

## A short note on the publicness for developing PSS: review on the availability of development methodology

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**Abstract.** As product-service system(PSS) has been highlighted as a valuable strategy for customer satisfaction and sustainability, many PSSs have been lively adopted in both public and private sectors. Consequently, PSS has become a central issue in service management and many studies on development of PSS have been conducted. However, vis-à-vis privateness, the publicness of PSS has not yet been dealt with. Depending on the publicness of PSS, development process of PSS requires different approaches to support decision-makings. To aid development of PSS more effectively, this paper identifies the differences between private PSS and public PSS, which raise the different issues of development of PSS. Then, the availability of methods in dealing with the issues of developing PSS in private and public sectors are discussed. As the first attempt to dealing with developing PSS from the publicness perspective, this paper is expected to be useful for the PSS developers and researchers.

**Keywords:** PSS, Publicness, Development

### 1. Introduction

Since the term “product-service system(PSS)” was firstly suggested by [1] as “a system of products, services, networks of players and supporting infrastructure that continuously strives to be competitive, satisfy customer needs and have a lower environmental impact than traditional business models”, PSS has been a “hot issue” in the both academy and industry. Many studies have introduced PSS as an emerging and promising strategy dealing with the definition, characteristics, various cases, and implications [2, 3]. In practice, more PSSs have been adopted to fulfill customer requirements which are not sufficiently satisfied with pure products or services any more or to cope with intensified environmental regulations [4, 5, 6].

However, as an integrated offering of heterogeneous elements including products, services and actors, PSS presents challenges to PSS developers, who can not depend on the conventional way dealing with pure products or services any more. This fact has extended the role of service management and, at the same time, presented challenges to service management; service management does not limited to service industry and products and IT technologies are more highlighted as key elements to be strategically dealt with by service management. Although, some literatures try to support the development of PSS [3, 7], unfortunately, there still exists much lack of research regarding PSS development: how to create, design, evaluate, and implement a PSS. Above all, this study identifies that, although the publicness of PSS is noteworthy factor differentiating the development process of PSS, the publicness of PSS has rarely been dealt with in literatures.

Different from pure products or services, PSS has been initially driven by the public sector rather than private sector; publicness is inherent in PSS. However, as PSS has been adopted in the private sector, the main purpose of PSS in private sector has moved from the environmental sustainability to the customer satisfaction. Accordingly, the characteristic of PSS in private sector is different from that in public sector; the issues to be considered in the development process are different for the private PSS and public PSS.

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Therefore, this paper aims to note the implications of publicness for developing PSS based on the clues in the literatures and cases. After identifying the different characteristics of PSS and some issues of PSS development depending on the publicness of PSS, the methodologies to deal with each are addressed. Additionally, the availability of new approaches to cope with the remained void of research is briefly discussed as a fruitful area for future research.

## 2. PSS and publicness

Although there exist many definitions of PSS based on the [1]'s initial suggestion, PSS is generally accepted as a concept of “product(s) and service(s) combined in a system to deliver required user functionality in a way that reduces the impact on the environment”[1, 8]. As shown in the definition, PSS originally emphasizes the environmental friendliness. As the environmental crisis has been emerging as a significant global issue, it seems quite natural that PSS has been pushed ahead with by the public sector. Research projects such as “Creating Eco-Efficiency Producer Services”, “SusProNet”, “UNEP” conducted as an international undertaking have led the advance of PSS[9]. And, along with the active support of public sector including each government, PSS has been adopted by the firms who try to meet the intensified regulations on environmental impact in the private sector.

However, the powerful driver of PSS adoption in private sector is customer satisfaction rather than environmental impact. As single product does not enough to fulfill the varied and sophisticated customer needs any more, firms recognize PSS as a survival strategy to be more competitive in the market. By adding services to products systematically, PSS is capable to cope with the customer needs.

As a result, the characteristics of PSSs appear differently in public and private sectors as shown in the Table 1. These differences between public PSS and private PSS require the different approaches to concept development of PSS.

Table 1: Characteristic of PSS in public and private sectors

Perspective	Public PSS	Private PSS
Cases	Carsharing (Dutch government) Hotel office (Dutch State Buildings Services, Ministry of VROM, Gispem, ESD, Groeneveld Sign Systems)	Renting of cleaning products (Electrolux) Providing clear drinking water in every office(EauVital) Organic food by subscription (Odin)
Objective	Promoting the public welfare by efficient usage of resource or reduction of emissions	Increasing the market share by increasing customer satisfaction
Formational feature	Relatively large and complex	Relatively small and simple
Main participants	Government hosting PSS, product providers, service providers, infrastructure operators, etc.	The firm hosting PSS and a few partners
Main industry	Basic, heavy industry and transportation	Consumer goods industry

## 3. Development of PSS

The literatures dealing with PSS development generally divide the process into three phases: create, design, and evaluate. Table 2 summarizes the main studies on the development of PSS. Most literatures focus on the integration of elements as the distinguishing feature of PSS from single product or service, which is the intrinsic issue of developing PSS. Relatively many literatures deals with the design of PSS focusing on structuring information flow among the various elements including products, services, and actors. For the creation, several approaches for innovation are suggested mainly based on the product usage. Studies on the evaluation mainly focus on the environmental impact. Commonly, it is identified that these works emphasize the system-based view for the PSS development.

Table 2: Related works with the concept development of PSS

Literature	Work	Relevant phase
[1]	Suggesting 4 axis to evaluate PSS concept	Evaluate
[10]	Suggesting the process for the sustainable product and service development	Design
[11]	Developing MEPSS which is a set of methodologies and toolkits for	Create, Design,

	developing a PSS	Evaluate
[12]	Suggesting the activity modelling cycle(AMC)	Design
[13]	Suggesting the use case based modelling	Create, Design
[14]	Developing the product life cycle based PSS design framework	Design, Evaluate
[15]	Suggesting the set of models for designing PSS (flow model, scope model, view model, scenario model)	Design
[16]	Proposing the ontology based PSS modelling	Create, Design
[17]	Suggesting a PSS ideation methodology using gap analysis	Create

However, when PSSs are looked from the publicness perspective, more practical issues which are not fully supported by the existing approaches are discovered. Although the characteristic of PSS is different in private sector and public sector as addressed previously, the publicness of PSS has never been considered related with development. To deal with this void of literatures, the key issues in the development process of PSS depending on the publicness are identified and the availability of methodologies for each issue is discussed in the next section.

## 4. PSS concept development based on the publicness

### 4.1. Key issues in concept development process

Shown previously, the characteristics of PSS appear different in the private and public sector. It makes the development process of PSS different. In the private sector, a firm tries to extend market share by satisfying customers with PSS. Therefore, the development process of PSS concept focuses on the customers in the market and the capacity of firms. On the other hand, the public PSS led by government or public organizations to promote the public interest. Therefore, how to organize many social resources and to resolve the interests among the social elements make the development process of PSS concept difficult. Accordingly, the main issues of developing concepts are distinguished between private PSS and public PSS.

In the first phase, create ideas, firms in private sector try to discover the business opportunity in the market. The primary source of the business opportunity is customer needs; the primary issue of private PSS in create phase is how to identify customer needs. On the other hand, the ideas of public PSS are generated to solve the given problems, which have been generally recognized by the public: improving the environmental pollution, promoting the public welfare, creating jobs, etc.

The main issues in the design phase are summarized as capacity reorganization in the private sector vs. supplier selection in the public sector. The challenge which firms trying to adopt PSSs mostly face is reorganization of capacity. Firms should decide the way to supply new elements for composing the PSS. However, the composition of public PSS is generally realized by the external providers. Therefore the decision-making of concept design in the public sector is on how to select the external suppliers among the many candidates.

Finally, the designed concept is evaluated to downstream process. Firms want the marketable concept whereas government wants the effective concept to the public welfare; the private PSS mainly aims to customer satisfaction but the public PSS mainly aims to sustainability. As a result, the measuring item is summarized marketability in private sector vs. sustainability in public sector based on the object of PSS in each sector.

### 4.2. Methodologies

To deal with the issues, the availability of the methodologies is discussed. Although many studies have suggested the methodologies to deal with the systematic features of PSS as summarized in the section 2, the PSS development still mainly depends on the conventional approaches which have been developed for the pure product or service. However, the conventional approaches do not fully cope with the features of PSS, which require new methodologies.

Table 3: Methodologies to support decision-making on the key issues of PSS concept development

Development phase	Key issue (main sector)	Characteristics of conventional approaches	Limitations of conventional approaches	Available approach
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Create	Need identification (Private)	Depending on the intuitional exploration of customer needs	Lack of catching up the unrealized need(niche) discovery	Data mining and visualization (the Niche-map)
	Problem solving (Public)	Depending on the rough approaches such as benchmarking	Lack of supporting the radical innovation as a solution	CBR, TRIZ
Design	Capacity reorganization (Private)	Depending on the qualitative analysis or the financial analysis	Lack of the systematic integration of various factors for the in/out decision	Sophisticated modeling for MCDM considering the feature of PSS
	Supplier selection (Public)	Using simple evaluating methods such as scoring, indexing	Lack of the consideration of the interrelationships between products and services	Sophisticated modeling for MCDM, especially the ANP for considering interrelationships among the elements of PSS
Evaluate	Marketability measurement (Private)	Identifying preference to or satisfaction of given concepts using simple survey	Lack of the comparative framework for the existing offering and PSS	Customer value-based approach with fuzzy
	Sustainability measurement (Public)	Using simple measurement such as static and uni-dimensional indicators	Lack of dealing with the dynamic and multi-dimensional feature of PSS	System dynamics with TBL

For example, as customers are still very significant for the private PSS as for the traditional offering[18, 19], customer survey and customer focused group interview can be employed to identify customer need for the private PSS in the concept creation phase. However, these conventional methods cannot catch up the niche that customer does not realize by depending on the intuitional exploration of customer needs. As PSS is more capable to provide various and sophisticated functions than pure product or service, the PSS can be somewhat beyond customer's intuition. Therefore, the methodologies of niche discovery for PSS are required. As one of the available approaches, extracting meaningful information from various kinds of huge data using data mining technique and effective visualization seems useful for the purpose. The discussion of the methodological support for each issue is summarized in Table 3.

The identified limitations of the conventional approaches provide research opportunities for PSS including the elaboration of the proposed available approaches. To seize the opportunities, multidisciplinary approach based on the thorough understanding of PSS and the situational characteristics is essential.

## 5. Conclusions

This study deals with the development of PSS, which is at the center of service management currently, from the publicness perspective. Differently with the traditional offering which mainly focuses on the private market for profit, PSS extends the offered area into the public sector with the inherent features: reducing the environmental impact, composing a large and complex system, and requiring the cultural/organizational change. While PSS has been actively adopted in the private and public sectors, different approaches to developing PSS based on the publicness of PSS has been required. Therefore, this paper identifies the main issues of PSS development from the twofold: first, three phases of development process with create, design, and evaluate and second, the publicness of PSS with private and public. Then, the available methodologies to deal with the issues are discussed. As the first study dealing with the development of PSS from the publicness perspective, this paper contributes to the service management field by bringing up the void of research. And also, this study is expected to have practical utility value for the PSS developers in the private and public sectors.

However, this study is still subject to improvement. Finding more issues and solving each issue by more sophisticated approaches will be a fruitful area for future research. Furthermore, the analysis of the movement between the private and public sectors will provides more completed study.

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