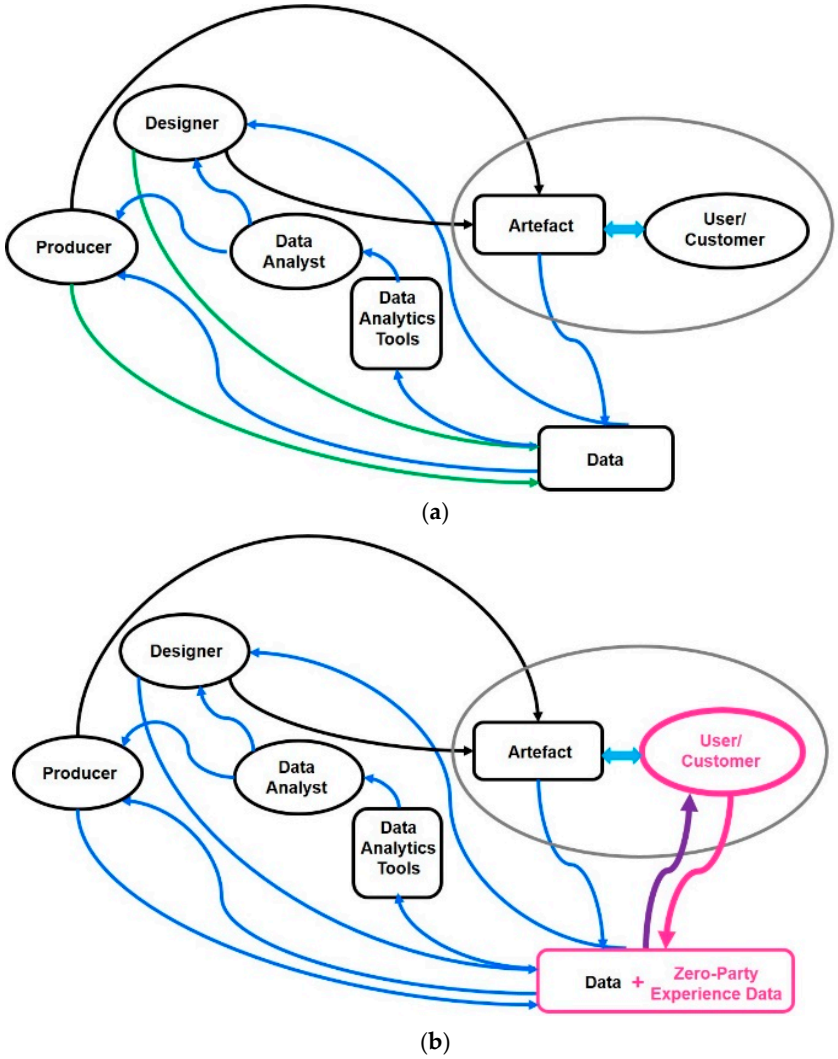

Figure 6. (**a**) Artefact Centered Data-Driven Design Scenario simplified from [17]. (**b**) Human Centered Data-Driven Experience Design Scenario.

While designers go through design thinking iterations of *seeing–imagining–drawing*, customers create customer experiences through the iterations of *experience–evaluate–engage*. Here, zero-party customer data are acquired and accumulated through the association of subject evaluation data and context data. In this way, smart PSS can be designed to reflect personal needs and context varieties. Through customer experience iterations of *experience–evaluate–engage*, customers could also enable behavior changes. This could be utilized in designing PSS for sustainable and responsible consumption [46]. In this way, diverse methods for customer experience design for PSS could be devised.

Note that both consistency and flexibility demonstrated by the two cases support that the framework is validated. The ways zero-party customer data with associated context data are defined and utilized in smart PSS design and the manners real-time subjective evaluations are acquired in conjunction with context data are consistent in both illustrative cases while those two products of their respective PSS cases are from completely different industry sectors. While LED lighting is in the industry sector where digital technology is highly developed, shower equipment is in the sector where digitalization is not yet of great applicability in their business practices. Yet, the framework enabled smart PSS design exploiting zero-party customer data in both cases. While the shower equipment PSS case is addressing specifically shower activities in diverse customer use scenarios and showering themes, many flexible kinds of activities and a variety of contexts can be

addressed in the lighting customization PSS. In this way, flexibility has been demonstrated in illustrative cases, enabled by the framework, regarding the range and the specificity of activities supported by the zero-party data definition and acquisition as well as the variety of levels of customer initiation.

While the proposed framework of CBAM and CESA can support various kinds of smart PSS design tasks, development of diverse PSS cases with diverse customer sectors could be developed in the near future to compare how such diversities are addressed in the way zero-party data are defined and experience evaluations are acquired. Together with the representation spaces of PSS proposed in [47], a platform for smart PSS design with zero-party data can be established. Ample cases stored in a sort of repository would serve in guiding personalized experience design for smart PSSs.

Meta-level customer preferences could be accommodated not only by specific experience activity-level preferences and context specificity. Additionally, smart PSS is characterized by massively co-creative efforts of ecosystem stakeholders as discussed in the introduction some new research would be desired on how to address collaborative decision making when more than one customer or one stakeholder make experience evaluations in a collaborative manner. This future research would be very challenging as this requires a new layer of social aspects in yet very new zero-party data.

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