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A METHOD OF VALUE CUSTOMIZATION

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1. Introduction

Customization has proven to be a promising avenue in industries where enterprises seek to attract customers in a competitive market. Actually, customization has a long history in business activities. Choice in which one can determine to buy a specific type is observed in many cases (e.g. choice between an ordinary room with a lower price and a room specifically for business use with a higher price provided by a hotel). Recently, even the concept of mass customization (MC) [Pine 1993, Hart 1995, Anderson 1997], which is defined for instance as "design and manufacture of customized products at mass production efficiency and speed" [Anderson 1997], is already widespread. Much of the MC literature largely deals with customizing properties of physical entities, while relatively few of its researchers have tackled the issue of customizing services (e.g. [Jiao 2003]). Although many theories and practices [Pine 1993, Anderson 1997, Tseng 1998] on *how* to customize are available, there exist very few theories at present concerning *what* should be provided depending on the customer's desire. The latter became more important according to recent servicification of business activities in industries. As a result out of this, new concepts such as Product-Service Systems (PSS), Functional Sales, and Functional Products have obtained attention in industries as well. In addition, it should be noted that the discussion on *how* is effective only after *what* is defined.
On the other hand, the authors have carried out fundamental research on a novel engineering discipline called Service Engineering (SE) [Sakao 2006] which seeks to provide a high value for customers by designing services in parallel with designing products. Furthermore, the possibility of integrating MC and SE has been pointed out [Sakao 2005], and an example of a practice of customization in the scheme of SE has been presented in an industrial case [Sakao 2006].
The aim of this paper is to present strategies for customizing value in design operations in the scheme of SE, which are subsequently explained in an industrial case.
The remainder of the paper consists of the following. Section 2 describes the motivation for the research. After Section 3 briefly describes the methods of SE, Section 4 presents the method of customizing value. The presented method is explained in a case in the accommodation industry in Section 5. Then, Section 6 discusses the results, and Section 7 concludes the paper.

2. Need for value customization

2.1 Need for customization

The situation faced by today's manufacturer is one of enormous challenge and unparalleled market turbulence. Some of the attributes of this increasingly complex and globalized market and competitive situation include [Pine 1993]:

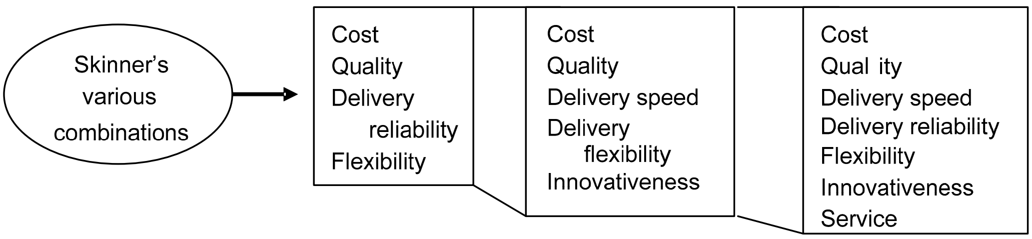
- customers are no longer a homogeneous base;

- customers demand specific products to suit their specific needs;
- product life cycles are significantly shorter;
- basic products are differentiated by options;
- new families of products are highly configurable;
- assemble-to-order is becoming a strategy of market leaders;
- customer responsiveness cannot be achieved through the simple build-up of inventories; and
- potentially greater profit margins can be made in customizing products.

The emergence of the manufacturing challenges listed above can be linked to several contributing factors. One factor is consumer awareness, enhanced through media such as the Internet. Today, literally millions of consumers have been empowered with the ability to investigate product offerings at the click of a mouse, and even to order those products directly from the manufacturer, on-line. Manufacturers have also benefited from the Internet, which according to Pine has facilitated the spread of information, helping manufacturing techniques such as just-in-time, continuous improvement and business process re-engineering to become mainstream [Pine, 1993].

Globalization is also a factor, given the shift from the stable and homogeneous markets of the past to today's highly volatile heterogeneous markets and market niches. For many manufacturers, success depends on satisfying the demands of these diverse market niches with diverse product offerings. The niche size for many of these products, however, is increasingly approaching, or has already reached the size of one – in other words, individually customized products.

An evolutionary perspective of competitive criteria by Spring and Dalrymple [Spring 2000], based on some of the prevalent literature in the area, is shown in Figure 1.



Skinner, 1969, 1974 | Wheelright, 1978 | Hayes *et al.*, 1988 | Chase, 1990 Garvin, 1993

Figure 1. Evolution of Competitive Criteria [Spring 2000]

In the literature, customization is often linked to such competitive criteria in Figure 1 as quality, flexibility, innovativeness and service. Together, such criteria provide customers with a perception of value.

2.2 Current mass customization methodologies and technologies

A number of authors have offered their views on how to accomplish mass customization, and a number of methodologies have been presented to assist manufacturers in its realization. Anderson [Anderson 1997], for example, provides the lengthy list of postponement, modular design, proactive vs. reactive customization, advanced product development methodologies, parts commonality, setup reduction, just-in-time, flexible manufacturing and build-to-order as ways to enable mass customization. Pine [Pine 1993], on the other hand, says mass customization is enabled by customizing services around standard products and service, creating customizable products and services, providing point-of-delivery customization, providing quick response through the value chain, and modularizing components to customize end products and services.

Spring and Dalrymple [2000] view modularity as "a principal tenant of mass customization, where customization is typically by choice from a predetermined and finite range of options". A method called component swapping is one of several types of modularity named by [Pine 1993]; the other types he names are component sharing, cut-to-fit, mix, bus and sectional modularity. Anderson

[Anderson 1997], on the other hand, views modularity as one of three methods for enabling mass customization, the other being adjustable and dimensional. Successful examples of modularity in industrial settings abound. One widely referenced best practice case is that of Scania, where standardized modules have been combined to produce numerous cab variants.

Similarly, Tseng and Jiao [Tseng 1998] discuss family-based design (FBD) and product family architecture (PFA) as two important methodologies for mass customization. These authors define FBD as "the underlying architecture of a product platform, which concerns the identification and exploitation of commonality among design solutions and manufacturing processes". This commonality, they continue, is subsequently captured and built in to a product platform to support the generation of new product variants so as to foster FBD. PFA, on the other hand, is described as "the underlying architecture of a product platform, within which various product variants can be derived from the basic product designs to satisfy a spectrum of customer needs related to various market niches".

There are several examples of integrated/concurrent methodologies for mass customization, one of which is called Design for Agile Product Assembly [Anderson 1997]. Anderson defines this rather comprehensively as "the design of products and their assembly processes to enable the assembly/configuration of all product variations in the family without any setup to retrieve parts, position parts, download programs, calibrate, or find and understand instructions". In this case, "products are designed around modular architectures and common parts, and assembly tools, fixtures, and processes are standardized whenever possible".

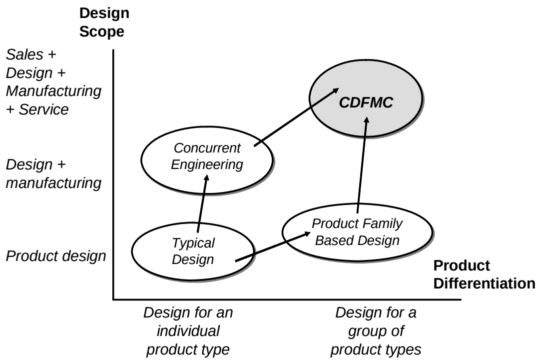


Figure 2. Concurrent Design for Mass Customization [Tseng 1998]

Tseng and Jiao [Tseng 1998] also advocate something they call Concurrent Design for Mass Customization (CDFMC), "based on the belief that mass customization can be effectively approached from design", and "in particular the front-end design". CDFMC, as shown in Figure 2, seeks to "to elevate the current practice of designing individual products to designing product families". At the same time, it considers an extended boundary of product design that encompass a larger scope than the traditional, spanning from sales and marketing to distribution and services.

As motivation for their CDFMC methodology, Tseng and Jiao [Tseng 1998] discuss the current state of CE practice as being able to provide only limited support for mass customization. The "whole solution", they argue, would be incorporation of the following considerations for CE into a mass customization context:

Expanding organizational boundaries (with an integrated design which covers the whole spectrum of the product development process, and one which extends the traditional boundary of CE to encompass a larger scope spanning customer needs acquisition to product delivery).

Optimizing reusability (which considers more explicit answers to achieving economy of scale and identifying commonality and building blocks to conduct design for reusability

so as to maximize common denominators in design and production).
Integrating stand-alone design for "X" tools (with the goal of a coherent framework).
Achieving context-coherent integration (to support multiple viewpoints by developing unifying product and product family models to serve as the meta-integration platform and thus achieve the contextual coherence for CE integration).

Da Silveira et al. [Da Silveira 2001] mention the enabler of "customer-driven design and manufacturing" as one important for mass customization. Here, both market trends and individual customer requirements are actively considered during the design, manufacturing and delivery of products. The aims of customer-driven practices, according this review, include:

- providing conditions for the customer to initiate the design process of a product; and
- building an infrastructure to develop new p roducts driven by the market.

2.3 Missing issues

As reviewed above, few methods for determining what should be provided depending on customer desires for SE have been presented, while methods describing how to realize customization are more or less mature in theory and practice. In addition, much research has focused on methods for developing physical products. Furthermore, the development of services has also been researched, but there has been little research on the combination of both products and services. In order to increase the customer value through customization, new methodologies need to be developed.

3. Service Engineering

This section gives a brief overview of Service Engineering (SE) [Sakao 2006]. SE is a discipline to increase the value of artefacts by focusing on service. So far, a methodology for modelling and designing services, and a computer-aided design tool called Service Explorer, have been developed.

In SE, positive and negative changes of customers are modelled as *value* and *cost*, respectively. Both of them are represented in the form of "receiver state parameter" (RSP). A service in general is associated with multiple RSPs. Preferred RSPs are value, while others are costs. For instance, in a service provided by a cafe, one can recognize positive RSPs such as "taste of coffee", "comfortability", "environment for writing papers", and "sound quality of music". On the other hand, negative RSPs in a cafe service may include a "monetary cost", "transportation to the cafe", and "noise level". It should be also noted that a service in some cases has a bushing structure. Namely, a service can be an aggregation of services (e.g. a hotel service is composed of several services such as lodging service, restaurant service, and tourist assistance service.). In addition, the model to describe a target customer is provided for grounding the identified value/costs.

A design methodology including the identification of value/costs with realization structures has also been provided. Furthermore, it allows for designing services in parallel with products. In regards to customization in the scheme of SE, the possibility to customize benefits for customers in a highly abstract level (namely value) while using the methods and tools of SE has been presented through an industrial example [Sakao 2006].

4. Method of customization

4.1 Positioning within the entire service design

The right-hand side of Figure 3 shows the entire flow of service design in SE [Shimomura 2006]. It includes a step of "E) modifying a solution", which modifies intermediate solutions to select a final solution. The value customization process newly proposed in this paper, which is depicted on the left-hand side, is an optional process employed for modifying intermediate solutions. Other options available for the modification include placing a new agent (organization) in the network for the service. Even when the option for value customization is adopted, the process of value customization is not necessarily carried out. There can be a case where no potential for modification or no potential for customization is found from the results of evaluating the service receivers' satisfaction on RSPs.

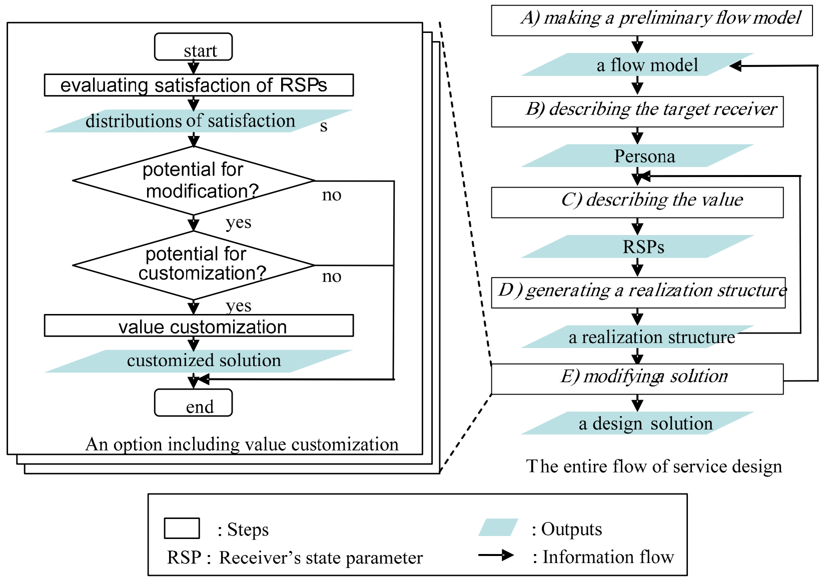


Figure 3. The flow of service design and the positioning of value customization

4.2 Strategies for customization

It is assumed here that a service as a whole can be rated with a one-dimensional score meaning to what extent a service receiver is satisfied with the service. Let us call this parameter "degree of satisfaction". In addition, a neutral point is assumed to exist on this parameter. In case of a positive score, one recognizes that the service has higher value in comparison with associated costs. Furthermore, it is assumed here that the score above, which is an overall evaluation of a service, is a sum of the evaluations of all RSPs associated with the service. For instance, one could appraise a service to accept it even by a higher price than is given in deed. The price could be equivalent to the willness-to-pay one has for the service. Otherwise, one would have less willness-to-pay than the actual price. These three conditions correspond to the cases where the score is positive, neutral, and negative, respectively.

Due to the higher level of the subjectivity in a service, the score is well likely to vary from one receiver to another. Thus, a distribution on this parameter can be defined from the receivers' evaluations of an RSP. The scores of some services given by a population can be different to a large extent among the population, while those of others have smaller variance.

In the presented method, depending on the distribution, the services will be classified into six types as depicted in Figure 4. Namely, they are categorized according to a small or large span (range) of the scores and whether the mean of the scores is positive, neutral, or negative. Furthermore, each of the distributions with a considerable span ((a), (c), or (e)) can be categorized into three types as shown in Figure 5. Namely, it is classified depending on the size of the arithmetical mean compared to the mean of the minimum and the maximum. The three types of distributions named (1), (2), and (3) have an identical span, while the arithmetical means vary due to the difference of their functions for probability density.

Potential for modifying the service can be judged by both its mean and its span. As described in Figure 4, promising strategies for operations include, needless to say, raising the mean. This could be achieved by general improving methods. In addition, a strategy of increasing the price is feasible for (a) and (b). Furthermore, one strategy acceptable in these operations is increasing its span by raising the arithmetical average. For instance, going for (e)-(3) from (f) is one of the acceptable operations (see Figure 6). It is hard to judge whether the strategy of going for (e) from (f) is good or not in general. Therefore, the types of distribution in Figure 5 have been introduced. This strategy seems to correspond to a wrong direction, especially in the field of quality management of physical products. Nevertheless, this is acceptable because it is a benefit subjective to a service receiver, namely a set of RSPs, that is designed in SE. Furthermore, this strategy could lead to a variety of ideas for further improvements (e.g. one could obtain more ways by going for (e) from (f) than for (d).). This makes more sense when all of these operations precede the market launch.

Potential for customization will be determined by the span. The bigger the span is, the larger the potential is. Strategies for customization are described in italics in Figure 4. In the case of (a) and (c), one promising strategy is making an RSP associated with the service optional. By doing so, each receiver could make a good balance of value over costs. In the case of (e), generating a newly-added optional value is promising. In this case, making an RSP optional is not good enough, because the mean is negative and should be raised.

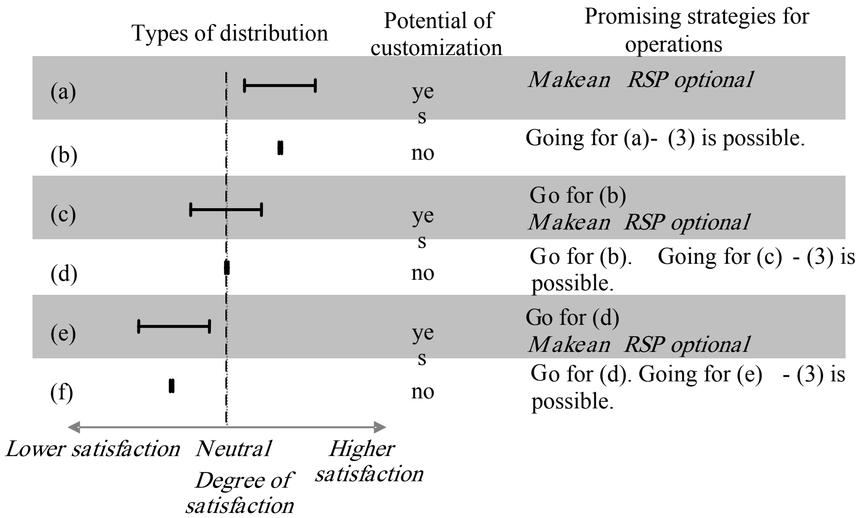


Figure 4. Types of evaluation of a service and suggested operations

4.3 The presented operations

This section describes the steps to be followed in the presented value customization, which consist of the following:

1. *Segmentation of service receivers.* Receivers of the target service are categorized depending on properties of the service.

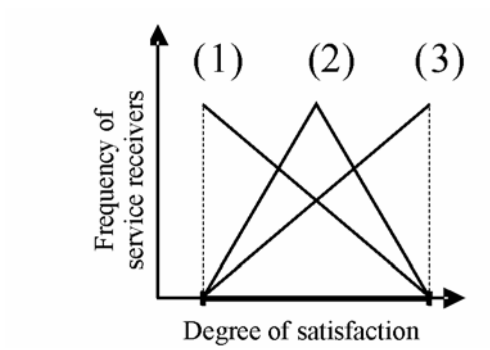


Figure 5. Types of distribution of the scores with an identical span

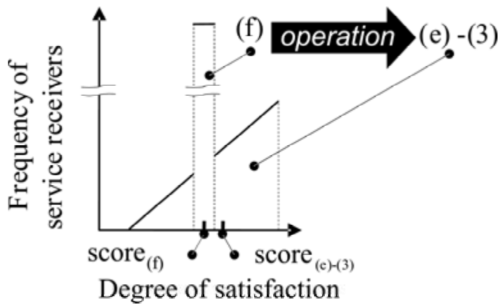


Figure 6. An instance of acceptable operation for (e)-(3) from (f)

2. *Describing RSPs of each service receiver*. What types of value and costs each category of receivers recognize in the service are described.
3. *Operation of RSPs with the associated structures*. RSPs will be the target of customization. Depending on the evaluation of each RSP by each service receiver, RSPs will be operated. It is natural that the structures associated with RSPs are operated as a result. A structure in this case means that of a physical product or of a service activity.

Elements of operations include the following:

a. delete a negative RSP, namely cost
b. decrease the absolute figure of a negative RSP, namely cost
c. instantiate a positive RSP, namely value
d. increase the absolute figure of a positive RSP, namely value

Since it is assumed that evaluation of each RSP is given in the stage of customization as shown in Figure 3, the operations can include those dealing with the change of RSP in the service that a receiver recognizes.

5. Examples

This section explains in part how the presented method of value customization supported activities of actual redesign of a hotel service in industrial operation [Sakao 2006]. Before the redesign, the hotel offered a service of Internet connection in a uniform way. In this service, an RSP, "Internet connection", is provided, while an economic cost to realize the service is born equally by each guest as a part of the accommodation fee. Apparently, two segments exist in hotel guests: Internet users and non-users. According to the data obtained from the survey, the category of "non-users" did not put a value on the service. Hence, the score of the service was negative as depicted in Figure 7.

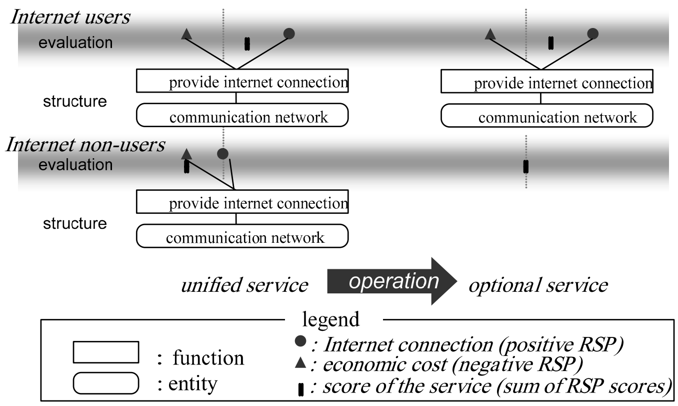


Figure 7. Operation of making a service of Internet connection optional

On the other hand, "users" appreciated this service. Thus, this service belonged to type (c) in Figure 4. Then, a strategy of making an RSP optional was adopted and an operation of deleting a negative RSP was carried out; in this case, the economic cost was deleted together with the other RSP, "Internet connection". As a result, "non-users" evaluated this service neutral after this redesign, because they received no RSPs. The service after the redesign could belong to the type (a), as implied in the right-hand side of Figure 7.

The other example concerns the customization of service activities. Far before the redesign, the hotel used to offer a service of washing every towel in a bathroom automatically in a uniform way. In this service, an RSP, "freshness of towels", is provided, with an equal economic cost on each guest. Guests with environmental consciousness recognize a negative RSP, "pollutants to the environment", caused by washing towels, while others care nothing about the RSP as depicted in the left of Figure 8. According to the results of our survey, degrees of counting environmental RSPs vary depending on guests more than those of others. This used to belong to the type (e) in Figure 4. An optional service, on-demand washing service, in which the hotel gives choices to the guests to decide whether the towels used in the bathrooms have to be washed or not, had been introduced before this redesign. This introduction is regarded as an operation b; here, an attempt was made to decrease the size of the negative RSP, "pollutants to the environment". As a result, the overall score was raised only for those guests who were highly conscious enough about the environment enough to accept the option.

Facing the situation (e) in Figure 4, a strategy of generating a new optional value was adopted; following this, an operation c was achieved. Namely, an activity of giving some form of discount to guests per a non-cleaned towel was introduced. This is feasible because reducing the number of washed towels allows the hotel funds to be used for another purpose. This could result in those guests who put relatively low but not zero weighting on environmental RSPs to accept this option.

6. Discussion

6.1 Quantitative evaluation of value/costs

The presented method is based on several assumptions. One of the critical ones concerns the ability to measure the degree to which a receiver recognizes each value or cost. Conjoint analysis, which is adopted widely in marketing to calculate a utility (part-worth) of a level for an attribute of products or services, can be employed for quantifying value or cost.

6.2 Comparison with value in Value Engineering

The term "value" in this paper is different from its use in Value Engineering [Miles 1971], where it is defined as function over economic cost. In SE, value is defined as the change of a receiver's state that he/she prefers, so that function is just a realization method to provide the value in SE. Representing value as such is crucial for dealing with services, since designing a service must be based on the degree of satisfaction with the state change of a receiver. This has not yet been addressed, however, because conventional engineering design mainly regards the performance of physical products and does not consider the state change of the receiver.

6.3 Comparison with existing customizing techniques

This section describes the superiorness of the presented method by comparing existing techniques to customize products or services. First, this method tries to customize *what* should be provided depending on the customer's desire; this is represented in the form of RSPs with connection to realization structures, namely structures of physical entities or service activities. This is quite a novel idea, since most theories and practices available [Pine 1993, Anderson 1997, Tseng 1998] concern *how* to carry out customization. In addition, this may be more crucial, as the needs and wants of customers at present vary greatly as pointed out in Section 2.

Second, the method seeks to design services in parallel with designing products to achieve a good balance between value and costs. Furthermore, it is being formalized as operations in design. Almost no method that can support such design activities exists. Although CDFMC by Tseng and Jiao [Tseng 1998], for instance, incorporates service into design scope, such operations that deal with a balance of value over costs cannot be found.

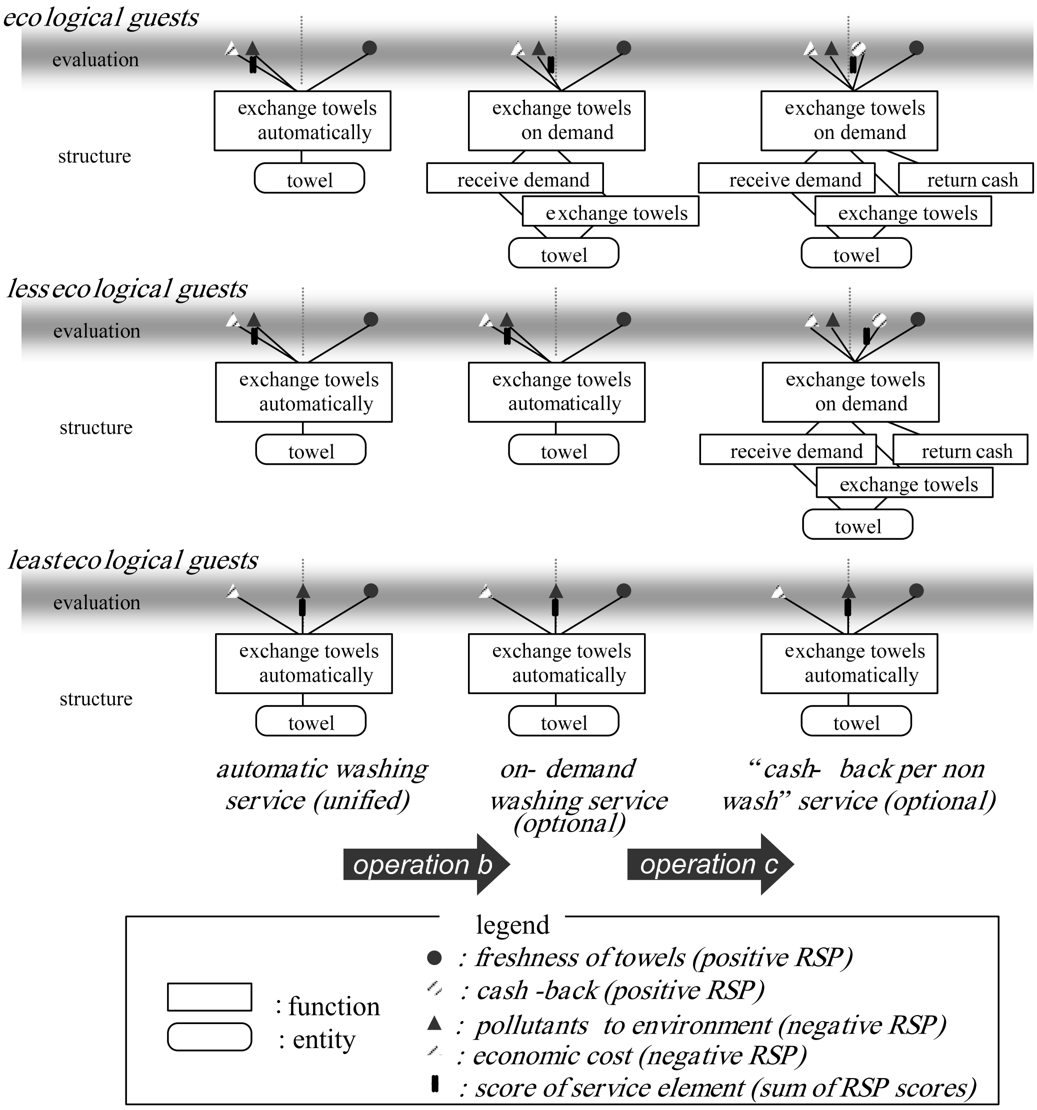


Figure 8. Operations of generating "cash-back per non wash"

7. Conclusions

This paper presented a method of value customization, which aims at increasing satisfaction levels of service receivers, and which was developed based on the modelling and design methods of Service Engineering. This has been explained using the actual redesign of an industrial service offered by a hotel. This method, however, requires verification through additional applications in the future. This will be effective for designing products or services whose value varies from one service receiver to another.

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