



**UNIVERSITY  
OF TURKU**

This is a self-archived – parallel-published version of an original article. This version may differ from the original in pagination and typographic details. When using please cite the original.

AUTHOR	Kim Yong Se
TITLE	A FRAMEWORK FOR SMART EXPERIENCE DESIGN BASED ON ZERO-PARTY CUSTOMER EXPERIENCE DATA
YEAR	2023
DOI	<a href="http://dx.doi.org/10.1017%2Fpds.2023.17">http://dx.doi.org/10.1017%2Fpds.2023.17</a>
VERSION	Publishers PDF
CITATION	Kim, Y. (2023). A FRAMEWORK FOR SMART EXPERIENCE DESIGN BASED ON ZERO-PARTY CUSTOMER EXPERIENCE DATA. <i>Proceedings of the Design Society</i> , 3, 161-170. doi:10.1017/pds.2023.17
LICENSE	<a href="https://creativecommons.org/licenses/by-nc-nd/4.0/">CC BY-NC-ND 4.0</a>

# A FRAMEWORK FOR SMART EXPERIENCE DESIGN BASED ON ZERO-PARTY CUSTOMER EXPERIENCE DATA

Kim, Yong Se

University of Turku

## ABSTRACT

Data about customer experiences would be critical in smart product-service systems. Research is desired on how to establish a framework for Smart Experience Design based on customer experience data so that determining what kinds of customer data are needed and how these data are acquired effectively can be supported. This paper presents a framework and a method to design customer experience personalization services based on customer experience evaluation data obtained in real time and accumulated together with context data. Two illustrative cases are provided to demonstrate the validity of the framework of smart experience design based on customer experience data.

**Keywords:** Product-Service Systems (PSS), Experience design, Service design, Data-Driven Design, Customer Experience Data

## Contact:

Kim, Yong Se  
University of Turku  
Finland  
yongse.kim@utu.fi

**Cite this article:** Kim, Y. S. (2023) 'A Framework for Smart Experience Design Based on Zero-Party Customer Experience Data', in *Proceedings of the International Conference on Engineering Design (ICED23)*, Bordeaux, France, 24-28 July 2023. DOI:10.1017/pds.2023.17

# 1 INTRODUCTION

A Product-Service Systems (PSS) is a system of products, services, supporting networks and infrastructure that is designed to satisfy customer needs and to generate values (Goedkoop et al. 1999; Tukker, 2004; Tan and McAloone, 2006; Tukker, 2015). Efforts are being made to accommodate experiences issues as primary design goals in PSS design by reflecting characteristics of customer experiences in human-centered design approaches (Valencia et al., 2015; Costa et al., 2018; Dewit, 2019). Customization and personalization issues are addressed recently (Song and Sakao, 2017; Kim and Hong, 2019). Digitalization supports servitization. Specific digital capabilities relevant to current and potential servitization functions have been identified including user and product identification, condition monitoring and usage monitoring (Ardolino et al., 2018). 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 (Valencia et al., 2015; Abramovici et al., 2015; Chowdhury et al., 2018; Wang et al., 2021).

Along with digitalization in servitization, the paradigm of data-driven design is emerging rapidly (Cantamessa et al., 2020). A conceptual framework of 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 (Cantamessa et al., 2020) addressed expanded activities of actors, with addition of data analysts who interact with designers and producers by interpreting data generated by artefacts and processed with data analytics tools. Design methods were also added so that multiple versions of artefacts were effectively designed exploiting data. Most of active research and industry efforts in current data-driven design were properly addressed by the framework. For data-driven smart PSS, additional types of data such as user-generated contents and internet information data can be used beyond artefact-generated data (Liu et al., 2022). Online contents posted by users on social media and forums are specifically referred to as user-generated contents in Liu et al.

While 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. Digital revolution is changing customer behaviours. Customers can communicate easily with other consumers and with product/service providers (Verhoef et al., 2021). More and more customers are willing to make their own participations and involvements to get better benefits (Schwab, 2016). Customer experiences are evolutionary and dynamic (Verhoef et al., 2009). Customer experience process is iterative and customer participation is critical in customer experience (Zomerdiijk and Voss, 2010; Lemon and Verhoef, 2016) along the customer journey composed of discovery, exploration, purchase, use, asking, and engagement. Note that data about customer experiences would contribute in designing smart PSS where experiences of users and customers are getting critical.

Thus customer experience data would be critical in PSS. The service aspects tightly integrated with co-created experiences of diverse actors would drive values in smart PSS. As customer experiences evolve with previous experiences and their reflections, experience evaluation and management in digital forms together with use data generated by artefacts would make critical contribution in digital transformation. That is, customer experiences evolve as customers *experience*, *evaluate* their experiences and *engage* with others and themselves iteratively. Integrated customer experience design of customer-led *experience – evaluate – engage* iterations should now be emphasized in designing smart PSS. Note that design thinking has been recently explained (Kim and Park, 2021) in the framework of visual thinking (McKim, 1972) composed of interactive iterations of *seeing – imagining – drawing*. Design thinking of *seeing – imagining – drawing* iterations and *experience – evaluate – engage* iterations for user experience process are to be associated in designing experiences.

Diverse kinds of customer data are collected to improve customer experiences (Lotame, 2019). First party data is the information a company collects directly from its customers including their digital transaction data as well as off-line survey data. User-generated contents (Liu et al., 2022) 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, analysing and interpreting them. However, many earlier efforts revealed difficulties. Data privacy issues are getting critical and data tracked and collected (with or without customer's awareness) are sometimes incorrectly interpreted. *Zero-party data*, that a customer intentionally and proactively provide for better benefits, draw a lot of attention lately (Forrester, 2020). 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 method to design customer experience personalization services 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 personalization, the *Context-Based Activity Modeling* (CBAM) method which systematically represents experience activities based on context (Kim and Lee, 2011; Kim et al., 2020) 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 experiences in real time with associated context, is then introduced (Kim et al., 2011; Kim and Hong, 2020; Kim et al., 2022) in response to the question of how customer zero-party 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 experience 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 so that personal needs and context varieties are accommodated. The paper is concluded with a discussion on contributions of the paper for data-driven customer experience design for 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 the reliability (Blessing and Chakrabarti, 2009) 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 (Kim and Lee, 2011; Kim et al., 2020). The experience evaluation method of CESA (Kim et al., 2011) 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 association of context data from various artefact have been registered for US patents (Kim and Hong, 2020; Kim et al., 2022). Note that the two cases of Shower Equipment Smart PSS and Smart Light Customization PSS serve as illustrative demonstration of validity and reliability of the CBAM method and the CESA method as meaningful constituents of a framework for customer experience data although only brief descriptions of the cases are given in the paper due to page limitation of the paper.

## 3 CUSTOMER EXPERIENCE EVALUATION DATA

### 3.1 Context-based activity modeling

Customer experiences and experience activities are influenced by contexts. Contexts include physical environment like time and place earlier (Bitner, 1992) and actors involved (Edvardsson et al., 2005). Contexts are not static but changing (Zomerdiijk and Voss, 2010; Lemon and Verhoef, 2016). Rich and structured handling of contexts has been used to model activities in a specific and formal manner in CBAM (Kim and Lee, 2011). CBAM was developed as schema for designing of services in specific and detailed manner (Kim et al., 2020) as services are basically activities performed for values for

others (Kotler and Armstrong, 1999). 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* (Kim and Lee, 2011; Kim et al., 2020).

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 smart experience design, 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 (Kim and Hong, 2019). A consumer takes (action verb) a shower (object) using shower equipment (tool). The showering activity is detailed with context information. The goal context is specified with to clean 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, emotion context, motivation context, etc. In this specific activity of Figure 1, the social context of 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 (Kim et al., 2020).

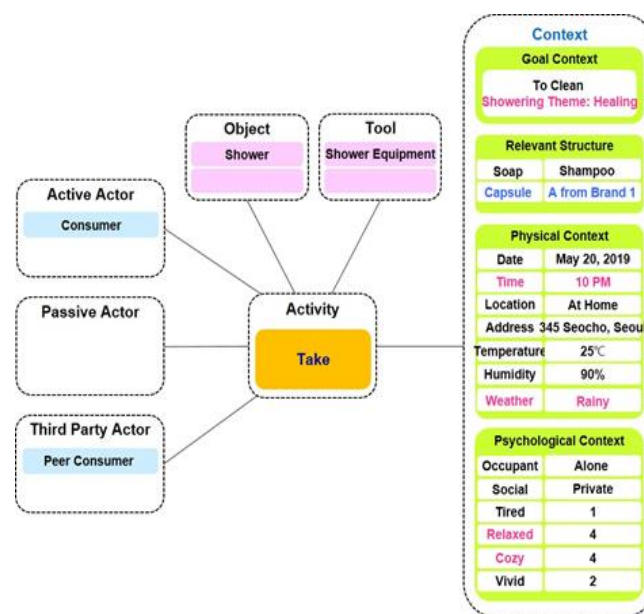


Figure 1. Context-based activity modeling of the activity to take a shower

### 3.2 Context-specific experience sampling and analysis

To understand experiences of customers and to evaluate experience services, customer experiences need to be measured. Outcome, moments-of-truth, and peace-of-mind can be measured, for example using surveys (Klaus and Maklan, 2012). Experience measurement methods include questionnaire, interview, survey, observation and many others (Zarour and Alharbi, 2017). Experiences are such that they are elucidated as they occur and thus after-the-fact survey cannot match the real experiences. Anecdotal self-report of experience sampling method (Csikszentmihalyi et al., 1977) would be a meaningful method for experience measurement. However, conventional experience sampling suffers from the problem that context information is obtained only by user descriptions without objective methods. Experience sampling method has been improved by systematically associating context information in the CESA method (Kim et al., 2011). Using CESA, human subjective experience evaluations are associated with physical context information (Choi et al., 2016). Note that customer

experiences are evaluated and stored in digital forms so that customer experiences can be customized utilizing the experience evaluation data.

The CESA method is composed of the following procedures. Customer journey map is constructed including the use phase as well as pre- and post-use phases. Evaluation keywords of experience value themes (Cho et al., 2010) are determined along the touchpoints of the journey through empathy with customers. Customer's subjective evaluations of experiences are acquired in real time at critical touchpoints using the corresponding evaluation keywords. Evaluation acquisition can be done using touch screen of smart phones and/or voice interfaces can be used. Synchronized with 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 of zero-party data has been coined in the customer relationship/experience management industry very recently (Forrester, 2020), 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 are collected through user-initiated experience evaluation only. Two related patents for CESA have been registered in USA recently (Kim and Hong, 2020; Kim et al., 2022).

## **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 is critical in designing smart PSS. In this section, some representative service units for smart experience design in 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 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 customer data formulation like CBAM. Diverse data obtained from various artefacts are available. However, identifying critical data for customer experience improvement is a big challenge in data-driven design of customer experiences for PSS. Associating experience evaluation data to such artefact-generated data is like putting the 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 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 unit 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.

#### **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 (Rodgers, 2002). Diverse engagements with peer customers and potential customer are also critical in elucidating experience values. These can be related with the customer behaviour change and customer ability enhancement. 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.

### **4.2 Case 1: Shower equipment smart PSS**

As a servitization project for a shower equipment manufacturing company, the smart PSS for shower equipment has been designed (Kim and Hong, 2019; Kim, 2021). Experience values such as *healing, beauty* and *health* have been identified from the empathy research of shower users. Very recently fragrance and therapeutic shower capsules have been introduced. It is anticipated that many different shower capsules would be produced in the near future and users would use many different kinds of capsules from diverse companies to suit for their personalized life style preferences and context varieties. Premium customers, who would be willing to provide their zero-party experience data to get better benefits, would like to do book-keeping of their showering experiences with different shower capsules to improve their showering experiences.

Experiences of capsule showering should be evaluated in real time together with context data. The In-Shower Experience Evaluation service has been designed. A capsule shower user evaluates her experiences of showering with a specific capsule so that experience evaluation data are stored with the context elements as briefly introduced in an earlier section of CBAM. The Information Provision service unit with personalized customization has been designed to enhance customer's healing, health and beauty as well as her ability to choose right perfume capsules for various contexts. Service interaction should be relational and led by the user with her initiation (Kim, 2020). The experiences are dynamic and evolutionary so that their future experiences are going to be better since experience evaluation data with context information are accumulated. If a consumer would like to choose a capsule based on her accumulated experience evaluations, the capsule information would need to be controllable while some contexts, like the showering theme, time and weather, serve as constraining contexts (Kim & Hong, 2019). A Capsule Shower Device has been newly devised to connect capsules of different sizes from various companies to the shower equipment. This device will also detect the identities 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 near the capsule device within her shower booth. Evaluation keywords are selectively used according to showering themes of her choice. The In-Shower Healing Diary service has been devised where users can make diary comments to reflect and share their experiences. This service helps those customers develop reflection and sharing behaviors by providing their accumulated experience data with all the relevant context information. Users can retrieve in-shower experience data and make her diary remarks using her smartphone. The Diary service would contribute in changing and forming behavioural habits of the customers with customer initiation. Note that this case has been explained as a case of creative digital transformation with contributions of the newly designed product-element of the Capsule Shower Device and the In-Shower Experience Evaluation service (Kim, 2021).

To illustrate how zero-party experience data is 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, 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, shown in the left part of Figure 2, together with the shower theme specified by the user. Physical context information such as time and weather can be acquired from the evaluation tablet, shown in the centre of Figure 2, installed in the shower booth. Personalized recommendation can be made based on accumulated experience evaluation data with the keyword of *relaxed* and *cozy*. Through the engagement using the In-shower healing diary service shown in the right part of Figure 2, the customer experience iterations of *experience – evaluate – engage* are now enabled.



Figure 2. Shower equipment smart PSS

#### 4.3 Case 2: Smart lighting customization PSS

As a servitization project for an LED light manufacturing company, the Smart Lighting Customization PSS has been designed. Different persons may get different kinds of values in their activities. Especially emotional experiences are elucidated in different ways depending who are the actors, what activities they are doing, and under what contexts. In the same lighting, different persons may get different emotional experiences. On the other hand, one person's most preferred lighting for a certain activity could be different from another person's most preferred lighting for the activity. Such diverse preferences of customers are to be taken care of by services through personalized customization.

In Figure 3 of the prototyping of this smart PSS, a user evaluates her selfie shot activity using three experience value themes of *pretty*, *fresh* and *natural* as she experiences her own selfie shots for different lighting conditions of A, B, C, D and E. Then if she asks the lighting for best evaluation of *pretty*, for example, the system finds and provides the lighting where her evaluation score is the highest among those five.



Figure 3. Smart lighting customization PSS

As a user conducts a specific activity under a specific lighting condition, the user evaluates her own experiences. The evaluation results are stored with the specific activity information and the specific lighting condition using the CESA method. As the experience evaluation data get accumulated, if the user wants to have the best lighting condition among those she has experienced for a 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 (Kim, 2020). To promote more user-initiated behavior of doing activities under 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 (Kim and Lee, 2021) where the collaborative PSS design process has been represented and explained using a service blueprint-like representation of PSS design activities of various stakeholders.

## 5 DISCUSSIONS AND CONCLUSION

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 on what kinds of zero-party customer data need to be defined and how these are to be collected. Two specific smart PSS design cases have been presented to illustrate that customer experience for PSS can be designed where customer experience evaluation data play critical roles through tight interactions with product and service elements of PSS. Note that the framework composed of CBAM and CESA presents advantages of the framework for smart PSS in dealing systematically with the relations between experience activity and product-elements and those among relevant product-elements as CBAM defines object element and relevant structure context elements.

As experiences are basically co-created or constructed by customers (Bolton et al., 2014), experiences can give more values when customers initiate and engage more (Zomerdijk and Voss, 2010; Torres et al., 2018). Thus when a customer is more willingly involved and provide zero-party customer data, her experiences can be better. Due to 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 (Park and Kim, 2007) developed to model design thinking iterations of *seeing – imagining – drawing* (McKim, 1972) with cognitive activities as well as knowledge and schema. Customer experience evaluation data are acquired and accumulated as customer conduct experiences using the schema of CESA, and this corresponds to knowledge construction involving *drawing* and *seeing*. The knowledge about structured customer experiences is constructed. The personalization service method using constraining and controllable contexts can be regarded as construction of a new schema for customer experience personalization service based on the schema of CBAM.

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 by artefacts. Different types of data have been addressed for data-driven design in (Cantamessa et al., 2020). The figure for the data-driven design scenario of (Cantamessa et al., 2020) has been reproduced as a little simpler version in Figure 4 (a). However, data provided by users, consumers and customers like zero-party customer experience data have not been addressed in (Cantamessa et al., 2020). This paper contributes by identifying important data types of customer data like zero-party customer experience data and addressing customer experience design based on such data. The data-driven experience design scenario of this paper is depicted in Figure 4 (b) 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 in a human-centred design with experience economy perspective unlike artefact-centred design with artefact economy perspective.

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 reflecting personal needs and context varieties.

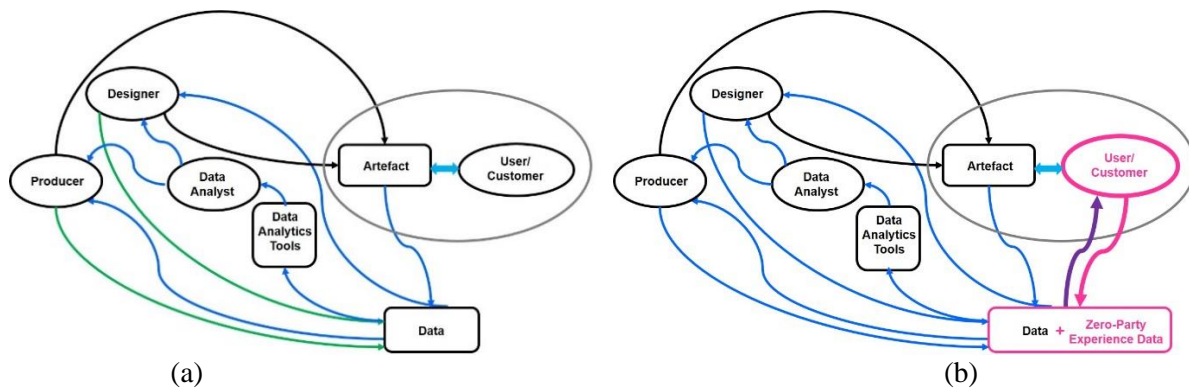


Figure 4. (a) Data-driven design scenario modified from (Cantamessa et al., 2020) and (b) Data-driven experience design scenario

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. In this way, diverse methods for customer experience design for PSS could be devised.

## ACKNOWLEDGEMENT

The author thanks the reviewers for comments that helped to identify more contributions of the paper. A journal paper (Kim, 2023) was submitted and published after submitting this paper to ICED 23.

## REFERENCES

- Abramovici, M., Göbel, J.C., Neges, M. (2015), 'Smart engineering as enabler for the 4th industrial revolution', In: Fathi, M. (ed.) *Integrated Systems: Innovations and Applications*, pp. 163–170. Springer.
- Ardolino, M., Rapaccini, M., Sacconi, N., Gaiardelli, P., Crespi, G., and Ruggeri, C. (2018), 'The role of digital technologies for the service transformation of industrial companies', *International Journal of Production Research*, 56:6, pp.2116-2132.
- Bitner, M.J. (1992), 'Servicescapes: the impact of physical surroundings on customers and employees', *Journal of Marketing*, Vol. 56 No. 2, pp.57-71.
- Blessing, L. and Chakrabarti, A. (2009), *DRM, a Design Research Methodology*, Springer.
- Bolton, R.N., Gustafsson, A., McColl-Kennedy, J., Sirianni, N., and Tse, D. (2014), 'Small Details That Make Big Differences', *Journal of Service Management*, 25 (2), 253-274. <https://doi.org/10.1108/JOSM-01-2014-0034>
- Cantamessa, M., Montagna, F., Altavilla, S., Casagrande-Seretti, A. (2020), 'Data-driven design: The new challenges of digitalization on product design and development', *Design Science*, 6, E27.
- Cho, C.K., Kim, Y.S. and Lee, W.J. (2010) 'Economical, Ecological and Experience Values for Product-Service Systems', *Proceedings of the 7th Design & Emotion Conference*, Chicago.
- Choi, Y.J., Ahn, E., Choe, Y., and Kim, Y.S. (2016), 'Smart Lighting Customization Service; Association of Human Subjective Experience Evaluation with Physical Context Information', *Asia - Design Engineering Workshop (A-DEWS)*, Osaka.
- Chowdhury, S., Haftor, D., and Pashkevich, N. (2018), "Smart product-service systems (smart PSS) in industrial firms: a literature review", *Procedia CIRP*, 73, pp. 26-31.
- Costa, N., Patricio, L., Morelli, N., and Magee, C.L. (2018), 'Bringing Service Design to manufacturing companies: Integrating PSS and Service Design approaches', *Design Studies*, Vol.55, pp.112-145.
- Csikszentmihalyi, M., Larson, R., and Prescott, S. (1977), 'The ecology of adolescent activity and experience', *Journal of Youth and Adolescence* 6, pp.281–294.
- Dewit, I. (2019), *Product-Service System Design, a Synthesis Approach*, University of Antwerp, Belgium.
- Edvardsson, B., Enquist, B. and Johnston, R. (2005), 'Cocreating customer value through hyperreality in the prepurchase service experience', *Journal of Service Research*, Vol. 8 No. 2, pp.149-161.
- Forrester (2020), Straight from the Source: Collecting Zero-Party Data From Customers, <https://www.forrester.com/blogs/straight-from-the-source-collecting-zero-party-data-from-customers/>, accessed, 2021.10.27.
- Goedkoop, M.J., van Halen, C.J.G., te Riele, H.R.M. and Rommens, P.J.M. (1999), *Product Service Systems, Ecological and Economic Basics*, the Dutch ministries of Environment (VROM) and Economic Affairs (EZ). Hague, The Netherlands.
- Lemon, K.N. and Verhoef, P.C. (2016), 'Understanding customer experience throughout the customer journey', *Journal of Marketing*, Vol. 80 No. 6, pp.69-96.

- Liu A., Wang Y., Wang X. (2022), Data-Driven Smart Product Service System', In: *Data-Driven Engineering Design*. Springer, Cham.
- Lotame (2019), 1st Party Data, 2nd Party Data, 3rd Party Data: What Does It All Mean?, <https://www.lotame.com/1st-party-2nd-party-3rd-party-data-what-does-it-all-mean>, accessed, 2021.10.27.
- Kim, Y.S. (2020), Representation Framework of Product-Service Systems', *Design Sciences*, Vol. 6.
- Kim, Y.S. (2021), Digital Transformation Types for Product-Service Systems', *International Conference on Engineering Design (ICED21)*, Gothenburg.
- Kim, Y. S. (2023), 'Customer Experience Design for Smart Product-Service Systems Based on the Iterations of Experience – Evaluate – Engage Using Customer Experience Data', *Sustainability*, 15 (1).
- Kim, Y.S., and Hong, Y.K. (2019), 'A Systematic Method to Design Product-Service Systems Using Personalization Services based on Experience Evaluations', *International Journal of Product Development*, 23 (4), pp.353-385.
- Kim, Y. S., and Hong, Y. K. (2020), *Real Time Experience Analyzing System and Method*, 10671645, USA Patent and Trademark Office, 2020.06.02.
- Kim, Y. S., Kim, J. H., and Hong, Y. K. (2022), *Context-Specific Experience Sampling Method and System*, 11222348, USA Patent and Trademark Office, 2022.01.11.
- Kim, Y.S. and Lee, S.W. (2011), 'Service Design for Product-Service Systems using Context-Based Activity Modeling', *International Association of Societies of Design Research (IASDR) Conference*, Delft.
- Kim, Y. S., and Lee, H. (2021), 'Process Characteristics of Product-Service Systems Development: Comparison of Seven Manufacturing Company Cases', *Journal of Cleaner Production*, Vol.286. 1 March 2021, 124971.
- Kim, Y.S. and Park, J.A. (2021), 'Design Thinking in the Framework of Visual Thinking and Characterization of Service Design Ideation Methods Using Visual Reasoning Model', *The Design Journal*, Vol. 24, Issue 6.
- Kim, Y.S., Hong, Y.K., Kim, J.H. and Kim, Y.M. (2011), 'Context-Specific Experience Sampling for Experience Design Research', *International Conference on Engineering Design (ICED11)*, Copenhagen.
- Kim, Y. S., Jeong, J. Y., Hong, Y. K., and Hong, S. J. (2020), 'A Schema for Systematic Service Imagining: Context-Based Activity Modeling', *Sustainability*, 12(22).
- Klaus, P., and Maklan, S. (2013), 'Towards a Better Measure of Customer Experience', *International Journal of Market Research*, Vol.55, Issue 2, pp.227-246.
- Kotler, P., and Armstrong, G. *Principles of Marketing* (8th ed.), Prentice Hall International, 1999.
- McKim, R. H. (1972), *Experiences in visual thinking*. Belmont, CA: Wadsworth Publishing.
- Park, J. A. and Kim, Y. S. (2007), 'Visual Reasoning and Design Processes', *International Conference on Engineering Design (ICED07)*, Paris.
- Rodgers, C. (2002), 'Defining reflection: Another look at John Dewey and reflective thinking', *Teachers College Record*, 104 (4), pp.842-866.
- Song, W. and Sakao, T. (2017), 'A Customization-Oriented Framework for Design of Sustainable Product/Service System', *Journal of Cleaner Production*, 140, pp.1672-1685.
- Schwab, K., (2016), *The Fourth Industrial Revolution*, World Economic Forum.
- Tan, A.R. and McAlloone, T.C. (2006), 'Characteristics of Strategies in Product/Service-System Development', *The 9th International Design Conference*, Dubrovnik, pp.1435-1442.
- Torres, E.N., Lugosi, P., Orłowski, M., and Ronzoni, G. (2018), 'Customer-led Experience Customization: A Socio-Spatial Approach', *Journal of Service Management*, 29 (2), pp.206-229.
- Tukker, A. (2004), 'Eight Types of Product-Service Systems: Eight Ways to Sustainability? Experiences from SusProNet', *Business Strategy and the Environment*, Vol. 13, pp.246-260.
- Tukker, A. (2015), 'Product services for a resource-efficient and circular economy – A review', *Journal of Cleaner Production*, 97, pp. 76-91.
- Valencia, A., Mugge, R., Schoormans, J.P.L, and Schifferstein, H.N.J. (2015), 'The design of smart product-service systems (PSSs): An exploration of design characteristics', *International Journal of Design*, 9(1), pp.13-28.
- Verhoef, P.C., Lemon, K.N., Parasuraman, A., Roggeveen, A., Tsiros, M. and Schlesinger, L.A. (2009), 'Customer experience creation: determinants, dynamics and management strategies', *Journal of Retailing*, Vol. 85, pp.31-41.
- Verhoef, P.C., Broekhuizen, T.L.J., Bart, Y., Bhattacharya, A., Dong, J.Q., Fabian, N.E., and Haenlein, M. (2021), 'Digital transformation: a multidisciplinary reflection and research agenda', *Journal of Business Research*. 122, pp.889-901.
- Wang, Z., Chen, C.-H., Li, X., Zheng, P., Khoo, L. P. (2021), 'A context-aware concept evaluation approach based on user experiences for smart product-service systems design iteration', *Advanced Engineering Informatics*, Vol. 50.
- Zarour, M., and Alharbi, M. (2017), 'User experience framework that combines aspects, dimensions, and measurement methods', *Cogent Engineering*, 4(1).
- Zomerdijk, L.G. and Voss, C.A. (2010), 'Service design for experience-centric services', *Journal of Service Research*, Vol. 13 No. 1, pp.67-82.