

# A Representation Framework of Product-Service Systems for Classification & Design

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## Abstract

A Product-Service System (PSS) is a system of products, services, supporting networks and infrastructure that is designed to satisfy customer needs and to provide values. PSSs are very different from each other while some PSSs are similar to some. A representation framework of PSSs has been devised so that various PSSs could be represented and compared using the framework composed of twelve spaces, or viewpoints. Also the framework could serve as a design guide so that those issues from the viewpoints of the specific spaces of the representation framework could be considered in designing PSSs. The framework is composed of spaces such as value, product, service, product-service ratio, customer, business model, actor, touchpoint, context, time, society, and environment. In this short paper, the framework and its spaces are described using examples represented in the PSS Representation and Repository system, which is being developed to support manufacturing servitization.

**KEYWORDS:** Product-Service Systems, Design, Representation Framework, Classification, Servitization

## Introduction

Product-Service Systems (PSS) has drawn significant attention since it can effectively address diverse values of consumers by integrating products and services. PSS has been defined as a system of products, services, supporting networks and infrastructure that is designed to satisfy customer needs and to generate values (Goedkoop et al, 1999, Dewit & De Roeck, 2014, Kim et al., 2012, McAloone et al, 2011). Manufacturing companies can accomplish business innovation by devising new service elements and providing PSSs starting from their

products. Such new efforts are called manufacturing servitization (Baines and Lightfoot, 2013). With analysis of the company's business contexts, diverse strategies could be set for servitization.

Services could be developed so that their product functions can be supported. Repair and maintenance services would fit this classification of services supporting products. On the other hand, new services could be devised to drive active emotional values of their customers in a broadly related manner with their products. Education services to enhance capabilities of the customers, for example, belong to this classification of service supporting customers. In this way, different servitization strategies in service space could be employed (Fischer et al. 2013).

To compare and classify different PSSs, the kinds of offerings of PSSs have been used as a key factor in classification (Gaiardelli, et al. 2014; Tukker, 2004). While these kinds of classifications are useful to compare the results of PSSs, they do not provide enough support in comparing servitization processes. Servitization process information is critical in supporting and guiding a new servitization. Thus, more diverse issues, or viewpoints, of PSSs could be used.

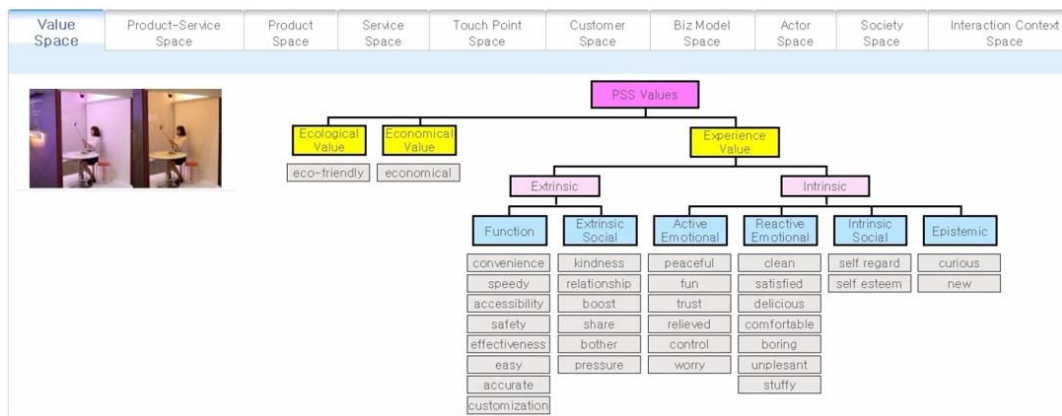
In this paper, a framework to represent PSSs is described using various issue spaces, termed dimensions, such as value space, product space, service space, customer space, actor space, business model space, context space, touchpoint space, and time space. Classification of PSSs using this representation would help in determining strategies and methods for new servitization efforts. Diverse PSS cases, including well-known PSSs and brand new PSSs, could be classified to demonstrate the coverage and the utility of the framework.

## PSS REPRESENTATION FRAMEWORK

For designing PSSs, various combinations of product and service elements should be considered. Previous design results on such combinations as well as other critical viewpoints should be saved and retrieved to design a brand new PSS. Experienced consultants may maintain good repositories of successful cases with effective searching mechanism to draw potential hints and insights from the cases to guide the new tasks. In this section, the spaces of the representation framework are described.

### A. Value Space

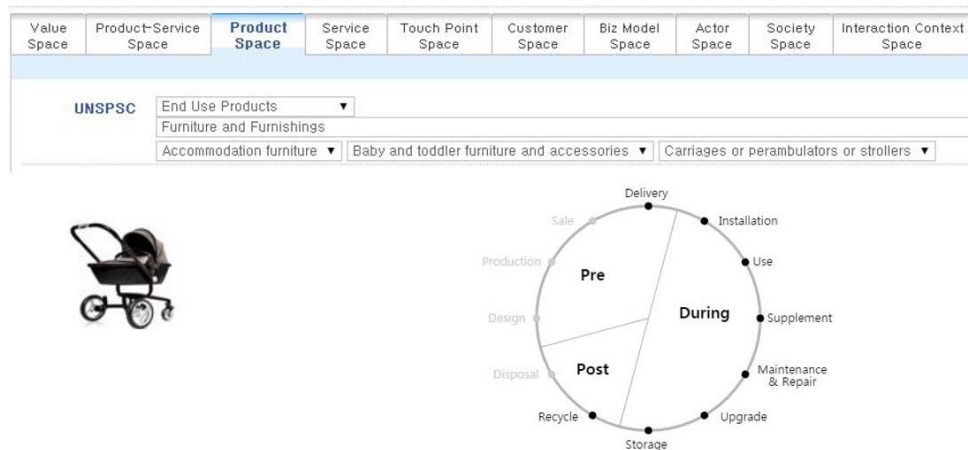
The E3 value concept of economic, ecological and experience values has been proposed in 2010 by Kim and his colleagues (Cho et al, 2010). Some experience values are extrinsic, while others are intrinsic. Function values are objective and extrinsic. Some social values like connectedness are extrinsic. But some social values like respect are intrinsic. Emotional values and epistemic values are intrinsic. Among emotional values, reactive emotional values come quick and go away quick with primary contribution by the external world, while active ones such as love and anger are more subjective. Epistemic values address basic human values related with knowledge like novelty and curiosity. Note that PSSs are designed to provide those values, and different PSSs provides different values. Thus value space of PSS representation addresses the goals of PSSs. An example case of values of a PSS case for smart lighting customization service is shown in Figure 1.



**Figure 1 Value Space**

## B. Product Space

In manufacturing servitization, PSSs are devised starting from products of the companies. The product space is an essential aspect in characterizing the PSSs. We use two sub-spaces. Product classification based on United Nations Standard Products and Services Code (UNSPSC) is used (UN Development Program 1988). The other sub-space is the life-cycle step aspect (Matzen & McAloone, 2009). This sub-space shows at which life cycle steps of the product the new PSS concept is addressed. An example on the product space is shown in Figure 2. This PSS case is about a stroller, which is an end use product that belongs to furniture and furnishings at the top level. It is an accommodation furniture and is in the category of baby and toddler one. Finally it is classified as a stroller. This hierarchy is used in identifying similarities of products used in different PSSs. This case addresses all steps in during phase as well as delivery and recycle as shown in the figure.



**Figure 2 Product Space**

## C. Customer Space

Services are made by interacting with customers who receive services. One sub-dimension of the customer space is the customer segmentation. Whether they are B2B customers and B2C customers could be the highest segmentation issue with many lower segmentation issues. The other sub-dimension of the customer space deals with classification of the activities of the customers using activity lexicon (USA Bureau of Labor Statistics 2014). Major human activities are classified into necessary activities, contracted, committed and leisure activities

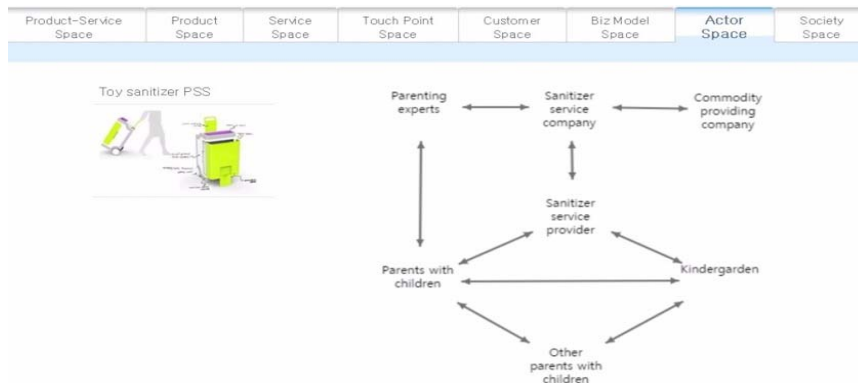
(Statistics Korea 2010). An example of customer space classification at the activity sub-dimension is shown in Figure 3. The customer space of a PSS tells what kinds of activities of what kinds of customers are supported by the PSS case. Note that the value space would be related with the customer space as a PSS would provide those values in the value space to the customers in their activities in the customer space.



**Figure 3 Customer Space**

#### D. Actor Space

Context-based activity modeling approach (Kim & Lee 2011) puts the activity at the center of the analysis; actors are elements of activities and important part of the representation scheme. Also the interactions among the actors are also important. By using the customer value chain analysis (Donaldson et al 2006), this information is represented as shown in Figure 4 where Toy sanitizer PSS is represented by the actors involved in the service concept.



**Figure 4 Actor Space**

#### E. Service Space

Services could be developed so that their product functions can be supported. Repair and maintenance services would fit this classification of services supporting products. On the other hand, new services could be devised to drive active emotional values of their customers in a broadly related manner with their products. Education services to enhance capabilities of the customers, for example, belong to this classification of service supporting customers.

We developed the service space composed of five grades from service supporting products to service supporting customers: SSPP, SSPc, SSPc, SSCp and SSCC. If the service supports only product functions, it is regarded as *SSPP*. If the service addresses customer values not directly related with the product, but critical to customers of the product, it is classified as *SSCC*. For example, simple parts replacement and maintenance services are classified as SSPP as in the case of typical tool PSS. Nike Plus service, for example, can be contrasted as it does not add functions of their products of sporting wear or shoes, but it changes

behavior of their customers leading to more sales of their products. This kind of services is classified as SSCC. If there is a little aspects for customer value support while mostly product is supported, it is *SSPc*. If the service mainly supports customer values with a little product supports, it is *SSCp*. *SSPC* (or equivalently *SSCP*) represents the case where product supporting and customer supporting are about the same.

The service space of a PSS case of Personalized Furniture DIY is shown in Figure 5. The PSS has 6 service concepts. It provide DIY furniture, and this is *SSPP*. They deliver furniture after DIY, and this is *SSPc* because this service is basically to bring the product to home. The whole DIY service is customized to customers in terms of what furniture is made and in terms of DIY guide. This is *SSPC*. The education part is to enhance customer capability, but focused to the corresponding furniture. Thus it is *SSCp*. Community and advice services are not confined to the specific furniture and classified into *SSCC*.



**Figure 5 Service Space**

**F. Business Model Space**

New PSS concepts and their business models are designed together. In the business model canvas (Osterwalder & Pigneur, 2010), 9 aspects are used in representing a business model. For each aspect, strategies and business characteristics have been determined by deriving from real business cases (Lee et al., 2011). Specific business model space is represented using those strategies as well as specific additional comments as shown in Figure 6. Smart lighting customization service at coffee shops has been devised where Shop in shop channel strategy is used with commission revenue strategy targeting niche customer segment who would like to have personalized lighting for their activities in coffee shops. Similarities in business model can be obtained by comparing those strategies used in different PSSs.



**Figure 6 Business Model Space**

## G. Interaction Context Space

Services involve interactions among actors. Also some of service interactions involve physical touchpoints. Interaction context space is representing these interactions. Unlike actor space, specific human-to-human interactions and human-to-physical touchpoint interactions are represented.

## H. Touchpoint Space

Those physical touchpoints used in service interactions are represented with explicit types of provider-touchpoint interaction and receiver-touchpoint interaction. Also affordances and affordance features for these interactions are specifically represented (Kim et al. 2011).

## I. Time Space

Diverse values are realized in PSS by interactions between service providers and receivers. The time space addresses when those value creating interactions happen along the time line. Some services provide values only at transaction in discrete manners. Values are continuously delivered in some services as the other extreme situation (Lovelock, 1983). In between these two are the case where values are provided at certain times and the case where values are provided when requested or needed (Tan and McAloone, 2006). Examples of the time spaces of a few PSSs are shown in Figure 7. Toy sanitizer service provider visits each family at certain times as schedule for example. The umbrella rental would be available when it rains and thus when needed. The health check-up service design case provides the value of self-esteem that they have been checked OK with the best hospital throughout the year by using app service telling healthcare guides reflecting the check-up. This contributes that customers kept being reminded about their good experiences, giving much benefits to the hospital (Suzuki et al, 2015).

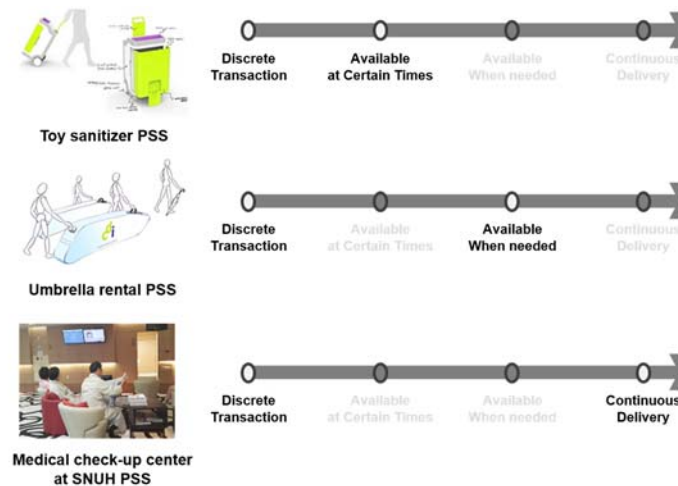


Figure 7 Time Space

## PSS REPOSITORY

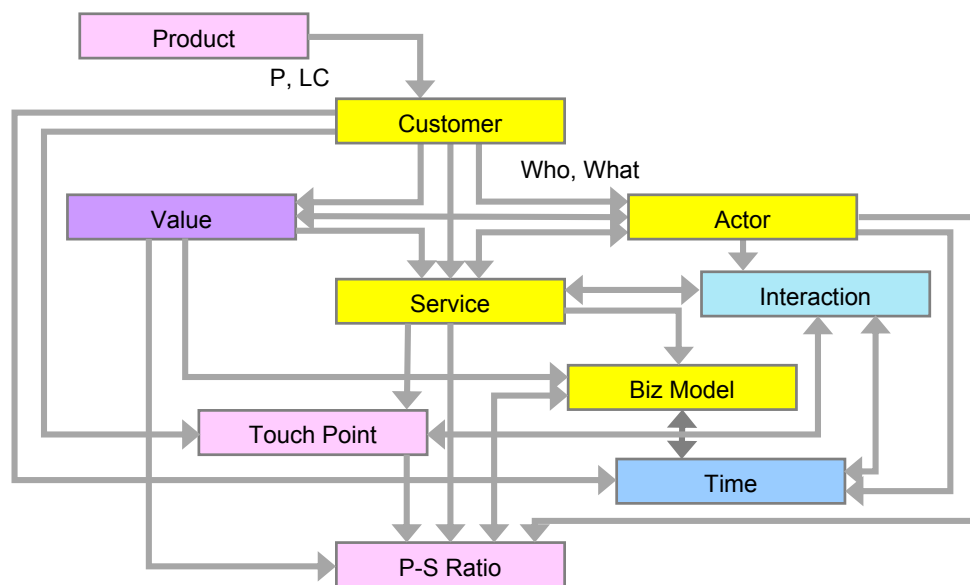
Various PSS cases are being represented and stored in a repository so that existing PSS cases can be used when designing a new PSS. Similarities among PSS cases are evaluated as well. Similarities can be computed for each space or for a combination of spaces. Examples on how similarities in different spaces of PSSs are used in designing a new PSS are not shown in this paper due to page limitation, but can be found in (Kim et al 2015).

## Conclusion

Diverse PSSs are designed and implemented. While there has been some classification using P-S integration types such as product-oriented, use-oriented, and result-oriented, a more comprehensive representation framework for PSSs is desirable so that many issues in designing and implementing PSSs could be addressed. We have described our on-going work on development of such a framework. The framework is composed of 12 spaces. In this paper, 7 spaces have been explained with examples and 2 spaces are briefly discussed (due to page limitation). Value space, product space, customer space, actor space, service space, business model space, interaction context space, touchpoint space and time space have been described.

Note that these spaces could be used in guiding PSS designing so that such issues are properly addressed in the design stage. For example as depicted in a generic way in Figure 8, for a product of the company around which a new PSS is to be design, life cycle steps and their stakeholders are analyzed and these are shown in product space and customer space. Among the activities in the customer space, a proper subset is identified so that those activities and the values associated these are selected so that a new PSS can provide those values. These design processes involve value space and customer space. To drive those values, activities of actors including service providers are designed to propose service concepts to be represented in service space. Evaluation of service concepts are to be done by evaluating corresponding business models. Also specific service interactions and physical touchpoints are designed. With a proper time space guide, a new PSS is proposed with analysis on the weight of product contribution and that of service contribution.

A repository of PSSs is being built where PSS cases are represented using the framework. Also similarities among different PSSs are evaluated so that similar PSS cases from some dimensions can be retrieved to design addressing other issues in new design. It would be desirable many PSS cases designed by other design teams could be stored in the repository to collectively increase the PSS cases space.



**Figure 8 Spaces in PSS Representation Framework**



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