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The task to design highly service-oriented Product-Service System

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Abstract

In recent years there has been much research on designing Product-Service systems (PSS), but difficulties still remain with regard to implementing them into industries. In order to break through this situation, this paper aims to clarify the problems regarding current research into PSS design. In particular, we investigate a literature review on PSS design and conduct interviews with experts in PSS research. Based on the results, we clarify and organize the tasks needed for effective PSS design, discussing the problems associated with it. Finally, we identify research issues concerning PSS design that require further work.

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Keywords: PSS; Service-orientation; Design task; Customer requirement; Value-in-use

1. Introduction

Product-Service Systems (PSS) are new business strategies that create high added value by integrating physical products and services [1]. PSS can generate a higher sustainable profit by offering various services to customers throughout the entire product lifecycle. The key to PSS is shifting from a product orientation to a service orientation, whereby the activity and knowledge associated with the use of a product is considered to be more valuable to the customer than the product itself. Many authors have pointed out that this approach has the potential to enable manufacturing to enhance its products and services, making them more efficient and more economically and environmentally sustainable [2]. Therefore, it is important for manufacturing to design highly service-oriented PSS.

Although many authors have addressed the development of design methodologies for PSS, difficulties still remain with regard to implementing them into industries. It is not easy for traditional manufacturers to design highly service-oriented PSS, and they usually design product-oriented PSS because they have focused on developing the product itself. In order to break through this situation, this paper aims to clarify the tasks that are necessary for designing highly service-oriented PSS.

2. Literature review

2.1. Definition of PSS

In the research into PSS that has been conducted so far, many authors have proposed definitions of PSS. Mont defined PSS as a system of products, services, networks of actors, and supporting infrastructure that is developed to be competitive, satisfy customers, and be more environmentally sound than traditional business models [3]. Based on this definition, there are three dimensions for PSS feasibility: economic competitiveness, environmental soundness, and customer satisfaction. Economic competitiveness evaluates whether enterprises enhance their competitive advantage by generating added value for their products and services. Environmental soundness evaluates whether PSS has a lower environmental impact than traditional business models by reducing the consumption of products. Customer satisfaction in PSS is fundamental. In order to realize it, PSS designers should integrate traditional parameters with customer involvement in system design and customer education.

In addition, based on Mont's definition, PSS has four elements. The first element of PSS is products. The product should be considered by system optimization. Product

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improvement depends on the type of product, the intensity of its use, and the values and factors associated with its ownership. The second element is services. Services represent a provider's activities that enable the customer to use a product and receive support through the entire product lifecycle. The third element is infrastructure. Infrastructure represents the backbone of society that enables enterprises to provide services for customers, such as roads and communication facilities. The fourth element is networks of actors. This represents the relationships among the many stakeholders that are involved in the process of providing services.

2.2. Design process for PSS

In Service Engineering, a PSS design process is proposed [4]. Figure 1 partially illustrates this design process. This section introduces the service design process in detail.

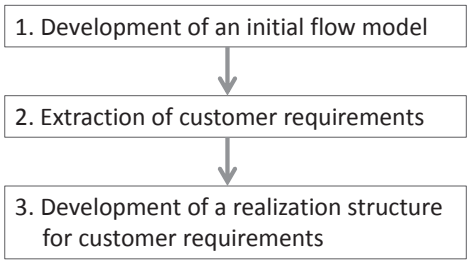

Figure 1: PSS design process [4].

Step 1: Development of an initial flow model

In this PSS design process, designers first define a chain of agents. Many services form complex structures consisting of many agents. In Service Engineering, a flow model is proposed to represent the chain of agents [5–7] (see Figure 2). In this step, an initial flow model is determined by defining the agents and their relationships.

Figure 2: Flow model of an elevator service [5–7].

Step 2: Extraction of customer requirements

For the extraction of customer requirements, in this step a persona is described for each agent that works as a receiver in the service. The persona is a tool that gives a simplified description of a customer, which functions as a compass in the design process [8]. Based on this persona, a scenario is then developed to clarify the context in which the service is received. The scenario is like a short novel in which the experiences of the persona in using a product/service are written in natural language. Therefore, a designer can imagine the situations in which customers use a product (e.g., what customers use, what products they use, when they use them, and how they use them). From the descriptive content of a scenario, a designer can extract a customer's requirements.

Step 3: Development of a realization structure for PSS

In this step, designers determine a realization structure for PSS, based on customer requirements. In PSS research, a view model is proposed to clarify the realization structure [9].

A view model represents the relationships between customer requirements, products, and services. As shown in Figure 3, this model consists of functions and entities, which are the concepts originally used in product design methodologies (e.g., [10] [11]). Function is an abstract concept that represents what is offered to fulfil customer needs. A function is described as "verb + noun" (e.g., "capture + images in elevators"). Entity represents any of the physical products and human resources that construct a PSS (e.g., staff, technicians, machinery, and facilities). In this case, human resources correspond to the service share of the PSS, while physical products correspond to the product share. A view model enables designers to clarify the roles of the products and services in PSS.

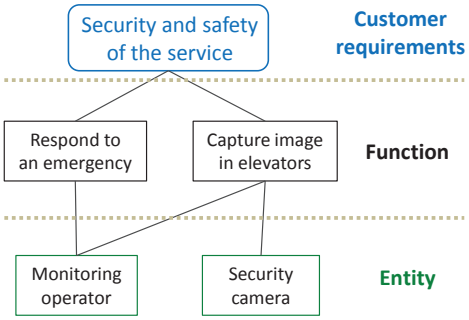

Figure 3: View model of an elevator service [9].

3. Organizing PSS design problems

3.1. Overview

In the PSS design process, the extraction of customer requirements, which is conducted in Step 2 (see 2.2), influences the design processes that follow. This means that extracting customer requirements is one of the most important steps for designing highly service-oriented PSS. Accordingly, as the first step of this research project, this paper aims to clarify the tasks involved in extracting customer requirements in order to design a highly service-oriented PSS. To do so, we conducted a PSS design workshop, and then each designed solution was classified according to its level of service orientation. By comparing solutions with a high service orientation with one with a low service orientation (i.e., a product-oriented PSS), we then clarified the tasks for designing highly service-oriented PSS. In evaluating the level of service orientation, this study adopts the types of service proposed by Tan [12]. In the following section, these types of service are introduced.