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Service Selection Method for Facilitating Life Cycle Options in Environmentally Benign Product and Service Business

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Abstract

Designing environmentally benign businesses requires the selection of an appropriate combination of services that can facilitate life cycle options (LCOPs), reduce the environmental load, and satisfy user needs. This study proposes a method of identifying services for facilitating the effectiveness of LCOPs and combining them with those identified based on user needs. The effectiveness of the proposed method is demonstrated by applying it to a managed document service.

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Keywords: productct and service system; life cycle options; user need; life cycle simulation

1. Introduction

Given the increasing environmental concerns, manufacturing industries must turn their businesses into environmentally benign operations that minimizes environmental impacts and resource consumption. However, manufacturing companies find it difficult to employ life cycle options (LCOPs), a means of reducing the environmental load and resource consumption during product life cycles, when simply selling their products to customers [1]. This is why environmentally benign businesses based on the Product Service System (PSS) have recently gained research attention. This study defines an environmentally benign PSS business (or "e-PSS business") as any business that provides products and services designed to reduce the environmental load and resource consumption through life cycle options and delivery modes (delivery modes are ways of providing products and services to customers).

Providing services for securing the execution of LCOPs is useful for effective LCOPs implementation. Companies must also maintain controllability over their products, not only in the beginning of the life cycle (BoL) but also in the middle (MoL) and the end (EoL), by changing the delivery mode—for example, from selling to leasing.

In designing e-PSS businesses for products, we therefore need to select the proper combination of life cycle options, services, and delivery modes. A number of studies have been conducted on PSS design methods [2], most focusing on the user [3, 4]. Schmidt et al. propose a design method consisting of three layers: the customer, customer barriers, and solutions. They demonstrate a mechanism by which a PSS can increase customer acceptance by reducing the influences of customer barriers. Since environmental friendliness is regarded as inherent to a PSS, design methods for reducing the environmental load have also emerged.

Thus, current design methods consider either user needs or the environmental load; however, services for satisfying user needs are not necessarily the same as those for facilitating the effectiveness of LCOPs. If the provider (the company providing products and services to users, which can be, but is not necessarily, the manufacturer) selects services based only on user needs, they may have little effect on proper LCOPs execution. Thus, services should be selected based on both user needs and their effects on LCOPs.

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This study proposes a design procedure for the e-PSS business that considers the relations among user needs, services, LCOPs, and delivery modes. We focus on service method selection based on both LCOPs and user needs.

The rest of this paper is organized as follows. Section 2 outlines our e-PSS business design procedure, consisting of five steps. In Section 3, the proposed method is applied to the MDS (Managed Document Service) to demonstrate its effectiveness. Finally, Section 4 concludes the paper.

2. Service selection method for facilitating life cycle options

2.1. Outline of the service selection method

This section discusses the procedure for designing an e-PSS business for a given product, focusing on a service selection method that considers LCOPs and user needs. Figure 1 shows the outline of the proposed service selection method; it consists of five steps.

In the first step, we identify the service options based on the user actions required for the user's enjoyment of the product functions. In the second step, we identify the services that would facilitate LCOPs effectiveness based on the product characteristics. In the third step, we select the services that would satisfy the needs of each individual user. In the fourth step, we generate candidates for service combinations, considering both LCOPs and user needs. In the fifth step, candidates for e-PSS businesses are generated by specifying the proper delivery modes for the provision of each service combination. The best e-PSS business is then selected based on the Total Performance Indicator (TPI) proposed by Kondoh [5] through a life cycle simulation (LCS).

2.2. Step 1: Identification of service options

We are discussing the selection of services for a given product that provides predetermined functions; thus, we do not consider services for providing additional functions but consider only those for removing barriers to the user's enjoyment of the product functions. Such services are divided into two categories: action services and information services. The former dispatches personnel to execute actions on the user's behalf, such as operations and maintenance. The latter provides advice to users about the proper execution of the actions. These services can be identified by analyzing the user actions required to enjoy the product functions without the help of any service.

To identify service options, we first enumerate such actions, as shown in Table 1; the actions necessary for using the product are categorized in terms of the procedure for using the product. Then, we identify two types of service option, action services and information services, in relation to each user action.

2.3. Step 2: Selection of services based on effectiveness of life cycle options

In the second step, we select services for facilitating the effectiveness of LCOPs. Table 2 shows the LCOPs adopted in the MoL and EoL phases considered in this study. We do not consider LCOPs in the BoL phase, such as miniaturization, because they are not directly related to services.

First, we perform a life cycle assessment (LCA) to identify which life cycle phases have dominant environmental loads. Then, we select the LCOPs that will be effective in reducing the environmental loads in the life cycle phases with large ones.

We identify the services for facilitating the execution of the selected LCOPs by examining which user actions are related to the execution of each LCOP. In the right-most column of Table 1, we show the LCOPs related to the actions

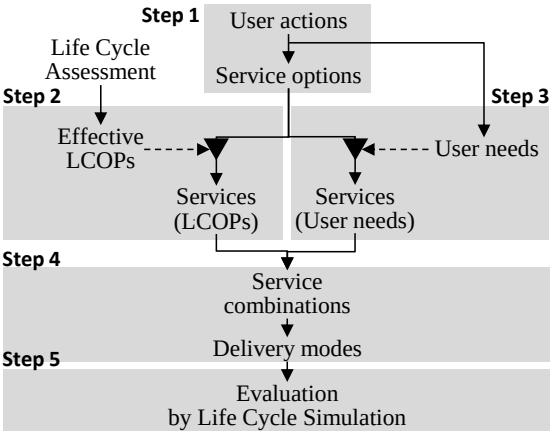

Figure 1. Outline of the method of selecting services

Table 1. The user actions

Category	Actions for using products	Related LCOPs
Prepa-ration	Selecting installation location	Increasing operation rates
	Setting up machine	
	Reading manual	
	Ordering consumables	Inventory optimization
	Setting or replacement of consumables	
	Setting machine parameters	Proper use of consumable
Opera-tion	Going to machine	
	Selection of operation modes	Proper use of consumable
		Proper use of energy
	Starting machine	
	Retract processed material	
Mainte-nance	Cleaning up of machine	Maintenance
	Application of preventive maintenance	
	repairing machine	
End of life treatment	Product return	Optimization of transportation
		Product reuse
		Parts reuse
		Recycling