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Hokyoung Ryu, Hakyoung Song, Kyougwon Seo & Jieun Kim

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Servicizing Solutions for Manufacturing Firms: Categorizing Service Ideas from Product-Service Integrated Examples

Hokyoung Ryu
Department of Arts & Technology, Hanyang University, Seoul, Republic of Korea

Hakyoung Song
Department of Consumer Science, Agro ParisTech, Paris, France

Kyougwon Seo
Industrial Engineering Department, Hanyang University, Seoul, Republic of Korea

Jieun Kim
Graduate School of Technology and Innovation Management, Hanyang University, Seoul, Republic of Korea

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ABSTRACT The present study developed four servicing solutions building upon the systematic literature review including 80 product-service integrated examples from 2003 to 2015. Using both open and closed card-sorting methods with experts and novices respectively, the four categorized servicizing solutions were empirically verified. These include: (1) *add a function with servicizing solutions*, (2) *offset a product's weakness using servicizing solutions*, (3) *propose new user experience (UX) solutions*, and (4) *mix products-services on the other firm's strengths (i.e. inter-firms cooperation)*. Our servicizing ideas may allow firms to practically mitigate the complexity for servicizing solution developments and co-create the ideas with designers and multiple stakeholders.

KEYWORDS: servicizing, card sorting, cluster analysis, product designer, product-service integration

Introduction

The boundary between manufacturing and services is getting blurrier (Christensen and Drejer 2007; Killen 2009; Lightfoot, Baines, and Smart 2013; Pilat et al. 2006). Christensen and Drejer (2007) have empirically demonstrated a high degree of complementarities between manufacturing and service activities. To specify the industry sectors, more than 40% of the firms in the area of transport equipment, wood products, furniture, as well as electronic components have been assigned NACE-codes from both manufacturing and services (NACE-code: Classifica options be fitted to the manufacturing tion of Economic Activities).

Importing new service concepts to manufacturing areas is not new. For example, Rolls Royce, a manufacturer of aircraft engines, provides services in terms of instrumentation and electronics for monitoring and diagnostics. Likewise, many manufacturing firms have become aware of how physical products may be delivered as part of a service package, or support a service delivery and adopted non-technological innovation as they have more become attuned to their customer's needs (Pilat et al. 2006).

With the addition of service components to products, we have also seen a proliferation of inter-industry collaboration (e.g. tertiary service sector and secondary manufacturing sector) to induce inter-firm cooperation (e.g. Samsung's new smart 'TV Plus' being developed by both Samsung Electronics and CJ E&M- Korea's largest TV content provider). TV Plus is a premium virtual channel service to provide personalized contents for viewers.

This trend is very much in line with what has been advocated by much literature on service design, by seeing services as 'systems consisting of people, artefacts and their interactions' (Segelström 2010).

The importance is that a product-service integration cannot be simply seen as an integrated combination of tangible products and intangible services. The emphasis has rather shifted to how to fulfil customer needs and how to provide customer value through product-service integration (Baines et al. 2007; Raijmakers, Thompson, and van de Garde-Perik 2012). This holistic view shows clear implications for the roles of designers to generate product-service integrated design concepts that better meet customers' needs and desires (Brown 2008). How designers and many stakeholders can readily and strategically co-create such integrated design concepts is still unclear.

Tukker (2004), in this sense, detailed three types of product-service integrated design concepts: '*product-oriented*' (e.g. maintenance service in conjunction with product selling), '*use-oriented*' (e.g. rental or leasing products for a better financing or marketing purpose), and '*result-oriented*' (e.g. product-servitization such as voicemail instead of answering machines). Martinez et al. (2010) also proposed a similar taxonomy, with a rather different emphasis on the products-services integration strategies and tactics of business. However, both Van Ostaeyen et al. (2013) and Reim, Parida, and Örtqvist (2015) criticized that such normative design concepts would fail to meet the diverse needs of different manufacturing firms, and it can generally propose dubious servicizing solutions that the designers cannot seriously take them on further (i.e. deservitization [Gebauer, Paiola, and Saccani 2013]).

Van Ostaeyen et al. (2013), instead, proposed a prescriptive model that dictated servicizing options be fitted to the manufacturing firm's dominant revenue mechanism: (i) *input-based* (a firm's resource inputs are additionally needed, e.g. repair or maintenance worker service), (ii) *availability-based* (e.g. monthly rental or leasing options), (iii) *usage-based* (actual usage-based revenue such as OTIS elevator repairing service), or (iv) *performance-based* (PB; revenue is generated based on the functional performance of the product or service). The PB model was then subdivided into three sub-types: *Solution-Oriented* (PB-SO; revenue is generated according to certain solution-specific functional performance, e.g. Initial, Cesco, and Sanokil sanitary product-service integration), *Effect-Oriented* (PB-EO; revenue is generated according to objective functional performance, e.g. ADT alarm products and home security service mix), and *Demand-fulfilment Oriented* (PB-DO; revenue is generated according to a subjective functional performance of how well a customer demand is fulfilled, e.g. Hyundai Motor '*Advantage program*' that replaces the purchased car with a new type of car within a one-month period when a customer is not satisfied).

From a designer's perspective, this normative and prescriptive service, taxonomy is not always amenable to the development of product-service integrated ideas for different types of manufacturing firms. Though previous research on servitization has proposed several models

(e.g. *functional hierarchical model* (FHM; Van Ostaeyen et al. 2013); *Dominant innovation system* (Lee and Kao 2014)), is less applicable in the ideation stage. In fact, the descriptive knowledge for the ideation stage, other than a normative or prescriptive modelling process, can give practical advantages that can involve both *knowledge-how* and *knowledge-that* (Russell 2001). The previous research is arguably seen to focus on the answers to the latter.

A note regarding the research methodology used in this paper is needed. Unlike many scientific investigations, we did not suggest an ideation method in advance or plan to test it with this study. Rather, we employed a systematic review approach to collect a wide range of product-service integrated examples and applied open-end and closed-end card-sorting methods with both experts and novices to obtain a common ground of servicizing solutions. From this, we applied an empirical rather than analytic logic to see if the clustered servicizing patterns could be easily applied to people with different competences and focuses.

Methodology

This study was carried out in three stages (see Figure 1). In the first stage, we gathered all relevant peer-reviewed journals and secondary resources to compile a total of 80 servicizing examples. Second, we employed the open-card- sorting method with three product designers to classify the servicizing examples. We then applied cluster analysis to suggest suitable servicizing ideation labels. Finally, to verify if the

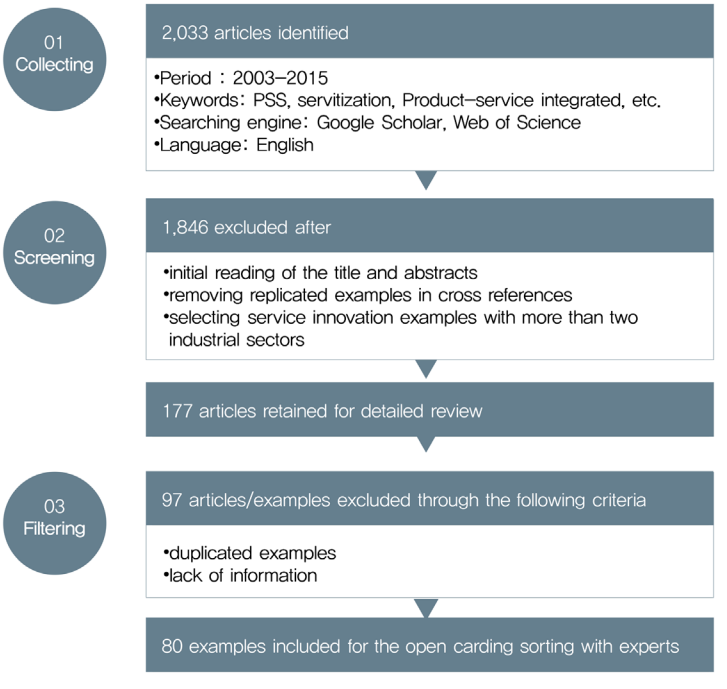

Figure 1.
The three steps to finalize 80 product-service integrated examples.

given servicizing ideation patterns effectively explain service innovation examples, we tested 50 novice designers with the closed-card-sorting method.

Step 1. Search, Screen, and Filter

To gather service innovation examples in the literature, we first carried out a systematic literature review with a specific focus on product-service integrated examples from peer-reviewed journals and secondary resources.

The time frame (2003–2015) for this study was specifically set because the concept of present servitization and service design for manufacturing firms has been widely agreed upon since Tukker's study (2004) that detailed three types of product-service integrated design concepts (Hou and Neely 2013; Reim, Parida, and Örtqvist 2015). The searches were then carried out with a broad range of keywords associated with manufacturing innovation, service engineering, and service innovation research disciplines. These keywords included '*product-service systems (PSS)*,' '*service-dominant logic*,' '*servitization*,' '*service infusion*,' '*integrated service offering*,' '*service transition*,' '*product bundling*,' '*servicizing*' and '*servitization of manufacturing*.' Publication data was collected from databases that comprehensively envelop various service design examples reported in peer-reviewed journals, conference articles, working papers, and additional data from company websites and online newspapers/magazines to supplementary information of cases, which we could not get from the journal. The web search was done using Google Scholar and Web of Science. However, we excluded all articles not written in English. We used EndNote for managing the references in the following systematic review process.

For analysis, we identified 2,033 resources, and for a triangulation purpose, two independent researchers who were not involved in the search and filtering process separately read and assessed the examples. Both researchers have more than ten years in service design and innovation field. As a result, 177 examples were considered for further analysis. With these examples, the authors performed another review to identify any duplicated examples, which resulted in a total of 80 examples, as shown in Table 1.

Step 2. Classifying Servicizing Solutions – Open-Card Sorting with Expert Designers

This stage was intended to group the 80 examples from the systematic review process into similar servicizing ideas. These classified servicizing solutions were reviewed to discover the service innovation patterns and offer service innovation ideas for the product designers.

We recruited three experts with seven to ten years of experience related to product servitization, service innovation, and product design. They were asked to group the 80 examples into similar categories. Figure 2 shows the card example presented to the expert designers.

Table 1. The 80 products-services integrated examples.

ID	*Company*	*Products-services integrated example*	*Reference*
1	Apple	App store & iTunes service	Kim et al. 2011; Nam et al. 2009; Park, Geum, and Lee 2012
2	Hankook tire	T'Station	Ko, Rhim, and Shin 2012; Kim et al. 2011
3	Kachun Hospital	Diabetes diagnosis service	Kim et al. 2011
4	Zipcar	Car sharing service	Gaiardelli et al. 2014; Kim et al. 2011; Kim 2010
5	Call a bike	Bike rental system	Beuren, Ferreira, and Miguel 2013
6	Hilti	Tool rental service	Kim et al. 2011
7	PPG Industries	Total fluids management	Gaiardelli et al. 2014; Kwon 2012
8	York	Guaranty for cool air service	Kim et al. 2011
9	Ecolab	Guaranty for cleaning environment	Kim et al. 2011
10	IBM	Data management service	Tunisini and Sebastiani 2015
11	Xerox	Managing documents service	Baines et al. 2007; Beuren, Ferreira, and Miguel 2013; Gaiardelli et al. 2014; Wang et al. 2011
12	GE	Remote diagnosis service	Jang, Lee, and Lee 2010; Rapaccini and Visintin 2015
13	Megastudy	Online lecture service	Park et al. 2010; Jang, Lee, and Lee 2010
14	Woongjin purifier	Rental & Membership service	Park, Geum, and Lee 2012
15	Starbucks	'On the go' service	Park et al. 2010
16	Lego	Serious play workshop	Nam et al. 2009
17	Carrier Corp	Air cooling service	Lee 2009
18	DowChemical	Lease chemical product	Lee 2009
19	UPS: Rolling laboratory	Telematics service	Lee 2009

(*Continued*)

Table 1. *(Continued)*

ID	*Company*	*Products-services integrated example*	*Reference*
20	Amazon	Personal cloud computing service	Park et al. 2010
21	Hyundai Car	BLU members service	Jang, Lee, and Lee 2010
22	KIA UVO	Infotainment system	Jang, Lee, and Lee 2010
23	Daewoo	USN fire control system	Jang, Lee, and Lee 2010; Kim 2014
24	SK Telecom	Mobile telematics service	Jang, Lee, and Lee 2010
25	Melon	Music streaming service to mobile	Jang, Lee, and Lee 2010
26	LG CNS	Medical service system	Jang, Lee, and Lee 2010
27	KIA K5	Car application with telecommunication	Jang, Lee, and Lee 2010
28	Infopia	Portable medical device	Jang, Lee, and Lee 2010
29	Nexen Tire	Tire rental service	Song 2016
30	Warby Parker	Home try-on service	Marquis and Villa 2012
31	GM	Overdue prediction model	Jang, Lee, and Lee 2010
32	Electrolux	Pay-Per-Wash service:	Baines et al. 2007; Beuren, Ferreira, and Miguel 2013; Park, Geum, and Lee 2012; Kim 2010
33	Mobility	Car sharing service	Baines et al. 2007; Beuren, Ferreira, and Miguel 2013
34	Whirlpool	Monthly pay system	Beuren, Ferreira, and Miguel 2013
35	Océ	Printer integrated system	Rapaccini and Visintin 2015
36	SAME Deutz-Fahr	Precision farming system	Shin 2010
37	Nikon	CS service	Rapaccini and Visintin 2015
38	Velo'v	Bike rental system	Amaya, Lelah, and Zwolinski 2014
39	Ecolo Green Car Wash	Door to door service	Gaiardelli et al. 2014

(*Continued*)

Table 1. *(Continued)*

ID	*Company*	*Products-services integrated example*	*Reference*
40	Philips	Healthcare remote service	Gaiardelli et al. 2014; Shin 2010
41	Nexans	24/7 service system	Gaiardelli et al. 2014
42	Toyota	Eco-tagliando service	Gaiardelli et al. 2014
43	Toshiba	Upgrade warranty service	Gaiardelli et al. 2014
44	Peugeot	Customizing service	Gaiardelli et al. 2014
45	Go Green Car & Van Rental	Eco-friendly service	Gaiardelli et al. 2014
46	Swepac	Customizing service	Lindahl, Sundin, and Sakao 2014
47	Rolls-Royce	Total care support	Kwak et al. 2011; Wang et al. 2011; Shin 2010
48	SmartBike	Sharing bike system	Ceschin 2013
49	EGO	Sharing wardrobe system	Ceschin 2013
50	Smoot	Sharing route system	Liedtke, Buhl, and Ameli 2013
51	Kone	Customizing design elevator	Kwon 2012
52	Interface	Carpet maintenance service	Kim 2011; Shin 2010; Wang et al. 2011
53	Stork Technical Service	Technical support service	Kwak et al. 2011
54	Nike Sports	Supporting US sports camp	Kim 2010
55	Hanssem	Interior consulting service	Lee, Woo, and Park 2011
56	Stitch fix	Online styling service	Kim 2014
57	OTIS	Remote control of monitoring and managing service	Lightfoot, Baines, and Smart 2013
58	Unix	Beauty portal site	Song 2016
59	Panasonic	Fluorescent light rental & recovery service	Kim 2010; Shin 2010

(*Continued*)

Table 1. *(Continued)*

ID	*Company*	*Products-services integrated example*	*Reference*
60	Hyundai Mipo Dockyard	Lifetime service	Song 2016
61	Vinch	Direct investment for construction	Shin 2010
62	LG Household & Health Care	Whoo spa service	Song 2016
63	Hyundai Heavy Industry	'Hi-mate' remote control system	Jang, Lee, and Lee 2010; Kwak et al. 2011
64	Deere & Company	Farming information system	Shin 2010
65	Caterpillar	Remote management system	Kwak et al. 2011
66	Left	IT service for customizing shoes	Song 2016
67	Fiat	Eco-friendly mobile app	Song 2016
68	SHL Telemedicine	Real-time ECG monitoring	Shin 2010
69	Blacksocks	Socks delivery service	Shin 2010
70	Doosan Capital	Machinery financial service	Kwak et al. 2011
71	Betterplace	Battery change service to electronic car	Kim 2010
72	Arrow Electronics	Semiconductor distribution service	Caravella and Deighton 2002
73	Maeil Dairies	Application for baby care solution	Lee, Woo, and Park 2011
74	Cemex	Campaign for social circle	Shin 2010
75	Samsung Electronics	High-quality customer service	Gaiardelli et al. 2014
76	Jindo Fur	Storage service	Song 2016
77	Shouldice Hospital	Patient mentoring service	Heskett 2003
78	LittleMissMatched	Selling three pairs of socks	Fink, Glassboro, and Davis 2013
79	Jafflechutes	Parachute sandwich	Song 2016
80	Meatpack	Kidnapping promotion	Song 2016

The cards were provided in random order. The sessions required around four to five hours and were individually carried out to ensure independent and unbiased evaluation.

Each expert's review of the 80 examples was assigned a numeric score (0 for not the same group, and 1 for the same group) and then subjected to hierarchical cluster analysis (see Figure 3).

In this study, the Euclidean distance of each review result was calculated as a linkage criterion that specifies the dissimilarity of the clusters as the minimum variance criterion. This means that, at any clustering step, the total within-cluster variances were measured (i.e. 3,124 for three clusters, 2,143 for four clusters, and 2,264 for five clusters); in terms of '*Silhouette*' coefficients (Rousseeuw 1987), the four clusters had the largest score (0.705) to explain the different groups.

We then invited the three experts again to revise their previous grouping and to reach agreeable labels as follows: (1) *add a function with servicizing solutions*, (2) *offset a product's weakness by servicizing solutions*, (3) *propose new user experience (UX) solutions (i.e. product-servitization)*, and (4) *mix products and services based on the other firm's strengths (i.e. inter-firm cooperation)* (See Table 2).

Step 3. Verifying Servicizing Ideation Types with Novice Designers

We applied a closed-card-sorting method to ascertain if the four groups could reliably distinguish various servicizing ideas. We invited 50 novice product designers (32 males and 18 females aged 23 to 53 (M = 34.72, SD = 5.78), who had less than three years of experience (M =1.67, SD =.75) in the R&D departments of different manufacturing firms in Korea (e.g. transportation, display, electrical appliance).

The closed-card sorting was conducted by an unsupervised Web data collection method using OptimalSort website (https://goo.gl/lbmTc2) (See Figure 4). The website defined service innovation patterns and the most relevant examples of each category. We randomly selected 24 servicizing ideas from the 80 examples, and then all participants were asked to evaluate and place each idea into one of the four

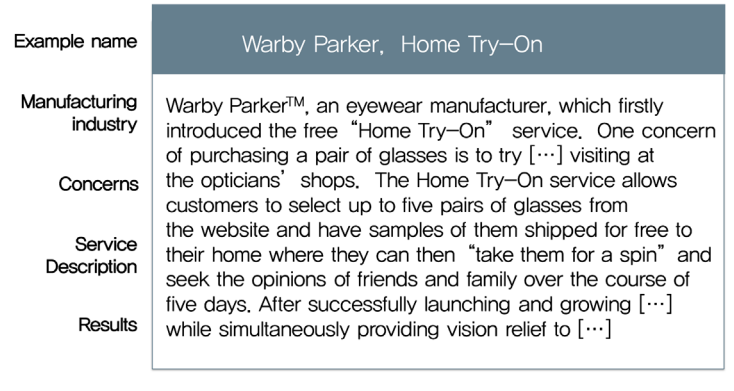

Figure 2.
The card example used in step 2.

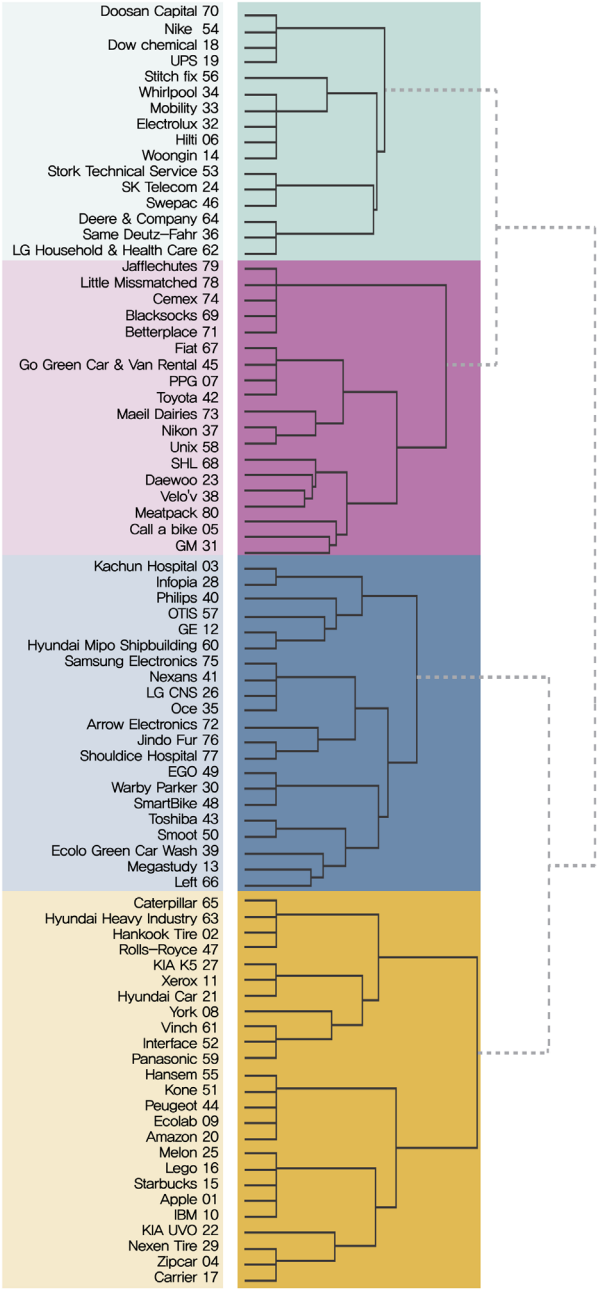

Figure 3.
Dendrogram of the cluster analysis.

servicizing idea categories. All data logs were collected during this Web data collection, and the total response time was between 15 and 25 min. The inter-coder reliability of the classification model was assessed by Fleiss' kappa (0.73).

Table 3 shows how the novice designers classified the examples into one of the four patterns, and the agreement levels of each exam-

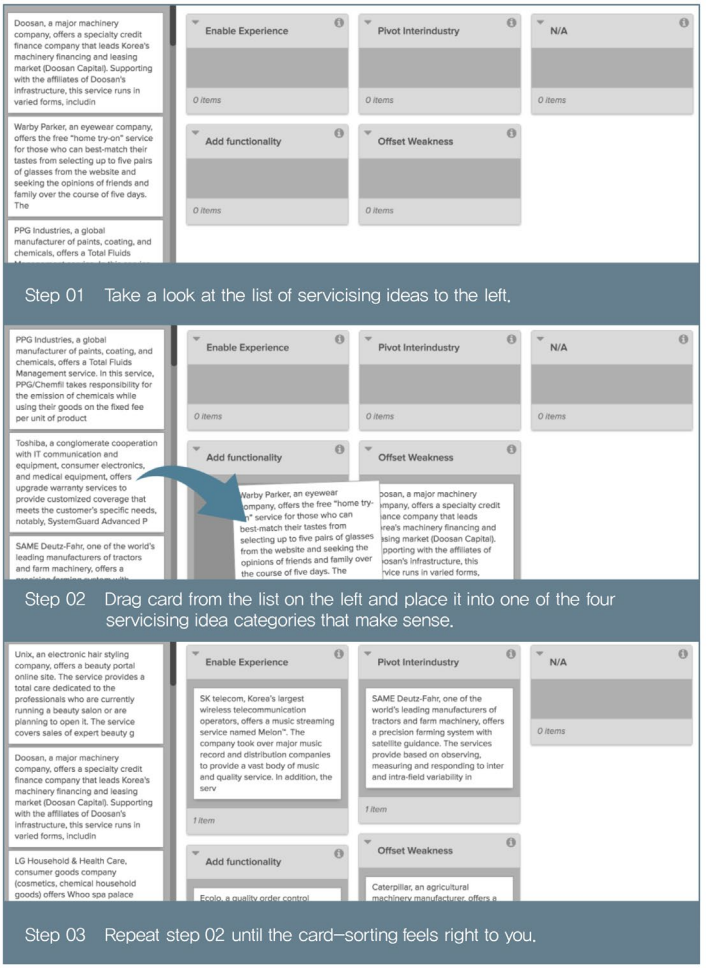

Figure 4.
Closed-card sorting using OptimalSort website.

ple are shown in the last two columns (one for the internal agreement, the other for external agreement with the expert appraisal). The score implied a substantial level of agreement among the novices; except for the inter-firm cooperation category, a consistent appraisal (0.66 to 0.84) between the experts and novices was found. The issue of the inter-firm cooperation category will be further explained in the Discussion Section.

Discussion

Tables 4 and 5 summarize the servicizing solutions suggested in the present study. The first two servicizing solutions are aimed to readily upgrade a firm's existing products for efficacy (i.e. Product-service configuration, Lightfoot, Baines, and Smart 2013; *Resource Utilization,* Gaiardelli et al. 2014; Reim, Parida, and Örtqvist 2015) and sustainability (i.e. Environmental issues, Beuren, Ferreira, and Miguel 2013; Reim, Parida, and Örtqvist 2015). In contrast, the third pattern, new UX

Table 2. Grouping of the 80 product-service integrated examples by the expert designers.

Add a function	*Offset a product weakness*	*UX solutions*	*Inter-firm cooperation*
Doosan Capital (70): Machinery financial service	**Jafflechutes (79):** Parachute sandwich	**Kachun Hospital (3):** Diabetes diagnosis service	**Caterpillar (65):** Remote management system
Nike Sports (54): Supporting US sports camp	**LittleMissMatched (78):** Selling a pack of three mismatched socks	**Infopia (28):** Portable medical device	**Hyundai Heavy Industry (63):** 'Himate' remote control system
Dow Chemical (18): Lease chemical product	**Cemex (74):** Campaign for social circle	**Philips (40):** Healthcare remote service	**Hankook Tire (2):** T'Station
UPS: Rolling laboratory (19): Telematics service	**Blacksocks (69):** Socks delivery service	**OTIS (57):** Remote control of monitoring and managing service	**Rolls-Royce (47):** Total care support
Stitch Fix (56): Online styling service	**Betterplace (71):** Battery change service to electronic car	**GE (12):** Remote diagnosis service	**KIA K5 (27):** Car application with telecommunication
Whirpool (34): Monthly pay system	**Fiat (67):** Eco-friendly mobile app	**Hyundai Mipo Shipbuilding (60):**Lifetime service	**Xerox (11):**Managing documents service
Mobility (33): Car sharing service	**Go Green Car & Van Rental (45):** Eco-friendly service	**Samsung Electronics (75):** High-quality customer service	**Hyundai Car (21):** BLU members service
Electrolux (32): Pay-Per-Wash service:	**PPG Industries (7):** Total fluids management	**Nexans (41):** 24/7 service system	**York (8):** Guaranty for cool air service
Hilti (6): Tool rental service	**Toyota (42):** Eco-tagliando service	**LG CNS (26):** Medical service system	**Vinch (61):** Direct investment for construction
Woongjin purifier (14): Rental & Membership service	**Maeil Dairies (73):** Application for baby care solution	**Océ (35):** Printer integrated system	**Interface (52):** Carpet maintenance service
Stork Technical Service (53): Technical support service	**Nikon (37):** CS service	**Arrow Electronics (72):** Semiconductor distribution service	**Panasonic (59):** Fluorescent light rental & recovery service
SK Telecom (24): Mobile telematics service	**Unix (58):** Beauty portal site	**Jindo Fur (76):** Storage service	**Hanssem (55):** Interior consulting service
Swepac (46): Customizing service	**SHL Telemedicine (68):** Real time ECG monitoring	**Shouldice Hospital (77):** Patient mentoring service	**Kone (51):** Customizing design elevator

(*Continued*)

Table 2. *(Continued)*

Add a function	*Offset a product weakness*	*UX solutions*	*Inter-firm cooperation*
Deere & Company (64): Farming information system	**Daewoo (23):**USN fire control system	**EGO (49):**Sharing wardrobe system	**Peugeot (44):** Customizing service
SAME Deutz-Fahr (36): Precision farming system	**Velo'v (38):** Bike rental system	**Warby Parker (30):**Home try-on service	**Ecolab (9):** Guaranty for cleaning environment
LG Household & Health Care (62): Whoo spa service	**Meatpack (80):** Kidnapping promotion	**SmartBike (48):**Sharing bike system	**Amazon (20):** Personal cloud computing service
	Call a Bike (5): Bike rental system	**Toshiba (43):** Upgrade warranty service	**Melon (25):** Music streaming service to mobile
	GM (31): Overdue prediction model	**Smoot (50):** Sharing route system	**Lego (16):** Serious play workshop
		Ecolo Green Car Wash (39): Door to door service	**Starbucks (15):** 'On the go' service
		Megastudy (13): Online lecture service	**Apple (1):** App store & iTunes service
		Left (66): IT service for customizing shoes	**IBM (10):** Data management service
			KIA UVO (22): Infortainment system
			Nexen Tire (29): Tire rental service
			Zipcar (4): Car sharing service
			Carrier Corp (17): Air cooling service

solutions for the customers who take basic requirements for granted, exhibits greater potential to deliver more value to manufacturing firms (i.e. *customer relationships*, Lightfoot, Baines, and Smart 2013; *Extent of customer interaction*, Reim, Parida, and Örtqvist 2015). Finally, as a firm needs to expand its business model, inter-firm cooperation suggests a new design strategy (i.e. *Extent of Innovation*, Reim, Parida, and Örtqvist 2015).

Solution 1: Add a Function with Servicizing Solutions

Research on servitization suggests that combining product and service businesses can provide a competitive advantage. Current research proposes that the transition to solutions offering integrated combinations of products and services provides strategic benefits to the manufacturing firm, including improved customer satisfaction, higher profitability, and more stable revenue streams (Mathieu 2001).

The first servicizing solution addresses that, in relation to the core products, the servicizing solution can enhance a company's efficiency and effectiveness. For instance, as shown in the UPS and SAME Deutz-Fahr cases, when the risk of transition to a full servitization business model is relatively high (Valtakoski 2016), manufacturing firms tend to focus on a marginal improvement of their product offerings through servicizing solutions.

Solution 2: Offset a Product's Weakness by Servicizing Solutions

Despite some encouraging success stories of servicizing offerings being added to existing prod Davies ucts, many manufacturing firms find the transition difficult to implement and thus fail in servitization (Benedettini, Neely, and Swink 2015; Gebauer, Paiola, and Saccani 2013). As Davies, Brady, and Hobday (2007) suggests, a product-service integration solution means a '*valuable*' solution to the customer. Moreover, it is an integrated solution of product and services customized for a set of customers that allows them to achieve better outcomes than the sum of individual solution components.

The 'offset a product's weakness by servicizing solutions' pattern concerns how servicizing solutions can bolster the weakness of the product offerings to yield a product-service solution. Many hygiene firms (e.g. Initial) work as such solution-providers, rather than individually selling either the product or the service. This means that the fit between the service solution and product design is a critical success factor (Gebauer and Kowalkowski 2012; Gebauer et al. 2010).

The LittleMissMatched case highlights this further. A primary weakness of socks is the loss of one sock from a pair. To change the customer's relationship with their socks, LittleMissMatched offers a design solution that includes each sock with a variety of patterns with only a four-coloured system. Then, it sells three single socks in a pack, where the customer's motives match well with the intent of LittleMissMatched.

Table 3. Results of closed-cards sorting.

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
2	Hankook Tire: T'Station	Hankook Tire, a tire manufacturer in Korea, launches T'Station, which offers total care of car service associated with the battery and break pad. The service includes a premium consulting service to be fitted to the vehicle type, conditions, and customer's preference. They also inform an optimal replacement cycle to enhance the security and the driving comfort of the customer.	UX solutions	0	2	37	11	0	0.59	37/50 = 0.74
7	PPG Industries: Total fluid management	PPG Industries, a global manufacturer of paints, coating, and chemicals, offers a Total Fluids Management service. In this service, PPG/Chemfil takes responsibility for the emission of chemicals while using their goods on the fixed fee per unit of production. This service gives significant environmental benefits in terms of reducing the number of chemicals used, lowering the VOC emissions and improving waste management.	Offset weakness	1	42	6	0	1	0.72	0.84

(*Continued*)

Table 3. *(Continued)*

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
10	IBM: Data management service	IBM, a global computer mainframe manufacturer, offers a data management service. The service provides not only high-end software-defined storage offerings designed to simplify storage management that scale to keep up with data growth, but also solutions about how to build valuable data and effectively analyse them.	Inter-firm cooperation	12	0	14	23	1	0.34	0.46
13	Mega study: Online lecture service	Mega study, the biggest Korean education contents provider, offers a high-resolution online lecture service on the portable mobile device (PMP) developed by a SME called Cowon®. This service provides optimal contents interface and program fitting to the mobile platform and creates a pay-per-download sales system	Inter-firm cooperation	13	1	8	26	2	0.35	0.52

(*Continued*)

Table 3. *(Continued)*

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
15	Starbucks: 'On the go' service	Starbucks, the world's largest coffee chain, offers 'on the go' service. This is a premium self-serve beverage solution providing a selection of hot drinks and gifts in Starbucks' coffeehouse-like experience at work, at leisure, or on the go.	UX solutions	7	1	33	8	1	0.47	0.66
17	Carrier Corp.: Air cooling service	Carrier Corp., a manufacturer and distributor of heating, ventilating, and air conditioning systems, offers a functional service: instead of selling an air conditioner alone, the company gains profits from the air cooling quality and stability.	Inter-firm cooperation	4	1	10	34	1	0.50	0.68
19	UPS: Rolling laboratory	UPS, the world's largest package delivery company, offers telematics sensor-equipped vehicles to monitor the performance of packing cars, including speed, braking, directions, and vehicle conditions. With GPS data, information can be gathered to optimize the efficiency of delivery routes and customer delivery data.	Add functionality	33	8	3	6	0	0.47	0.66

(*Continued*)

Table 3. *(Continued)*

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
25	Melon: Music streaming service to mobile	SK Telecom, Korea's largest wireless telecommunication operators, offers a music streaming service named Melon™. The company took over major music record and distribution companies to provide a vast body of music and quality service. In addition, the service app is pre-installed in the mobile connected to SK telecom carrier to reduce the entry barrier of the first music streaming service in Korea.	Inter-firm cooperation	42	0	3	4	1	0.71	0.08
29	Nexen Tire: Tire rental service	Nexen, a tire manufacturer, offers a tire rental program for winter and free door-to-door maintenance service. The service provides various choices of tires – design and special function – for driving conditions and prevents possible tardy replacement of tires, which might directly menace car safety, especially in special seasons.	UX solutions	11	1	36	1	1	0.56	0.72

(*Continued*)

Table 3. *(Continued)*

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
30	Warby Parker: Home try-on service	Warby Parker, an eyewear company, offers the free 'home try-on' service for those who can best-match their tastes from selecting up to five pairs of glasses from the website and seeking the opinions of friends and family over the course of five days. The company also presents the online application where a customer can upload a photo of their face and virtually 'try on' multiple pairs of glasses.	UX solutions	4	11	35	0	0	0.54	0.7
32	Electrolux: Pay-Per-Wash service	Electrolux, a home appliances manufacturing company, offers functional sales: instead of buying a washer, consumers pay according to how much they use it, a 'pay per wash' service. The service connects the washing machine to a central database via the Internet (i.e. smart meters). After 1,000 washes, households can replace/upgrade the machine.	Inter-firm cooperation	29	5	10	6	0	0.39	0.12

(*Continued*)

Table 3. *(Continued)*

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
36	SAME Deutz-Fahr: Precision farming system	SAME Deutz-Fahr, one of the world's leading manufacturers of tractors and farm machinery, offers a precision farming system with satellite guidance. The services provide based on observing, measuring and responding to inter and intra-field variability in crops.	Add functionality	4	0	10	36	0	0.56	0.08
39	Ecolo green car wash: Door to door service	Ecolo, a quality order control product manufacturer, offers car-cleaning services to companies directly in car parks using their eco-friendly cleaning goods. The service provides the convenient car washing experience to the customer and resolves to raise worries of its environmental impact.	UX solutions	6	6	37	0	1	0.57	0.74

(*Continued*)

Table 3. *(Continued)*

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
40	Philips: Healthcare remote service	Philips, consumer electronics and small appliances company, offers a global remote diagnostic service for their goods (named Philips Healthcare). By using an advanced virtual private network, the service protects system security and patient privacy, allowing the identification of system errors for diagnosing, troubleshooting and performing an immediate remote repair.	Inter-firm cooperation	36	0	6	8	0	0.55	0.16
42	Toyota: Eco Tagliando service	Toyota, a Japanese automotive manufacturer, offers a green maintenance service solution to reduce the environmental impact of its maintenance activities. The service provides 'green' spare and consumable parts, like synthetic oils, which help to reduce the vehicle's fuel consumption and the CO2 emission. Tree planting, mileage coupons, and an extended warranty are then rewarded.	Offset weakness	0	37	8	2	3	0.57	0.74

(*Continued*)

Table 3. *(Continued)*

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
43	Toshiba: Upgrade warranty service	Toshiba, a conglomerate cooperation with IT communication and equipment, consumer electronics, and medical equipment, offers upgrade warranty services to provide customized coverage that meets the customer's specific needs, notably, SystemGuard Advanced Protection Coverage, At-Home Repair, Business On-Site Repair, and Service Express.	UX solutions	6	1	37	5	1	0.56	0.74
56	Stitch Fix: Online styling service	Stitch Fix, a cloth online shopping site, offers the free personal styling service. A styling subscription box offers that an expert stylist send five pieces based on registered profile and customer can try them on at home. Each cloth incorporates a set of styling cards with suggestions on how to wear the particular item.	UX solutions	0	9	36	5	0	0.55	0.72

(*Continued*)

Table 3. *(Continued)*

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
58	Unix: Beauty portal site	Unix, an electronic hair styling company, offers a beauty portal online site. The service provides a total care dedicated to the professionals who are currently running a beauty salon or are planning to open it. The service covers sales of expert beauty goods and equipment, education, hair styling trends, expert communities, and relevant consulting.	UX solutions	18	1	31	0	0	0.50	0.62
62	LG Household & Health Care: Whoo spa service	LG Household & Health Care, consumer goods company (cosmetics, chemical household goods) offers Whoo spa palace chain. This service is formed in a premium aesthetic salon using oriental hand massage techniques and Korean traditional medicine cosmetics produced by LG H&H.	Inter-firm cooperation	30	0	14	3	3	0.43	0.06

(*Continued*)

Table 3. *(Continued)*

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
65	Caterpillar: Remote management system	Caterpillar, an agricultural machinery manufacturer, offers a remote management system. Using telemetrics, the service provides remote monitoring information about the location, utilization, and condition of equipment. This helps to maximize efficiency, increase productivity, and lower operating costs.	Add functionality	4	3	12	31	0	0.44	0.08
67	Fiat: Eco-friendly mobile app	Fiat, an automotive manufacturer, offers eco-friendly mobile app service connected to the car. The service provides a range of electric car battery-related features, such as monitoring battery charge level, location nearby charging stations, precondition vehicle remotely, and scheduling a charge.	Offset weakness	1	34	1	11	3	0.51	0.68
68	SHL Telemedicine: Real-time ECG monitoring	SHL, the pharma/biotech company, offers the smartheart™, the first personal mobile 12-lead ECG device enabling various remote diagnostic and emergency services. Using Bluetooth, digitally encoded ECG data can be sent 24/7 to a monitoring service centre when identifying heart attacks and major and minor turning points affecting health.	Inter-firm cooperation	42	0	4	4	0	0.71	0.08

(*Continued*)

Table 3. *(Continued)*

ID	*Company name*	*Description (short version)*	*Expected pattern by the experts*	*Add functionality*	*Offset weakness*	*UX solutions*	*Inter-firm cooperation*	*N/A*	*Agreement level within novices*	*Agreement level against the experts*
70	Doosan Capital: Machinery financial service	Doosan, a major machinery company, offers a specialty credit finance company that leads Korea's machinery financing and leasing market (Doosan Capital). Supporting with the affiliates of Doosan's infrastructure, this service runs in varied forms, including instalment financing, secondary construction machinery loans, leasing medical equipment, and other facilities.	Inter-firm cooperation	42	1	4	2	1	0.71	0.04
71	Better Place: change service to electric car	Better Place, an Israel-based electric car company, offers battery-charging and battery-switching services for electric cars. In addition, battery-switching stations provide education and a consulting program to check-up electric car specific issues for early users.	Offset Weakness	2	31	14	3	0	0.46	0.62

Table 4. Four types of servicizing solutions for the designers.

Solutions	*Descriptions*	*Goal*	*Primary stakeholders*
Add a function with servicizing solutions	How servicizing solutions can improve efficacy of the core product's performance and process	Efficacy	Manufacturing firm
Offset a core product's weakness by servicizing solutions	How servicizing solutions can ensure sustainability by removing weakness of a core product	Sustainability	Manufacturing firm
Propose new UX solutions	How servicizing solutions can attract existing or potential customers by providing new user experience, underlying the product lifecycle	Attraction	Existing/potential customers
Inter-firm cooperation	How a firm can expand their business model by cooperating with other industrial sectors	Expansion/ Cooperation	Manufacturing firm/ Potential customers

Table 5. Summary of our approach and the literature review of systematic research associated with product-service integrated examples.

Authors	*Methodology*	*Scope*	*Key findings*
The present study	Literature review Open and Closed card sorting	• Data bases: Web of Science, Google Scholar, Web data about company annual reports, research reports • Period: 2003–2015 • Total key journals: 40	Service ideation patterns: Add functionality, Offset weakness, New UX solutions, and Inter-firm cooperation
Reim, Parida, and Örtqvist 2015;	Systematic review Content analysis	• Data bases: Elsevier, Emerald, Springer and Wiley • Period: 2003–2012 • Total key journals: 67	A tactical set of servitization business models: Contract, Marketing, Product design, Sustainability, Networks
Gaiardelli et al. 2014;	Literature review Workshop and conference In-depth interview	• Data bases: Scopus and Pro-quest (ABI Pro)/ Company websites and their brochures • 20 academic experts at workshops/conferences • Interviewed 15 senior level managers from service business and operation sectors for 1-2 h(s) • Data base: ISI Web knowledge, Scopus, Compendex, and Springer Link	A classification model for product-service offerings: Orientation (product-, use-, result oriented), focus (product, process), interactions (transaction-based, relationship-based)
Beuren, Ferreira, and Miguel 2013;	Systematic review	• Data base: ISI Web knowledge, Scopus, Compendex, and Springer Link • Period: 2006–2010 • Total key journals: 149	Definition, benefits and barriers, planning, methodologies, and tools for the Product-Service System
Lightfoot, Baines, and Smart 2013	Systematic review A descriptive and thematic analysis	• Data base: Compendex, Inspec, Web of Science, Pro-quest, ABI Inform, Emerald, and Google Scholar • Period: 1961–2010 • Total key journals: 148	Five generic research themes on servitization: Product-service differentiation, competitive strategy, customer value, customer relationships, product-service configuration

As a result, the customers purchase the solution for their own value creation (Vargo and Lusch 2008). In a similar vein, but to avoid the weakness from environmental risk, such as the surrounding physical environments, Jafflechute provides a 'catch-n-eat' service option using a parachute to deliver sandwiches from the seventh floor to a reserved spot on the ground (a.k.a. float-down eatery).

Combined with a firm's business model and strategies, as with LittleMissMatched and Jafflechute, such servicizing driving forces can remove potential weaknesses in conjunction with service innovation ideas, and this can be touted as providing more economically and environmentally stable product-service offerings.

Solution 3: Propose New User Experience (UX) Solutions

Compared to the two servicizing solutions discussed above, the 'propose new user experience' solution aims to create new customer experiences from product-servitization (Tukker 2004). From a customer's perspective, the need for a servicizing solution stems from the need to create a completely new configuration in the existing product offerings.

This servicizing solution refers to the realization of the overall solution through development and delivery of the required experience components. Therefore, if the solution is implemented and operated successfully, it creates value-in-use for the customer, part of which is appropriated by the manufacturing firm as value-in-exchange during solution implementation or during the operations phase of the system life cycle through value sharing arrangements, such as performance-based contracting.

Thus, we can further analyse where servicizing solutions can be applied in the product life cycle (i.e. buy, use, and maintain & dispose of). For instance, a common pain-point of buying a pair of glasses is the need to try on several frames at the optician's shop. Warby Parker resolves this discomfort by introducing a free 'home try-on' service that delivers several glasses frames to the customer for trial use. For the 'use' in the product lifecycle, a new servicizing idea to attract the N generation (i.e. digital natives) was proposed by Maeil (the biggest dairy company in Korea), that developed a mobile application for young parents to upload pictures of their babies' excrement. This service design also includes the recommended infant food based on their analysis and is now planned to move towards an infant food consulting service (i.e. performance-based contracting).

The category of new UX solutions delivers an integrated solution which requires sufficient design knowledge (or capabilities) of the manufacturing firms that deploy the servicizing solutions. It emphasizes that the required design knowledge is contingent on the analysis of customer's pain points. Given the variance in customer pain points, as well as the complexity and uniqueness of the delivered solutions, there will be considerable variance in servicizing solutions, and each delivery mechanism should be accordingly specified.

Solution 4: Inter-Firm Cooperation

Service innovation can be related to cooperation among manufacturing firms. For instance, Lego Serious Play®, instead of just selling their conventional Lego blocks, saw a market expansion opportunity in the education service sector. That is, pivoting on their original industrial sector (the plastic toy bricks), Lego® expanded their business into a new product-service integrated idea with servicizing solutions.

However, although studies have increasingly addressed the inter-organizational or inter-industry structure of solution provision (Davies, Brady, and Hobday 2007; Gebauer, Paiola, and Saccani 2013), few studies have practically achieved the cooperation and division of labour among organizations. In this respect, it is important to note the studies by Vargo and Lusch (2008) that emphasized the service dominant-logic of marketing based on the division-of-labour for value co-creation. We noted the case of Megastudy, the biggest Korean educational content provider, which offers its high-resolution online lecturing service on a specialized mobile device developed by an enterprise called Cowon. This means that the two firms (an education service firm and electric appliance firm) acknowledged the other party's strengths, and the inter-firm cooperation program yielded a new business market. Of course, it is not mandatory for a manufacturing firm to collaborate with other organizations, particularly if they can independently provide robust product-service offerings. Literature on organizational searches indicates that other firms are a significant source of external knowledge (Laursen 2012). As new production is costly, the firms may choose to instead access the resources of other firms. Hence, collaboration is ideal, as the manufacturing firm does not always possess sufficient resources for implementing the planned solution, and servitization by definition means that interaction among organizations is inevitable.

One of the limitations of this servicizing solution is a poor understanding by the novice designer. Upon reviewing Table 3, many novices were confused with this servicizing solution. It is quite straightforward that this servicizing solution is itself a new function, but the novices could not capture the knowledge-based view of the firms or market trends in their decision. The knowledge-based view, which the expert would

Figure 5.
A sample card for product-service integrated Idea generation.

normally have, hints that knowledge constitutes the key resources of a servicing ideation process. Similarly, Reim, Parida, and Örtqvist (2015) claimed that conglomerate integration in new product developments such as outsourcing, merging, and alliances with other firms could be explained in this regard.

Conclusions and Implications

Many studies on service innovation for manufacturing firms suggest that combining product and service businesses can provide a competitive advantage. Furthermore, our empirical observations also showed that the manufacturing industry acknowledges its importance with the introduction of new service business models and some types of integrated offerings (Gaiardelli et al. 2014; Reim, Parida, and Örtqvist 2015; Tukker 2004).

It is noteworthy that the previous service design taxonomies have not been tested by the product designers who would commonly put forward servicizing ideas for the manufacturing firm. As mentioned by Johnstone, Daintry, and Wilkinson (2009), much of the literature in service design focused on what organizations should do but it did not provide information on how to execute service design. Hence, for design and development, the servicizing solutions proposed in this article work as a springboard to ensure service innovation. Indeed, the hermeneutics of service innovation patterns by the product designer at different levels of competence have not been examined empirically, which is the primary contribution of this research.

Figure 5 illustrated how the four descriptive solutions could be further designed in a set of ideation cards (Idea Snatch Up 2017). A 24-card deck was drawn from the product-service integrated examples collected from the systematic review process. The detailed servicizing story and terms have been partially modified to be applicable for larger subjects involved in an ideation session. While selecting a random array of the cards, the cards may be phrased as questions (e.g. 'How can servicizing solutions ensure sustainability?' or 'How can servicizing solutions attract existing or potential customers?') or provocations to examine similar product-service integration to the one the team is trying to build.

The four descriptive service types can further help the product designer in at least two ways. First, the proposed solution should be what the customer needs, or it will not create sufficient value for the manufacturing firm. That is, if the solution lacks customer orientation, it will not generate enough revenue for the firm. Through this ideation process, the product designer can simulate the solution in the firm's value-creation processes. Second, the servicizing solution may tell the product designer to appreciate the level of customer engagement for the firm's value co-creation. An important concern of service design is to determine if the solution relies too much on the customer; if so, the servicizing solution would be less successful for the firm. For instance, once popular in Korea, total-care service for air purifiers (e.g. a mainte-

nance worker does monthly home-visits) is now being replaced with a self-filter replacement service design thanks to the dynamic changes of customer engagement level.

Our servicizing solutions might practically show a way to support firms' decision-making points and provide a critical link among further strategic-level decisions, operational-level actions, and offerings. We assume that the modularity of integrated solutions is important for service innovation, which is why manufacturing firms need to consider a servicizing solution for their product offerings. Instead of being monolithic, solutions consist of components that are interdependent yet may be developed or acquired separately. Modularity allows the manufacturing firms to mitigate the detrimental effects of complexity for servicizing solution developments. Cooperation between different sectors, as a whole, enables the parallel development of manufacturing firms and service providers (as witnessed in Samsung Smart TV in cooperation with CJ E&M). Further studies are needed to confirm this interpretation.

There are a number of potential limitations to this study. For example, three experts first developed the four product-service categories, which might limit the results of this study. This issue needs to be more rigorously examined in another round of open-card sorting, which we plan to do in the near future. An understanding of how the four patterns parse service innovation also needs to be achieved. We leave these limitations mentioned above as interesting issues and avenues for further research.

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Biographies

Hokyoung Ryu is a professor in the Department of Arts & Technology at Hanyang University, Republic of Korea. He is interested in service experience design, and how arts and service design can be merged to indicate a new way of service design development. He is also currently working on several VR arts projects with students who graduated with degrees ranging from arts to pure mathematics.

Hakyoung Song is a PhD student in the Department of Consumer Science at Agro ParisTech in France. Her research interests include the development of user-centred design tools, product-service design and methodologies regarding to interaction between consumer and product during multi-sensory perceptions.

Kyoungwon Seo is a PhD student in the Industrial Engineering Department at Hanyang University. His research interests focus on applying insights from both virtual reality technology and cognitive psychology to enhance user experience. He is particularly interested in design manufacturing and the healthcare domain to improve user's psychological, emotional, and behavioural experiences.

Jieun Kim is an assistant professor and the co-leader of Imagine X Lab at the Graduate School of Technology and Innovation Management at Hanyang University, Republic of Korea. Previously, she was a Leverhulme Research Fellow at the Royal College of Art. In 2011, she completed her MSc and PhD in Design at Arts et Metiers ParisTech. Her research interest covers the area of technology design for innovation, including design creativity and service design.

Address for Correspondence

Jieun Kim, Graduate School of Technology and Innovation Management, Hanyang University, Seoul, Republic of Korea.
Email: jkim2@hanyang.ac.kr