21ST INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED17
21-25 AUGUST 2017, THE UNIVERSITY OF BRITISH COLUMBIA, VANCOUVER, CANADA

15 INDUSTRY CASES OF PRODUCT-SERVICE SYSTEMS FOR MANUFACTURING COMPANIES AND THEIR COMPARISON FRAMEWORK

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Abstract

Many manufacturing companies develop Product-Service Systems (PSS) based on their product strengths by devising service elements to achieve business innovation. Such servitization processes and resulting PSSs are all different reflecting the corresponding company's business context and customer needs. We have developed a representation framework for PSSs to help compare different PSSs and to support the design process of a new PSS through comparisons of many different PSS from diverse viewpoints. In this paper, we compare 15 PSSs developed for servitization of manufacturing companies using the representation framework. It is intended that the utility of the representation framework can be assessed through comparisons of these industry cases.

Keywords: Product-Service Systems (PSS), Service design, Case study, Servitization, Business innovation

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Please cite this paper as:
Surnames, Initials: *Title of paper*. In: Proceedings of the 21st International Conference on Engineering Design (ICED17), Vol. 3: Product, Services and Systems Design, Vancouver, Canada, 21.-25.08.2017.

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; Dewit and De Roeck, 2014; Kim et al., 2012; McAloone et al., 2011). A PSS is designed reflecting the strengths of the product of a manufacturing company to provide added values to the customers of the product. Designing a PSS is the key in manufacturing servitization (Baines and Lightfoot, 2013; Fischer et al., 2012) to pursue business innovation of the manufacturing company.

A framework to represent PSSs has been proposed by the author and a PSS is described using various 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 (Kim, 2016). Previous design results on such combinations as well as other critical viewpoints should be stored and retrieved to be referred in designing a new PSS. The framework is developed into PSS representation and repository system, which is a software that saves each PSS case with aspects of 10 spaces. It also performs similarity comparison among the cases in specific dimensions to determine how similar the strategies and gain insights from previous cases for designing new PSS (Kim et al., 2015a). The algorithms for similarity computation has been presented (Wu et al., 2017).

Note that this representation could allow comparison of servitization processes while some other classification methods (Gaiardelli et al., 2014; Tukker, 2004) of PSSs can only compare the resulting provisions of PSSs. In this paper, 15 industry PSS cases conducted in a government sponsored project of Manufacturing Servitization Support Framework in the past 2 years are briefly introduced. Comparisons of these real-world cases using the PSS representation framework and similarity assessments are explained. In this way, the utility of the PSS representation and repository framework is illustrated.

2 15 INDUSTRY CASES OF PRODUCT-SERVICE SYSTEMS (PSS)

The objective of the Manufacturing Servitization Support Framework project (http://mssf.kr) is to showcase business innovation strategy using servitization to help small and medium sized manufacturing companies can overcome difficulties in the complicated competition market. The primary contribution of servitization is to identify and drive customer experience values (Cho et al., 2010) through service activities newly designed in the PSSs. However, business contexts of manufacturing companies are all different. A systematic approach in dealing with these contexts has been developed. Using a comprehensive but systematic PSS design methods and tools, the consortium performed the servitization process. The consortium is composed of three research groups of universities and two associations of professional consultants. While the research teams developed the methods, Sungkyunkwan University team performed rather the primary role of service design as the institution has a dedicated interdisciplinary graduate program of service design (http://sdi.skku.edu) (Kim et al., 2015a). Most of the students of the institute are matured ones with industry experiences.

Regarding sizes of these 15 companies, they are very different. Some companies are global big ones, while some are venture companies with small revenue records so far. Products of these companies vary a lot from chemical cleaning product to fashion shoes to personal posture assistive devices. These companies and their products are very briefly introduced in the following.

(a) A small furniture manufacturing company case developed personalized DIY service (Kim et al., 2015b). (b) A medium sized LED manufacturing company case was the smart lighting customization service for coffee shops. (c) A child care service for working couples was developed for a venture service robot company. (d) The case of children posture assistive devices of a small venture company was conducted. (e) A big living care company's IoT-based air quality sensor case was developed with focus on the service interaction between customers and service providers. (f) A PSS was developed for a health information management system which measures physical capabilities of users for a venture company. (g) A diverse channel enhancement services was developed for a medium sized van customization company. (h) Customer purchase experience service design was developed for an optical company

named Davich with 200 franchise stores. (i) Issues for purchasing shoes were addressed for a female shoes company named Babara with about the 5th ranking in the national market. (j) A PSS has been developed for a heating tent company named ByMom. (k) A small venture company that produced customized photo albums for kindergartens received enhances service design support. (l) An IoT-based interaction service was developed for a bluetooth-based entertainment technology company. (m) A company producing cleaning chemicals wanted to develop a new business opportunity with bicycle market so that a comprehensive PSS to enter this new business had been devised. (n) A new business division of a global car manufacturer is developing children car-seats, for which a brand new car-life experience service design has been conducted. (o) A small but strong company that makes shower systems wanted to innovate its business with servitization so that a new service platform had been developed. Descriptive images of these companies are shown in Figure 1.

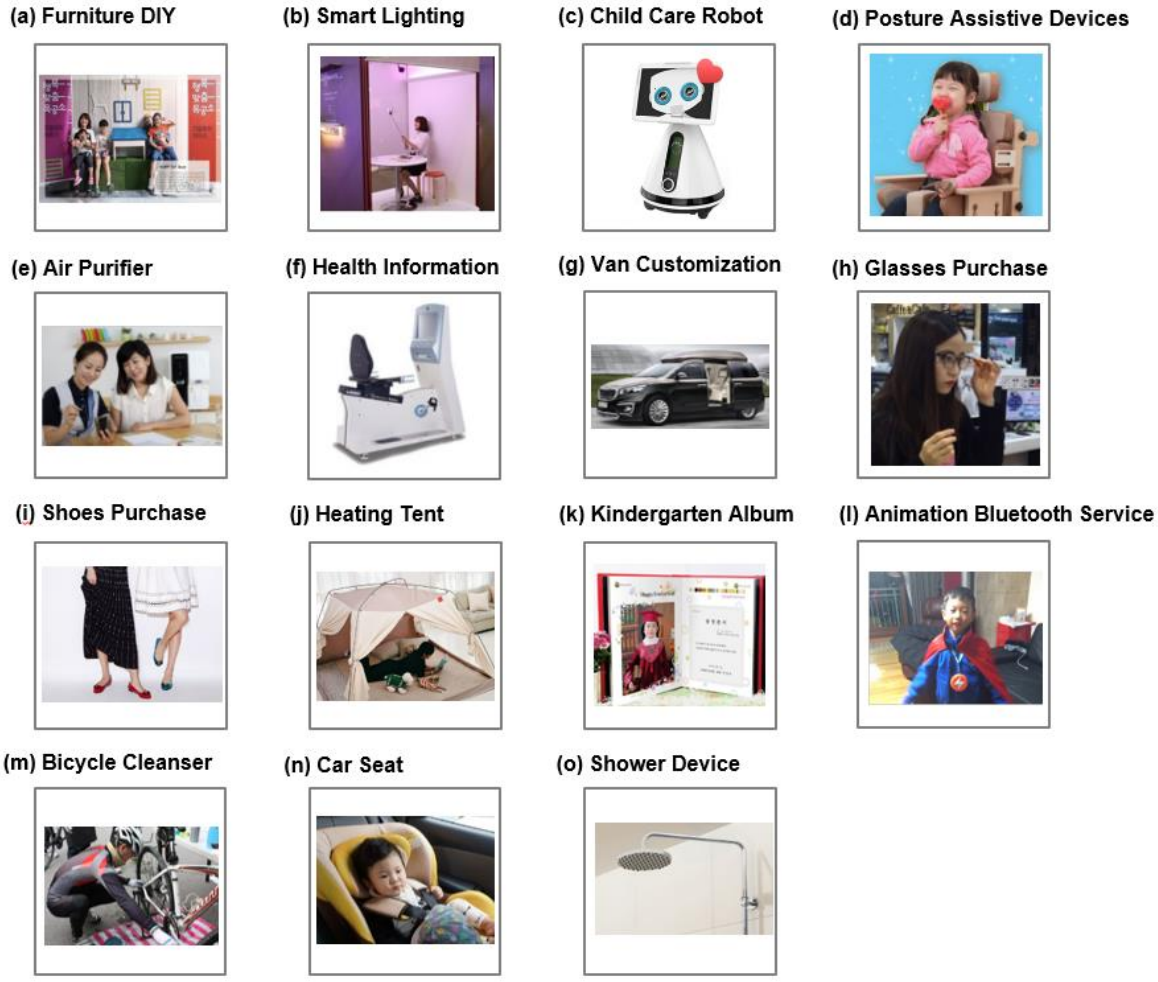

Figure 1. 15 Industry Cases of Product-Service Systems

3 PRODUCT-SERVICE SYSTEM (PSS) REPRESENTATION

In this section, the PSS representation framework is briefly reviewed. A hypothetical PSS design process could be conducted in the following way using the spaces of the representation. First, the company's product to be servitized is addressed in the product space. UN standard for product classification is used as well as at which life-cycle step of the product is to be the focus of service design. Then, the customers of the product are identified in the customer space. Also what activities of the customers are the target activities of the services are determined. Again for this, we use a standard on human basic activities. A most important space of the representation is the value space. Now the designer should address what values in the taxonomy of E3 values, including functional, social, emotional and epistemic experience

values, are critical values for the customers in their above identified activities. Note that a repository of a hierarchical value map could be used to determine service activities to drive those values. The actor space is also important to identify stakeholders and their relations in providing values.

New service concepts are then developed to drive the values considering the relations between actors. Often new services come with introduction of new stakeholders. Note that several service concepts are proposed in a typical PSS and these service concepts can be classified into 5 categories in the service space; service support products (SSPP), service supporting mainly products and partially customers (SSPc), service supporting products and customers about half and half (SSPC), service support mainly customers and partially product elements (SSCp), and services supporting customers (SSCC) (Kim et al., 2015a). Service concepts design the corresponding PSSs of 15 industry cases are shown in Figure 2, where services with primarily supporting products are shown in the upper-left corner and services with primarily supporting customers are shown in the lower-right corner.

Interaction between actors in these service concepts are designed as well as physical touchpoints of the service activities in the interaction space and in the touchpoint space respectively. Also business models for the proposed service concepts are represented in the business model space. Regarding service contact time, how often services encounter is determined in the time space. Revenue portions between product elements and service elements are to be determined as the new business is to be operated in P-S ratio space. A more detailed description of the representation spaces could be found as well as a flow diagram of potential PSS design process in (Kim et al., 2015a; Kim, 2016).

Figure 2. Service Spaces of 15 Industry Cases of Product-Service Systems

4 COMPARISON OF PRODUCT-SERVICE SYSTEMS (PSS) CASES

In previous section, the PSS representation spaces have been reviewed as a PSS design can be done addressing the relevant spaces in some order while there have to be iterations in any designing processes. We now illustrate how classifications of PSS cases could be used in design a new PSS. Comparison of

PSS cases in their overall aspect could be quite difficult. When PSS cases are represented in a specific space of the representation, similarities among PSS cases could be compared rather easily.

4.1 Product Space Comparison.

Similarity comparison of PSS cases in the product space can be done through the hierarchical classification of the products in the United Nations Standard Products and Services Code (UNSPSC). UNSPSC is composed of 5 hierarchical levels. Thus, two PSS cases would have the same product space classification if their classifications upto the 5th level are the same. The product space similarities of 15 cases are shown in Figure 3. Note that the similarity of the Car Seat case (n) and the Furniture DIY case (a) is the highest in this comparison. They are the same upto the 3rd level; they are both accommodation furniture as shown in Figure 4.

Product-Service	Glasses Pur	Kindergarte	Posture Ass	Child Care F	Heating Ten	Car Seat	Bicycle Cle	Shower Dev	Animation E	Shoes Purc	Van Custom	Health Infor	Air Purifier	Smart Light	Furniture DIY
Glasses Purchas	1.00														
Kindergarten Alb	0.38	1.00													
Posture Assistive	0.66	0.38	1.00												
Child Care Robo	0.00	0.00	0.00	1.00											
Heating Tent	0.38	0.38	0.38	0.00	1.00										
Car Seat	0.38	0.38	0.38	0.00	0.38	1.00									
Bicycle Cleanser	0.00	0.00	0.00	0.00	0.00	0.00	1.00								
Shower Device	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00							
Animation Blueto	0.38	0.66	0.38	0.00	0.38	0.38	0.00	0.00	1.00						
Shoes Purchase	0.38	0.38	0.38	0.00	0.38	0.38	0.00	0.00	0.38	1.00					
Van Customizatic	0.00	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	1.00				
Health Informatio	0.66	0.38	0.66	0.00	0.38	0.38	0.00	0.00	0.38	0.38	0.00	1.00			
Air Purifier	0.38	0.38	0.38	0.00	0.38	0.38	0.00	0.00	0.38	0.38	0.00	0.38	1.00		
Smart Lighting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.00	1.00	
Furniture DIY	0.38	0.38	0.38	0.00	0.38	0.83	0.00	0.00	0.38	0.38	0.00	0.38	0.38	0.00	1.00

Figure 3. Product Space Comparison

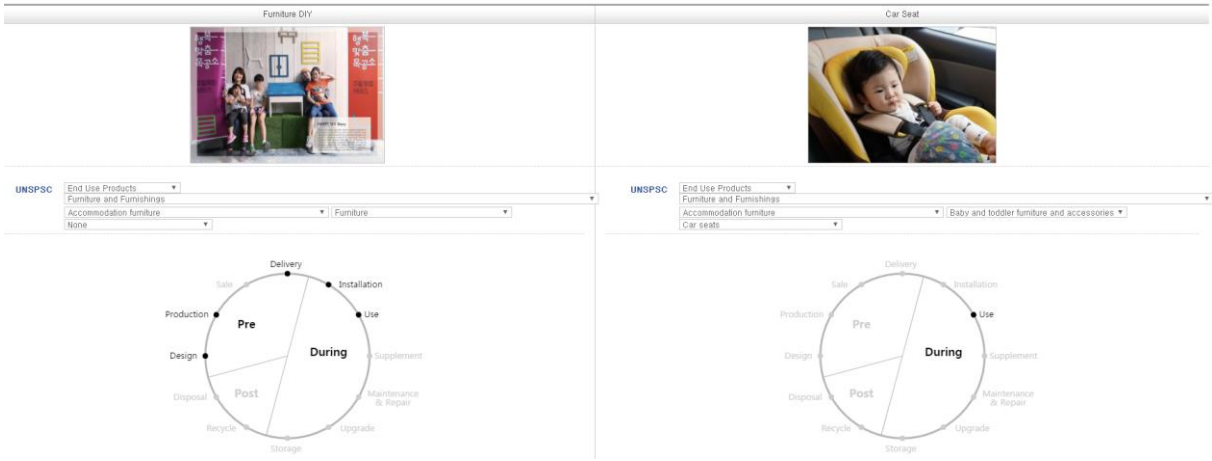

Figure 4. Product Space Similarity (Furniture DIY vs Car Seat: 0.83)

4.2 Value Space Comparison

E3 values of PSS cases are represented in a tree structure as shown in Figure 5. Specific value themes are listed in the corresponding branch as identified through various methods from stakeholders including customers. Among experience values, functional values and some social values are extrinsic. Both active and reactive emotional values are typical intrinsic values as well epistemic and some social values among oneself. In similarity assessment, the syntactical aspects of the value trees like which value classes are more important than others are considered. Also semantic aspect of value themes are considered in similarity assessment using the WordNet where distances of two words are computed (Pedersen et al., 2001).

A specific example cases are now compared. While product space similarity of Shoes Purchase case and Glasses Purchase cases is very low, 0.38, as shown in Figure 3, these two cases have many similar value themes in common. For example, both address cost issue in economic value. Expertise and choice are common in functional value branch. Kindness, boast, pressure and communication are appearing in both cases in the extrinsic social aspect. Trust, indecision, and worry are common in active emotion aspect. Stylish appears in both cases in reactive emotion part. Loveliness and pretty are similar though not identical as they respectively appear in reactive emotion category. Thus the similarity of these two cases is about 0.75 (75%), which is very high. The comparison of 15 cases in their value space is shown in Figure 6.

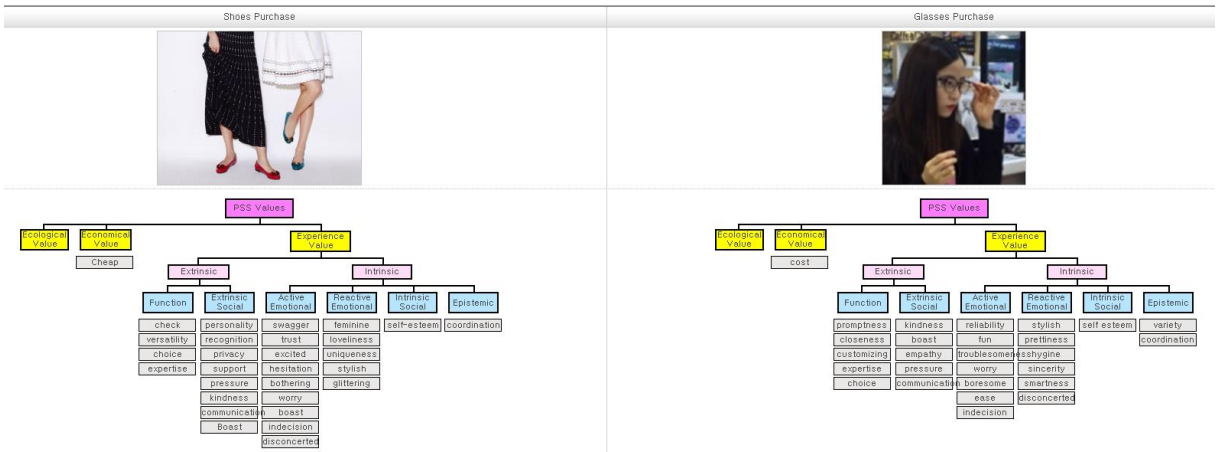

Figure 5. Value Space of Shoes Purchase and Glasses Purchase

Product-Service	Glasses Pu	Kindergarte	Posture As	Child Care F	Heating Ten	Car Seat	Bicycle Cle	Shower Dev	Animation E	Shoes Purc	Van Custom	Health Infor	Air Purifier	Smart Light	Furniture DI
Glasses Purchas	1.00														
Kindergarten Alb	0.55	1.00													
Posture Assistive	0.67	0.56	1.00												
Child Care Robo	0.68	0.53	0.63	1.00											
Heating Tent	0.54	0.41	0.58	0.53	1.00										
Car Seat	0.63	0.65	0.60	0.61	0.45	1.00									
Bicycle Cleanser	0.62	0.46	0.59	0.58	0.62	0.51	1.00								
Shower Device	0.61	0.50	0.60	0.58	0.62	0.54	0.67	1.00							
Animation Blueto	0.59	0.42	0.56	0.61	0.60	0.51	0.63	0.65	1.00						
Shoes Purchase	0.75	0.54	0.64	0.69	0.51	0.61	0.55	0.62	0.59	1.00					
Van Customizatic	0.50	0.59	0.52	0.51	0.37	0.40	0.43	0.47	0.45	0.53	1.00				
Health Informatio	0.60	0.43	0.62	0.58	0.61	0.54	0.65	0.66	0.65	0.58	0.42	1.00			
Air Purifier	0.63	0.45	0.57	0.64	0.61	0.54	0.63	0.69	0.63	0.68	0.42	0.65	1.00		
Smart Lighting	0.66	0.47	0.56	0.59	0.61	0.56	0.63	0.70	0.64	0.66	0.44	0.64	0.70	1.00	
Furniture DIY	0.62	0.64	0.63	0.61	0.51	0.67	0.57	0.59	0.57	0.61	0.50	0.59	0.53	0.56	1.00

Figure 6. Value Space Comparison

4.3 Service Space Comparison

Service concepts proposed in a PSS are classified into 5 categories as discussed in Section 3. PSS cases are compared in service space whether which class of services are of primary foci in the corresponding cases. Like in the case of the value space, the syntactical aspect in the 5 classes is considered. Also keywords of each service concepts are compared using WordNet. While rough comparison of service concepts can be shown in Figure 2, specific pairwise similarities of these 15 cases are shown in Figure 7. Note that the similarity of 0.88 is computed for Shoes Purchase case and Glasses Purchase case. As shown in Figure 8, their syntactic aspects are the same in the service space. Also some semantic aspects are very similar as they include Looks and Coordi both. Another pair of high service space similarity is the pair of Shower Device case and Bicycle Cleanser case as shown in Figure 9. Their syntactical service classifications are similar and they both have Diary Service concepts which help customers book-keep their service experiences to manage and plan their activities and values better. From these cases, the

strategy of PSS design that finding similar cases of the given new PSS case and making some kind of analogical reasoning of the service concepts of similar cases could be used.

Product-Service	Glasses Pur	Kindergarte	Posture Ass	Child Care F	Heating Ten	Car Seat	Bicycle Cle	Shower Dev	Animation E	Shoes Purc	Van Custom	Health Infor	Air Purifier	Smart Light	Furniture DIY
Glasses Purchas	1.00														
Kindergarten Alb	0.59	1.00													
Posture Assistive	0.66	0.65	1.00												
Child Care Robo	0.69	0.75	0.54	1.00											
Heating Tent	0.45	0.41	0.56	0.35	1.00										
Car Seat	0.57	0.66	0.47	0.68	0.28	1.00									
Bicycle Cleanser	0.61	0.67	0.65	0.63	0.44	0.62	1.00								
Shower Device	0.63	0.63	0.56	0.65	0.37	0.73	0.74	1.00							
Animation Blueto	0.43	0.39	0.54	0.33	0.64	0.27	0.42	0.35	1.00						
Shoes Purchase	0.88	0.62	0.64	0.69	0.45	0.57	0.61	0.64	0.43	1.00					
Van Customizatic	0.58	0.44	0.66	0.41	0.70	0.32	0.49	0.40	0.56	0.55	1.00				
Health Informatio	0.41	0.65	0.43	0.56	0.36	0.61	0.56	0.54	0.48	0.42	0.26	1.00			
Air Purifier	0.61	0.62	0.75	0.63	0.44	0.61	0.71	0.70	0.42	0.60	0.51	0.51	1.00		
Smart Lighting	0.54	0.54	0.48	0.56	0.60	0.48	0.59	0.57	0.38	0.54	0.49	0.54	0.60	1.00	
Furniture DIY	0.57	0.54	0.45	0.55	0.50	0.58	0.55	0.62	0.31	0.56	0.43	0.52	0.55	0.73	1.00

Figure 7. Service Spaces Comparison

Figure 8. Service Space Similarity (Shoes Purchase vs Glasses Purchase: 0.88)

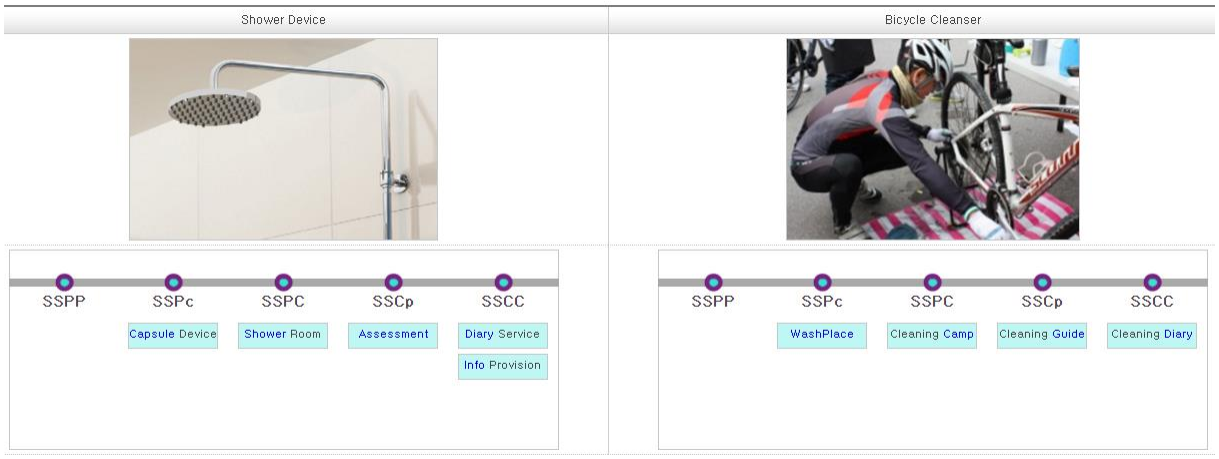

Figure 9. Service Space Similarity (Shower Device vs Bicycle Cleanser: 0.74)

5 CONCLUSION

Many manufacturing companies develop PSS based on their product strengths by devising service elements to achieve business innovation. Such servitization processes and resulting PSSs are all different reflecting the corresponding company's business context and customer needs. In this paper, a representation framework for PSSs to help compare different PSSs and to support the design process has been reviewed. 15 industry PSS cases developed for servitization of manufacturing companies have

been briefly introduced. Comparisons of PSS cases using the representation have been illustrated with product space, value space and service space. It is intended that the utility of the representation framework can be assessed through comparisons of these industry cases. It is desired that more PSS cases from possibly various different industry cases throughout global countries could be represented and stored in the repository so that more diverse utilities of such representation framework can be validated.

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