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Generating New Product-Service System Concepts Using General Needs and Business System Evolution Patterns: A Furniture PSS Case

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ABSTRACT

In a product environment where various product-service systems (PSSs) are already being provided, the provision of a different type of PSS is difficult for second movers but necessary for their sustainability and differentiation. Despite the importance of providing distinguishing PSSs to market, prior PSS studies have not effectively considered the influence of existing PSSs in their methods. In response, we suggest an approach to generate new PSS concepts by employing general needs (GNs) and business system evolution patterns (BSEPs). Our approach 1) identifies customer GNs fulfilled by existing PSSs, 2) generates advanced PSS ideas from an evolutionary perspective by mapping the existing PSSs onto BSEPs, and 3) selects PSS ideas that can meet the unfulfilled or insufficiently considered GNs using a GN-PSS linking matrix, thereby generating new PSS concepts based on the selected ideas. The workings and practicability of this approach are illustrated using a PSS case study of furniture industry. This approach would provide PSS planners with an ability to generate the differentiated PSS concepts that handle the customer needs that have been untapped throughout a product's lifecycle. In addition, this approach as a module will have a synergetic effect when incorporated with other PSS methodologies.

Keywords: Product-Service System, Concept Generation, General Needs, System Evolution Patterns, Furniture

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1. INTRODUCTION

The reduction in product consumption and increase in global competition in modern society have increased the pressure on manufacturing firms over the last few decades (Mont, 2002). To cope with this pressure, manufacturers have started to provide new types of goods that combine their products with services for new business opportunities and sustainable profit-generation (Morelli, 2006). Such goods are called product-service systems (PSSs). A PSS, which is defined as the combined provision of products and services capable of fulfilling users' needs (Goedkoop, 1999), can satisfy customer needs on a higher level (Tukker, 2004; Baines *et al.*, 2007) because it focuses on the utility of the products and services throughout a product's life cycle, rather than only on selling the actual products.

Due to the usability of PSS, PSS practices are increasingly recognized as an alternative to secure competitiveness in various industries, including those of automobile (Williams, 2007), water purification (Baines *et al.*, 2007), and furniture (Besch, 2005), so that manufacturing firms can differentiate and diversify their business models from their surrounding products to better respond to changing customer needs (Isaksson *et al.*, 2009). Therefore, it has been suggested that a firm's ability to deliver new PSSs to the market is positioned at the core of PSS competitiveness (Park and Yoon, 2015).

Generic PSS development processes are largely composed of four steps: requirement analysis, concept generation, detailed design, and evaluation. Early studies suggested comprehensive PSS concept development frameworks, which contain steps, tools and checklists, such as the methodology of PSS (MEPSS) (Van Halen *et al*., 2005) and the define, focus, analyze, create, evaluate-service innovation (DFACE-SI) (Uchihira *et al*., 2008). MEPSS supports the creation of PSS concepts through identifying the relationship between customer needs and PSS functions, and measuring the economic and environmental values of PSS concepts in a product life cycle; DFACE-SI in particular creates PSS concepts by analyzing the situations where customers use products. However, due to the importance of distinguishing business models in competitive environments, the first two steps are considered the most critical in the PSS development process (Morelli, 2006). Later studies therefore focused mainly on the PSS idea or concept generation and approaches combined with other techniques were suggested, including TRIZ (Russian acronym for the theory of inventive problem solving) (Chen and Li, 2010; Chen and Huang, 2011; Yang and Chen, 2011), product life cycle data (Yang *et al*., 2009), quality function deployment (Kim and Yoon, 2012), categorization of 118 PSS cases (Kim *et al*., 2012), PSS maps (Fujata *et al*., 2013), and chance discovery theory (Park and Yoon, 2015).

Considering that PSSs will be accepted as an effective means for sustainability in industries (Beuren *et al*., 2013), there would be a high likelihood that PSSs related to a product are already provided in the market and are in competition with each other. In this situation, such existing PSSs would impede second movers to develop and differentiate new PSSs. Although the aforementioned previous methods are useful in terms of their new idea generation capability, they may not work well in the PSS environments where competing PSSs already exist. This is because prior studies paid little attention to developing a method to generate distinguishing PSS concepts from the existing PSSs; rather, these previous methods are appropriate for a product environment that has few or no existing PSSs. An effective way to develop a differentiated type of PSS concept would be to identify the types of customer needs that are being neglected or insufficiently considered, and thereby to generate PSS concepts to target these unfulfilled needs. This PSS concept development, which is similar to blue ocean strategies that create uncontested market space and make competition irrelevant, could create a unique and customized client relationship that competitors cannot easily copy, thereby positioning firms competitively in the value chain (Park and Yoon, 2015).

To tackle this issue, this study proposes an approach for generating a differentiated type of PSS concept by using customers' general needs (GNs) and the business system evolution patterns (BSEPs) of TRIZ. The proposed approach consists of1) identifying the currently satisfied customer GNs by using existing PSSs and our proposed GN-PSS linking matrix, 2) generating advanced PSS ideas in terms of system evolution by mapping the existing PSSs onto BSEPs, and 3) identifying distinguishing PSS ideas that can meet the neglected or insufficiently considered GNs using the GN-PSS linking matrix, and also generating new PSS concepts based on the identified distinguishing PSS ideas. We illustrate the workings and practicality of the proposed approach using a PSS case study in the furniture industry.

Our contribution is threefold. First, our approach provides a way to generate a different type of PSS concept from existing PSSs by using GNs, BSEPs, and the GN-PSS linking matrix. This study combines GNs and BSEPs functionally with our research motivation and suggests the GN-PSS linking matrix to identify the types of customer needs satisfied by existing PSSs and generated PSS ideas. Second, in the same vein of the first contribution, this approach will help PSS planners identify and develop new PSSs for unfulfilled customer needs under a product domain constrained by existing PSSs. Third, as a module for PSS concept generation, this approach will create a synergetic effect when incorporated into other comprehensive PSS development methodologies.

The remainder of this paper is organized as follows. In section 2, we present an overview of the theoretical background and in section 3, we describe our approach to developing new PSS concepts based on GNs and BSEPs. In section 4, we present a case study in which the proposed approach is applied and in section 5, we discuss the proposed approach, the contributions of proposed approach and the possibilities for future research.

2. THEORETICAL BACKGROUND

This study suggests a PSS concept generation approach based on GNs and BSEPs. This section therefore briefly overviews the two background theories in the PSS field.

2.1 Customers' GNs

Customer needs are variously represented because they depend on the products and their surrounding environmental contexts. A number of studies have been carried out to identify customer needs from a PSS perspective. In one study, a guideline was proposed to elicit and classify requirements using a checklist (Müller *et al*., 2010), and in another study, a bi-layered matrix was proposed to evaluate and classify the requirements identified in a business-to-business service based on the fulfillment levels of the requirements, the Kano quality, and SWOT analysis (Akasaka *et al*., 2010). In other studies, receiver state parameters have been used to represent customer needs and measure customer satisfaction levels (Shimomura and Tomiyama, 2005; Shimomura *et al*., 2009). These studies related to customer needs analysis

are useful for defining, evaluating and classifying the needs customized to specific products and customer situations.

However, the main task of our study is to holistically consider all customer needs, fulfilled and unfulfilled by existing PSSs, throughout a lifecycle perspective. To achieve this, our method needs to generalize variously represented customer needs from a PSS perspective and thus utilize customers' GNs. Customers' GNs were proposed by (Kim *et al*., 2012), and include a total of 20 generic customer GN types (Table 1). The 20 GNs are grouped into three stages of the PSS lifecycle: purchase, use, and disposal. The purchase stage (GN1-GN3) involves the needs at the time when customers purchase PSSs, the use stage (GN4-GN17) involves the needs at the time when customers use PSSs, and the disposal stage (GN18-GN20) describes the needs at the time when customers dispose of PSSs. As a useful tool to abstract and classify customer needs, GNs are able to transform variously expressed customer needs into general types (Kim *et al*., 2012). For example, the customer needs of 'customers who want to dispose of their car in an environmentally friendly way' can be converted into the GN of "pro-environment disposal" (GN18).

In this research, our approach combines the GNs and our proposed GN-PSS linking matrix to identify those customer needs that are dealt with by existing PSSs in the product domain in question. For example, an existing PSS offers a furniture lease and cleaning service, the GNs fulfilled by the PSS could be "low cost to buy or use" (GN1), "low maintenance" (GN11), and "ease of disposal" (GN19). By gathering and analyzing existing PSSs in a product domain, the GN-PSS linking matrix displays the GNs tapped by the PSSs, thereby locating the unfulfilled or insufficiently considered GNs as the potential customer needs for further PSS concept development. The customized use of GNs is a distinguishing aspect of our study and is the core step to identifying untapped customer needs.

2.2 BSEPs

TRIZ is a set of systematic tools for inventive idea generation and problem solving to increase the ideality

Table 1. GNs According to the PSS Lifecycle (Kim *et al*., 2012)

Stage	General needs	Description
Purchase	GN1. Low cost to buy or use	Customer wants to buy or use product/service at a low cost
	GN2. Ease of purchase;	Customer wants to buy product/service in an easy, convenient, and simple way
	GN3. Information on product/service life cycle	Customer wants information on the product/service life cycle
Use	GN4. Various functions	Customer wants information on the product/service
	GN5. Pro-environment material	Customer wants the product/service to be made of pro-environment materials
	GN6.Pro-environment resource	Customer wants the product/service to be made with pro-environment resources
	GN7. Resource reduction	Customer would like a reduction in the amount of resources used
	GN8. Customized use	Customer wants to customize the product/service according to his or her needs
	GN9. Optimized use	Customer wants to use the product/service in the best or most optimized condition.
	GN10. Best performance	Customer wants the product/service to show the best performance
	GN11. Low maintenance	Customer wants a low-maintenance product/service
	GN12. Flexible use	Customer wants the product/service to be flexible so he or she can use it in various ways
	GN13. Long term use	Customer wants to use the product/service for a long time
	GN14. Stable use	Customer wants a steady and consistent performance from the product/service
	GN15. Ease of use	Customer wants to use the product/service in an easy, convenient, and simple way
	GN16. Availability beyond space and time	Customer wants to use the product/service anytime and anywhere
	GN17. Additional value creation from use	Customer wants additional value from the use of the product/service
Disposal	GN18. Pro-environment disposal	Customer wants to dispose of the product/service in a pro-environmental manner
	GN19. Ease of disposal	Customer wants the ability to dispose of product/service easily
	GN20. Additional value creation from disposal	Customer wants addition value from the disposal of the product/service through disposal

of systems (Salamatov *et al*., 1999; Savransky, 2000). TRIZ techniques have been used in some studies, including the contradiction matrix, subject-field modeling, and 40 inventive principles (Chen and Huang, 2011; Kim and Yoon, 2012). Among various TRIZ techniques, the laws of technical system evolution are used to anticipate improvements that will most likely improve the systems (Verhaegen *et al*., 2009). A follow-up study extended the evolution laws to 35 specific evolution patterns (Mann, 2003) and, despite some controversies, the updated technical system evolution patterns were successfully used to identify technology forecasting and product opportunities (Verhaegen *et al*., 2009; Yoon and Kim, 2012; Park *et al*., 2013).

The technical system evolution patterns were converted into a total of 36 BSEPs from a perspective of business and management problems (Figure 1) (Mann, 2007). BSEPs are grouped into three types: time (6 patterns), space (5 patterns), and interface (25 patterns). Each BSEP includes "evolution stages" and explains "reasons for jumps" for directed idea generation to move from a prior stage to the next stage; the next stage indicates a quantum jump from the prior stage in light of system ideality. Our approach uses BSEPs to create new PSS ideas that are more advanced than existing PSSs from the ideality perspective. Using the GN-PSS linking matrix, this approach generates PSS ideas that handle the untapped or insufficiently considered GNs by existing PSSs. This differentiates our approach from other prior TRIZ-based PSS studies.

3. PROPOSED APPROACH

This section explains the proposed approach for PSS concept generation. The approach consists of three steps: 1) identifying customer GNs handled by the existing PSSs by using the GN-PSS linking matrix, 2) generating advanced PSS ideas from an evolutionary perspective by mapping the existing PSSs onto BSEPs, and 3) selecting new PSS ideas and generating new PSS concepts for the unfulfilled or insufficiently considered GNs by using the GN-PSS linking matrix (Figure 2). The following subsections describe each step in detail.

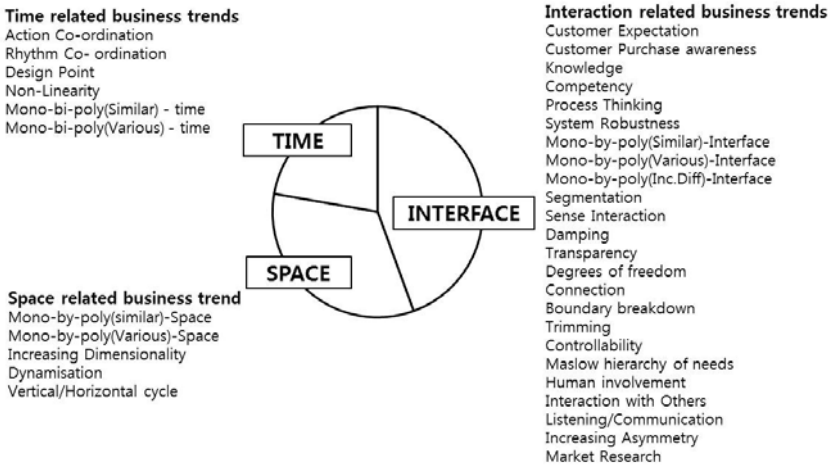


Figure 1. BSEPs, Redrawn from (Mann, 2007).

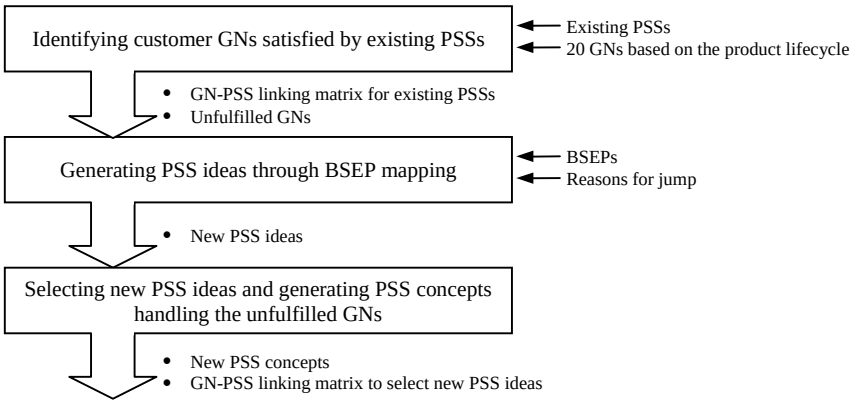


Figure 2. Flow Chart for PSS Concept Generation.

3.1 Identifying Customer GNs Satisfied by Existing PSSs

The aim of our approach is to generate a distinguishing type of PSS concept in a constrained environment where various PSSs exist within the product domain in question. The first step is therefore to collect the PSSs provided by competing firms and then determine the customer GNs currently fulfilled by the PSSs. Detailed information on the current PSSs can be obtained in the form of textual statements from the PSS firms' various resources, including interviews, websites, and commercial advertisements.

PSS design can provide customers with benefits over the product lifecycle (Yang *et al*., 2009), and accordingly, from the lifecycle perspective, the customer needs of certain types that can be fulfilled by existing PSSs could be converted into one of the 20 GNs in the three stages of purchase, use, and disposal. Therefore, in this step, the existing PSSs' features, such as mechanisms and characteristics, are analyzed to identify the customer GNs that are handled by each existing PSS.

We propose the GN-PSS linking matrix, which contains the relations between GNs and PSSs (Figure 3). Each PSS is either an existing PSS or a newly generated PSS idea, and can be related to one or more GNs. To link between existing PSSs and GNs, PSS planners can analyze the main features for each existing PSS in terms of lifecycle, thereby recognizing the GNs fulfilled by the existing PSSs. For example, EP1 currently deals with GN1 and GN20, and EP2 handles GN2. The links between new PSS ideas (NPIs) and GNs will be identified in section 3.3.

3.2 Generating PSS Ideas through BSEP Mapping

The second step involves generating PSS ideas, which become the material for creating PSS concepts. In this study, a reference-based approach using BSEPs is used to improve the current PSSs' ideality.

General Needs	Existing PSSs				Generated PSS ideas			
	EP1	EP2	···	EPn	NPI1	NPI2	···	NPIm
GN1								
GN2								
GN3								
···								
GN20								

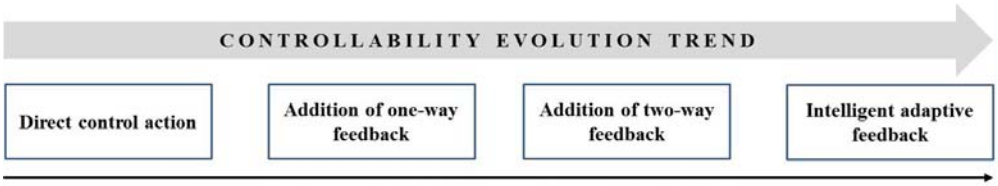
Figure 3. Schematic of the GN-PSS Linking Matrix (EPs = Existing PSSs; NPI = New PSS Ideas).

In order to generate new PSS ideas, we now identify the evolution stages of the existing PSSs using BSEPs. Methodologically, 36 BSEPs can be used, but to simplify the working process of applying our approach selectively choses BSEPs. After selecting BSEPs, the current evolution levels of the existing PSSs are determined by relating them to one of each of the BSEPs' evolution stages; the mapping guideline and practical examples for each BSEP, called "reasons for jump", have been well described in a prior study (Mann, 2007). For example, PSS concepts of continuous and automatic maintenance can be on an "intelligent adaptive feedback" stage in the BSEP "controllability" (Figure 4). This step outputs a radar diagram to represent an overall evolutionary state with respect to the existing PSSs and also we can recognize which evolution level of BSEPs is high or low. BSEPs with a low evolution level indicate that there would be a higher likelihood of being advanced PSS ideas from the perspective of system ideality.

Then, PSS ideas for PSS improvement are generated by examining the "reasons for jump" from a current evolution stage to the next stage; "reasons for jump" for each BSEP explains the generic methods to move towards the next generation. For example, considering a PSS is related to the BSEP "controllability" and its current stage is "addition of two-way feedback", analysts can create new PSS ideas for the shift towards the "intelligence adaptive feedback" stage by applying specific mechanisms, including self-learning and self-repairing (Figure 4). In this step, analysts generate PSS ideas based on "reasons for jump" through brainstorming, and the generated PSS ideas become the candidates to generate PSS concepts in the next step. As a result, this step outputs PSS ideas generated for each BSEP. The PSS ideas, as the building blocks for PSS concept generation in the next step, are represented as simple and abstract textual statements.

3.3 Selecting New PSS Ideas and Generating New PSS Concepts Handling the Unfulfilled GNs

Although each of the newly generated PSS ideas has the increased ideality, it would not always become a building block to construct new PSS concepts different from existing PSSs. For this reason, these PSS ideas are incorporated into the GN-PSS linking matrix (Figure 5) by applying the same logic as that in section 3.1. By positioning generated PSS ideas on the GN-PSS linking matrix, PSS planners can identify the distinguishing points of the new PSS ideas, taking into consideration the GNs that are being neglected or insufficiently considered. For example, GN4 is an unfulfilled GN because it is a need not previously considered by existing PSSs. Likewise, GN7 is not sufficiently considered by the existing PSSs because it is addressed by only one existing PSS (EP3). Therefore, for this example, the unfulfilled or insufficiently considered GNs are GN4 and GN7.



Evolution Stage	Reason for Jumps
Direct control action to Addition of one-way feedback	- improved morale - reduced misinterpretation of communication - reduced passive-aggressive behaviour
Addition of one-way feedback to Addition of two-way feedback	- system self-correction - reduced likelihood of error/catastrophic failure - ability to control function delivery to specified requirements - improved user-proofing - improved involvement and morale
Addition of two-way feedback to Addition of two-way feedback	- adaptive systems - self-learning system - self-repairing system - reduced likelihood of system failure

Figure 4. BSEP "Controllability", Redrawn from (Mann, 2007).

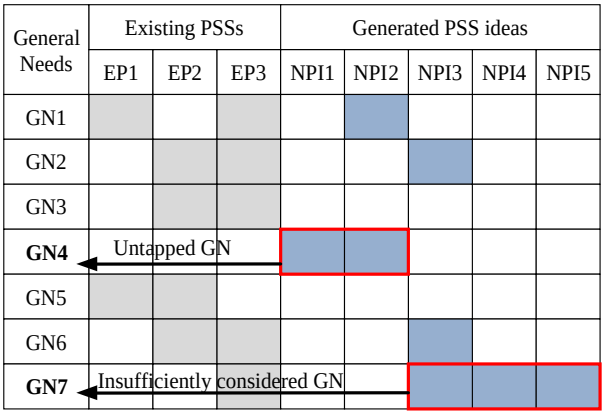


Figure 5. Selecting New PSS Ideas Using a GN-PSS Linking Matrix.

PSS planners can select some of the PSS ideas that deal with the unfulfilled or insufficiently considered GNs. In terms of potential needs and system evolution, these PSS ideas could possibly be differentiated from existing PSSs, because they aim to satisfy untapped or insufficiently considered GNs under the product environment constrained by existing PSSs.

Finally, since the PSS ideas are too abstract to be a business model, this step concretizes the PSS concepts by using selected PSS ideas. PSS concepts should be defined clearly; accordingly, they are usually composed of PSS titles, target customers, and channels (Kim *et al.*, 2012). The titles are implicative of the PSS concepts, while the target customers are the specific customers who need and want the generated PSS concepts and the channels are the methods used to provide the PSS concepts to the target customers. Therefore, new PSS concepts are generated in this step by concretizing each PSS idea selected or combining two or more PSS ideas.

4. ILLUSTRATIVE EXAMPLE: A FURNITURE PSS CASE

In this section, the proposed approach is illustrated using the case of a furniture PSS. Furniture firms have recently attempted to provide customers with various PSSs over the product lifecycle (including furniture purchase, use, and disposal) for sustainable development and competitiveness. For example, PSSs such as furniture cleaning and maintenance are now competing within the furniture domain. The provision of a distinguishing type of PSS would be highly constrained in this domain, and we therefore concluded that the furniture domain fits with the purpose of our approach.

To execute the proposed approach, we first collected existing PSSs that compete within the furniture domain. By searching furniture firms' websites and their service specifications, we found existing PSSs that are provided by six firms (Table 2).

Table 2. Existing PSSs

Firms	Brief description of existing PSSs
EP 1(Firm 1)	• Office environment consulting and regular checkups of furniture condition.
EP 2(Firm 2)	• Providing furniture fit for children based on personality type test when customer purchases furniture.
EP 3(Firm 3)	• Order production and interior solution by 1:1 consultation when customer purchases furniture.
EP 4(Firm 4)	• Two-way message service for fast interaction. • Furniture re-installation when moving. • Regular bed mattress checks and cleaning.
EP 5(Firm 5)	• Managing furniture selection, installation and maintenance.
EP 6(Firm 6)	• Furniture lease and customized consultation.

Table 3. GNs Fulfilled by Existing PSSs

Company	Fulfilled GNs	Description
EP1	GN2 Ease of purchase	Consulting service helps with selection of furniture.
	GN8 Customized use	Consulting service provides furniture suited to customers.
	GN9 Optimized use	Regular checkup service ensures the consistently optimized use of furniture.
	GN10 Best performance	Regular checkup service helps customers use furniture for best performance.
	GN13 Long use	Regular checkup service helps customers use furniture for a long time.
	GN14 Stable use	Regular checkup service helps customers use furniture in a stable manner.
	GN17 Availability value creation from use	Office environment consulting service can improve the efficiency of workers in the office.
EP2	GN2 Ease of purchase	Child characteristics-based furniture recommendation removes the stress of furniture selection.
	GN8 Customized use	Customized furniture is recommended based on children's personality types.
	GN17 Availability beyond space and time	Child characteristics-based furniture is helpful for growing children.
EP3	GN2 Ease of purchase	Customized order production and interior solutions ensure furniture is fitted to the customer
	GN8 Customized use	Customized order production and interior solutions enables furniture use based on customers' requirements.
EP4	GN10 Best performance	Re-installation and regular cleaning services help customers use furniture with the best performance.
	GN11 low maintenance	Re-installation and regular cleaning services help customers reduce maintenance costs.
EP5	GN2 Ease of purchase	Managing furniture selection helps customers buy furniture easily and simply.
	GN8 Customized use	Managing furniture selection and installation helps customers use customized furniture.
	GN9 Optimized use	Installation and maintenance service can help customers use furniture in the best or optimized condition.
	GN10 Best performance	Maintenance service enables customers to use furniture with the best performance.
	GN14 Stable use	Maintenance service allows customers to use furniture steadily and consistently.
EP6	GN1 Low cost to buy or use	Lease service can help customers use furniture inexpensively.
	GN2 Ease of purchase	Consultation and lease service can help customers buy furniture in an easy, convenient, and simple way.
	GN19 Ease of disposal	Furniture is returned at the expiration of lease service.

Six analysts, including researchers and graduate students who are familiar with PSSs, examined the detailed statements of each existing PSS to identify the GNs that are dealt with by existing furniture PSSs (Table 3). The GN-PSS linking matrix according to existing PSSs (Table 8) shows that the GNs of the purchase and use stages have been well considered by existing furniture-related PSSs and that the GNs of the disposal stage have not been addressed sufficiently. In particular, for most of the existing PSSs, attempts have been made to fulfill the GN8 "customized use" by providing furniture consulting for office environments and for specific children's personality types, and by developing furniture production and installation based on customized orders.

In order to generate new PSS ideas, we now identify the evolution stages of the existing PSSs using BSEPs. Methodologically, 36 BSEPs can be used, but to simplify the working process of applying our approach we selectively chose 12 BSEPs (Table 4): customer purchase focus, sense interaction, increasing transparency, connections, controllability, reducing human involvement, interactions with others, listening/communicating, market research, design point, and dynamization.

Three TRIZ analysts (experts with an average of 4.7 years experience) mapped the existing PSSs onto the evolution stages of BSEPs by examining the PSSs' statements and core mechanisms (Table 5). BSEPs contain various numbers of evolution stages, so we normalized each BSEP using the number of BSEPs' evolution stages. We could then output a radar diagram to visualize the overall evolution levels of the existing PSSs (Figure 6). The evolution level of BSEP "Listening/communication" (average = 0.7) was found to be relatively high in the existing PSSs, because most existing PSSs focus on communication with the customer in furniture consultancy. For example, providing a fit for the customer ac-

Table 4. Selected 12 BSEPs and Their Evolution Stages

Step	1	2	3	4	5	6
Customer Purchase Focus	Performance	Reliability	Convenience	Price		
Sense Interaction	1	2	3	4	5	
Increasing Transparency	Opaque	Partially Transparent	Transparent			
Connections	Fixed Connection	Discretely Switchable	Continuously Switchable			
Controllability	Direct Control Action	Addition of One-way Feedback	Addition of Two-way Feedback	Intelligent Adaptive Feedback		
Reducing human involvement	Human(H)	H+ Tool(T)	H+semi-Automated Tool (A.T)	H+(A.T)	(A.T)	(A.T) + Autopoeisis
Interactions with Others	Dependent	Independent	Inter-Dependent			
Listening/ Communication	Ignoring	Pretending to Listen	Selective Listening	Attentive Listening	Empathic Listening	
Market Research	Demographics	Findographics	Psychographics	Autopoeisis		
Design Point	System optimized for single operating point	System optimized for two operating points	System optimized for several operating points	System re-optimized continuously		
Dynamization	Rigid System	System With "Hard" and "Soft" Elements	Fluid System			

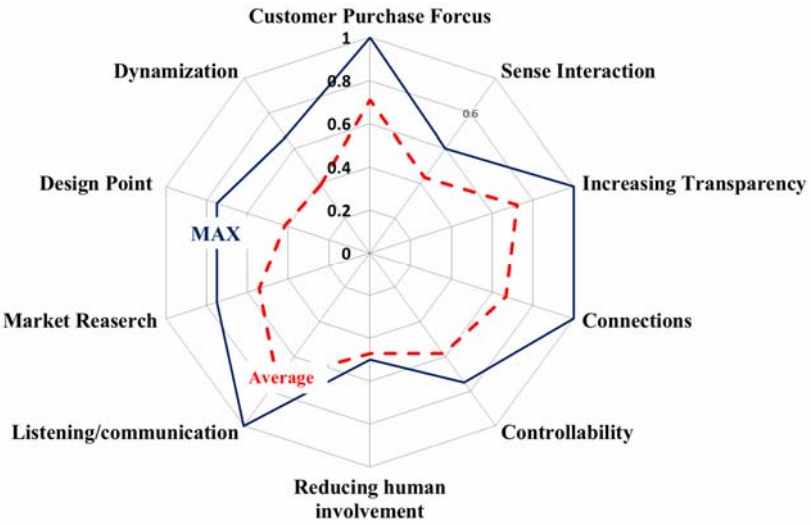


Figure 6. Diagram of Mapping Existing PSSs onto BSEPs.

Table 5. Mapping existing PSSs on BSEPs

BSEPs	Existing PSSs	level	Description
Customer purchase focus	EP1	2	Consulting and regular check-up ensure performance and reliability.
	EP2	2	Furniture fit for children ensures child safety.
	EP3	3	Order production ensures convenience.
	EP4	3	Re-installation, mattress checks and cleaning service ensure convenience.
	EP5	3	Management of selection, maintenance and installation ensures reliability and convenience.
	EP6	4	Furniture lease and customized consultation ensure performance and price.
Sense interaction	EP1	3	Office environment consulting allows for sight, touch, and hearing interactions.
	EP2	3	Providing furniture fitted to children's personalities service allows for sight, touch, and hearing interactions.
	EP3	2	Interior consulting service allows for sight and touch interactions.
	EP4	1	Re-installation, matrix checks and cleaning service account for smell.
	EP5	2	Managing of selection, maintenance and installation accounts for sight and touch
	EP6	2	Customized consultation service allows for sight and touch interactions.
Increasing Transparency	EP1	2	Consulting service is partially transparent.
	EP2	3	Provision of furniture fit for children includes all information on furniture material.
	EP3	2	Ordering furniture includes all information on furniture.
	EP4	2	Re-installation service, matrix checks and cleaning service do not include furniture information.
	EP5	2	Management of selection service is partially transparent.
	EP6	2	Customized consultation service is partially transparent.
Connection	EP1	2	Regular checkup is a discretely switchable option.
	EP2	1	Provision of furniture fit for children is a one-time option.
	EP3	3	Order production, and interior solution with 1:1 consultation are continuously switchable options.
	EP4	1	Re-installation, mattress checks and cleaning are fixed options.
	EP5	2	Maintenance service is a discretely switchable option.
	EP6	3	Lease service is a continuously switchable option.
Controllability	EP1	2	Consulting involves one-way feedback.
	EP2	3	Consultation and tests involve two-way feedback.
	EP3	2	Interior solution with 1:1 consultation involves one-way feedback.
	EP4	3	Message service involves two-way feedback.
	EP5	2	Consulting involves one-way feedback.
	EP6	2	Consulting involves one-way feedback.
Reducing human involvement	EP1	3	Consulting with humans and through computer visual programs.
	EP2	2	Provision of furniture according to personality type is performed with both humans and tools.
	EP3	3	Order production service involves humans and semi-automated tools.
	EP4	3	Two-way message service for fast interaction over the internet involves humans and semi-automated tools.
	EP5	3	Consulting involves humans and semi-automated tools.
	EP6	3	Customized consultation involves humans and semi-automated tools.
Listening communication	EP1	3	Selective listening for consulting.
	EP2	5	Empathic listening for personality type test.
	EP3	4	Attentive listening for customized furniture production.
	EP4	4	Attentive listening for message service.
	EP5	3	Selective listening for managing furniture selection.
	EP6	3	Selective listening for customized consultant.
Market Research	EP1	2	Consulting based on explicit customer needs.
	EP2	3	Personality test is based on latent customer needs.
	EP3	2	Customized furniture production by explicit customer needs.
	EP4	2	Message service can identify explicit customer needs.
	EP5	2	Consulting based on explicit customer needs.
	EP6	2	Customized consultant based on explicit customer needs.

Design point	EP1	1	Consulting service is a single operating point because this service is a one-time option.
	EP2	1	Provision of furniture fit for children is a single operating point because this service is a one-time option.
	EP3	1	Consulting service is a single operating point because this service is a one-time option.
	EP4	3	Re-installation service is a system optimized at several discrete operating points.
	EP5	1	Consulting service is a single operating point because this service is a one-time option.
	EP6	3	Lease service allows for changing furniture at several points.
Dynamization	EP1	1	Consulting service is a rigid system because this service is a one-time option.
	EP2	1	Provision of furniture fit for children is a rigid system because this service is a one-option.
	EP3	1	Consulting is a rigid system because this service is a one-time option.
	EP4	2	Re-installation service is a system with 'hard' and 'soft' elements.
	EP5	1	Consulting is a rigid system because this service is a one-time option.
	EP6	1	Consulting is a rigid system because this service is a one-time option.

Table 6. Generated New PSS Ideas for each BSEP

BSEPs	New PSS Ideas (NPI)
Customer Expectation	• NPI1. Providing a model house with displayed furniture for customers to feel the furniture. • NPI2. Discounting furniture price through an open house for general customers.
Customer Purchase Focus	• NPI3. Money back guaranteed sales. • NPI4. Providing replicas made of plastic and paper for the displayed furniture. • NPI5. Short time lease for about one month to experience the fit and usability. If a customer is satisfied, they can then buy the furniture.
Sense Interaction	• NPI6. Providing deep sleep space.
Increasing Transparency	• NPI7. Providing information about the manufacturing process, material and producer. • NPI8. Providing information about the price and pros and cons by comparing with other firms.
Connections	• NPI9. Allocating an exclusive manager to each customer. • NPI10. Providing a sharing space to enable customers to share information and sell used furniture. • NPI11. Providing customized service to customers based on customer reviews. • NPI12. Providing constantly customized service through constant connection.
Controllability	• NPI13. Customized service based on information (amount of dust, humidity, noise, temperature) obtained by monitoring (automatic sensor). • NPI14. Warning customers upon detecting deterioration and decay by constant monitoring.
Reducing human involvement	• NPI15. Providing images of displayed furniture and indirect experience using 3D computer automatic tools. • NPI16. Providing automatic recommendations for furniture based on information about customers' furniture use.
Design Point	• NPI17. Providing customized furniture according to children's growth. • NPI18. Reforming the service (change color and appearance, adding pictures) in each cycle.

cording to a personality type test corresponded to the most advanced evolution level of "empathic listening." On the other hand, the evolution level of BSEP "design point" (average = 0.4) was found to be relatively low for the existing PSSs. This is because the existing PSSs provided a one-off furniture consulting service.

We used the "reasons for jump" of each BSEP (Mann, 2007) to generate new PSS ideas by advancing from each current evolution stage towards the next stage. To this end, we explained the existing PSSs and their average evolution levels to the PSS analysts and TRIZ analysts. They conducted several rounds of BSEP-based directed idea generation sessions to generate a total of 18 new PSS ideas (Table 6); we generated new PSS ideas from the perspective of each BSEP. For example, the generated PSS idea of "warning customers through continuous monitoring (automatic sensor) of furniture deterioration, such as dust level" could be deduced from "reasons for jump" of BSEP "controllability."

The GN-PSS matrix is then used to select some of the new PSS ideas that deal with the unfulfilled or insufficiently considered GNs. The generated GN-PSS matrix is shown in Table 7. In the table, the latent GNs which were unfulfilled but are now fulfilled by new PSS ideas are GN18 and GN20. On the other hand, the latent GNs which were insufficient but are now fulfilled with new PSS ideas are GN1 and GN3. As can be seen in the latent

Table 7. GN-PSS Linking Matrix Using Existing PSSs and New PSS Ideas

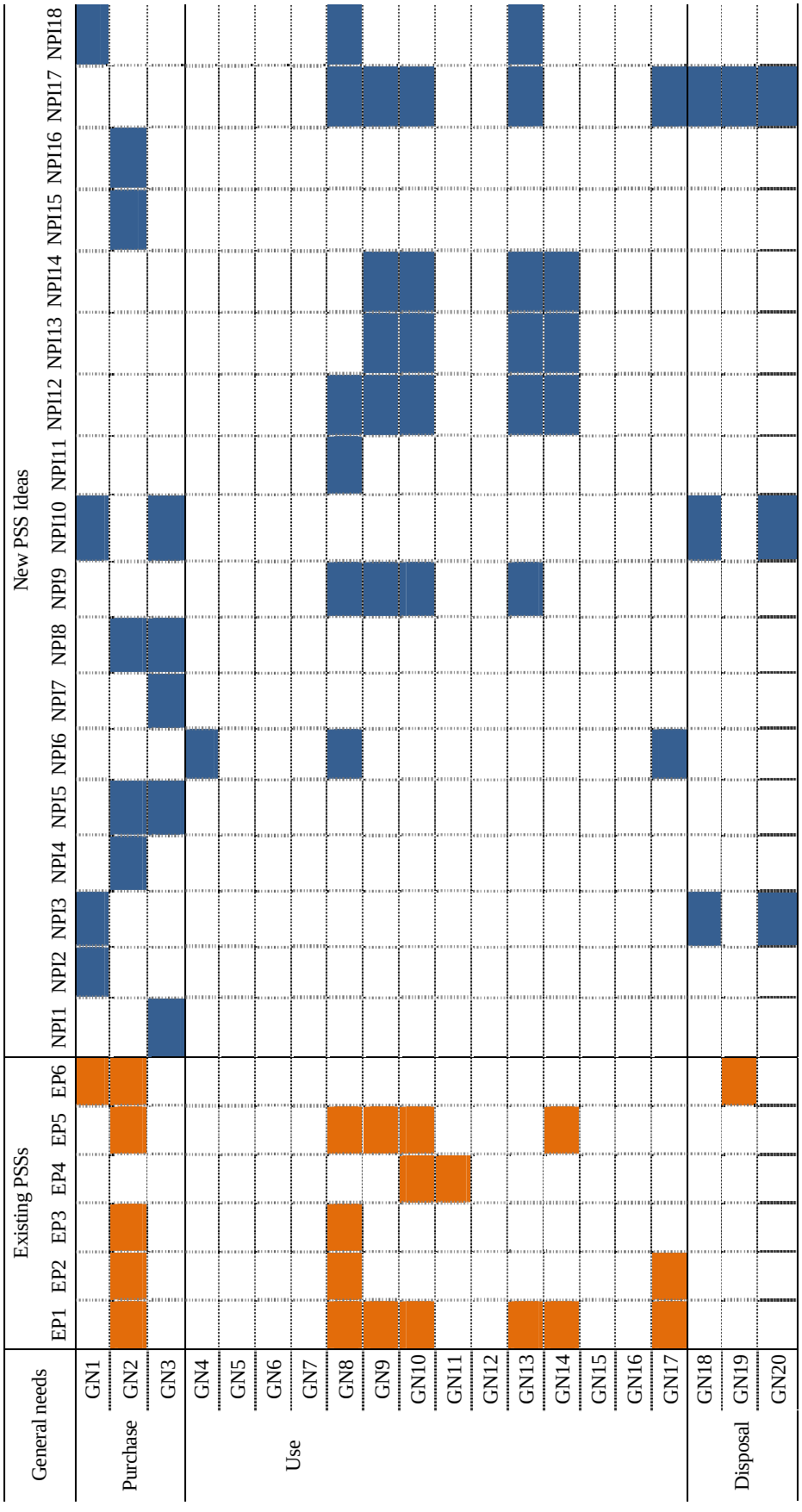


Table 8. Generated PSS Concepts According to Untapped NPIs

New PSS concept	Target customer	Channels, methods, and advantage
Open house	• Customers that want to buy discounted furniture through an open house. • Customers that want to experience realistic furniture display	• Providing discounted furniture if customer opens their house interior. • Customers can experience furniture that is realistic. • Directs the effectiveness of advertising.
Money back guaranteed sales	• Customers that want to buy discounted furniture and dispose of old furniture easily.	• When customers want to buy new furniture, they can get a discount by providing their used furniture to the firm. • This service can reduce cost for customers and is eco-friendly. • The firm can reuse used furniture material
Providing transparency of producer and production cost	• Customers that distrust furniture firms.	• Providing transparent information about the furniture, such as the material, producer, production cost, and manufacturing process. • Providing information about the price, pros, and cons by comparing with other firms • This service reduces customers' distrust.
Intermediate of sharing furniture	• Customers that want to buy used furniture and receive a real review of furniture.	• Providing sharing space to enable customers to share information and sell used furniture • Providing an Internet platform for a customer network. • Providing a community for substantive advice or opinions.
Consulting by child growth	• Customers with children.	• Providing continuously customized furniture according to children's growth. • Providing continuously customized furniture or service by analyzing children's personality. • This service can help with children's growth.
Reforming service	• Customers that use furniture for a long time and are annoyed easily.	• Reforming furniture (change color and appearance, add picture) periodically. • This service can reduce cost to purchase furniture and is eco-friendly.

GNs, the existing PSSs provide services that focus on the GNs of the 'Use' section; however, GNs that belong to the product lifecycle of 'Purchase' and 'Disposal' are latent GNs.

Finally, we generated PSS concepts using new PSS ideas that can deal with the unfulfilled or insufficiently considered GNs. PSS concepts can be generated by reifying one PSS idea or combining two or more PSS ideas, and are represented using titles, target customers and channels (Table 8).

We generated six new PSS concepts. First, the new PSS concepts of an 'open house' are generated by NPI1 and NP2.The 'open house' is used to provide discounted furniture providing a customer opens their house; this PSS concept has two advantages. The customers who open their house can purchase discounted furniture, and the customer who came to the open house can view furniture that is realistically displayed. This concept has the advantage that a firm can directly and effectively advertise their products. Unfulfilled GN1 and GN3 are now fulfilled by the advantages of discount and a realistic experience of the furniture provided when using this service. The new PSS concept of a 'money back guarantee' is generated by NPI3. This PSS provides discounted new furniture when the existing furniture is returned. The money back guarantee PSS concept has been widely used in diverse industries; however, this PSS is not used in the furniture industry. The advantage of this PSS is that the customer can purchase discounted furniture while sustainably disposing of their existing furniture reused by the firm for furniture materials. For these reasons, the unfulfilled GN1, GN18 and GN20 are now fulfilled. The new PSS concept of 'providing transparency of the producer and production cost' is generated by NPI7 and NPI8. This PSS provides information about the furniture for a customer who typically distrusts furniture firms; this PSS has some advantages. The customers can acquire the information about the life cycle, material, producer, and production cost of the furniture. Also, information is provided so customers can compare prices and quality of furniture with the furniture of other firms. This service can be helpful to customers when they purchase furniture, and can build customer loyalty. Existing furniture firms tend to provide little information about their furniture; however, this PSS makes all the information about the furniture available. These services can fulfill GN3. The new PSS concept of the 'intermediate sharing of furniture' is generated by NPI10 and NPI11. This PSS provides shared space to enable a customer to share substantive information about furniture and to manage used furniture through an internet platform. Using this service, the customer can acquire free substantive information about the new and used furniture. Also, the customer can dispose of their furniture in an environmentally friendly manner, and obtain additional value creation from the disposal. On the other hand, the firms can develop new furniture considering customers' opinion for furniture in sharing space. The unfulfilled GN1, GN3, GN18, and GN20 are now fulfilled by this PSS. The new PSS concept of 'consulting furniture considering the growth of the child' is generated by NPI17. This service provides continuous customized furniture according to a child's growth and personality. This service is effective for catering for a customer's children's physical and mental development. This PSS focuses on the GNs of the 'Use' section, customized use, optimized use, and performance through continuous customized service. However, this service is connected to the GNs of the 'Disposal' section because the child's growth is considerably rapid; therefore, a child's furniture is frequently changed. During this time, the used furniture is returned to the firm, thus allowing the customer to dispose of their furniture easily in a sustainable way. The final new PSS concept is 'reforming service', which is generated by NPI8. This service reforms furniture periodically by, for example, changing the color and appearance and adding pictures. This PSS is helpful for customers who want to frequently change their furniture and/or environment. Therefore, this PSS can reduce the amount of furniture being manufactured, and is thus eco-friendly.

5. DISCUSSION AND CONCLUDING REMARKS

PSSs have been recognized as a strategic alternative for sustainability in various product-based industries. Therefore, providing differentiated PSSs that can cope with customer needs has become important for firms to be able to differentiate their PSSs and thereby secure competitiveness. In response, this paper proposed an approach to identify unfulfilled or insufficiently considered customer needs and thereby generate a different type of PSS concept to handle such needs by employing two specific tools: 1) customer GNs and 2) BSEPs.

First, to detect unfulfilled or insufficiently considered customer needs, the proposed approach employed 20 GNs that are required throughout a product life cycle. Customer needs are variously represented due to customer situations and product domains, and thus it could be difficult to detect the customer needs that are fulfilled by existing PSSs in terms of a product's life cycle. For this reason, we generalized the customer needs considered by the existing PSSs, thereby constructing a GN-PSS linking matrix. This process enables us to understand the overall landscape of the PSS environment by distinguishing the GNs fulfilled by the existing PSSs. In this paper, we focused on the GNs that are unfulfilled or insufficiently considered by existing PSSs and selected different types of PSS ideas that can satisfy these GNs. We then generated new PSS concepts based on the selected PSS ideas. Whether or not unfulfilled GNs and PSS concepts are valuable might still be controversial because, when using our approach, new PSS concepts are used for unfulfilled GNs, and accordingly it is diffi-

cult to measure the value of such GNs. Nevertheless, by considering that the uniqueness of business models is becoming increasingly important to modern PSS firms, we expect that the PSS concepts generated using our approach could be helpful in PSS planning processes to develop new PSSs differentiated from existing PSSs.

Second, for new PSS concepts, we generated advanced PSS ideas through directed thinking based on BSEPs. TRIZ studies suggest that systems develop to increase their ideality (Savransky, 2000). The BSEPs among various TRIZ tools are systematic thinking tools for directed idea generation based on generic system evolution patterns. The transition from an early stage to the next stage in a BSEP can very likely result in new and revolutionary ideas that increase the system's ideality. By evaluating the evolutionary stages of the BSEPs related to the existing PSSs within the furniture domain, we were able to develop many new PSS ideas from the viewpoint of system evolution. Therefore, our approach using BSEPs could help PSS planners discover new PSS ideas that address the GNs of which customers may not even be aware.

This study has the potential to contribute to both academic and industrial fields. First, from a methodological perspective, this study proposed a novel approach to creating new PSS concepts under a PSS environment constrained by existing PSSs. Although prior studies of PSS concept generation have been performed, their methods either generate new PSS concepts with insufficient or no regard for the existence of competing PSSs, or they assume that potential customer needs have all been identified. Consequently, when generating new types of PSS concepts that differ from existing PSSs, prior methods might not be effective. Our approach addresses this issue by generating PSS concepts from unfulfilled or insufficiently considered GNs. Second, from an industrial perspective, this study can help firms build unique and customized client relationships in a competitive PSS business environment, because it facilitates PSS planners to develop a PSS concept that differs from existing PSSs, similar to the blue ocean strategy.

Apart from these contributions, opportunities remain for future research. First, we adopted 20 GNs as defined by Kim *et al*. (2012).However, GNs may vary according to product domains, so developing a method of customizing customer GNs by product domain could be an interesting future research topic. The method could then help produce further PSS concepts customized to the product domain. Second, this study concentrated on the generation of differentiated PSSs for unfulfilled or insufficiently considered GNs, but did not evaluate the potential of such GNs. Therefore, an interesting task in the future will be to develop a way to evaluate the importance of the unfulfilled GNs to enhance our approach. Third, while this study applies the proposed approach to the furniture industry, our approach has wide applicability in generating new PSS concepts in PSS environments constrained by existing PSSs. Therefore, future research should develop other practical examples using our approach. Finally, the proposed approach, as a module for PSS development, concentrates on PSS concept generation. Therefore, future research should develop a way to incorporate this approach into prior comprehensive PSS methodologies to create a synergetic effect.

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