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CONTENTS QUARITY DESIGN CONSIDERING CORPORATE RESOURCE WITH SERVICE ENGINEERING

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Keywords: service engineering, genetic algorithm, resource distribution

1. Introduction

1.1 Background

Recently, it is important to reduce the product and service and consumption volume of artefacts, because we should solve environmental problems for the sustainable society. One of the solutions of this problem is that products have more values, supplied largely by knowledge and service contents, rather than just materialistic values. In this context, a novel engineering method, called service engineering, has proposed to evaluate services and to design the services [Arai 2004]. This methodology includes design methodology of both products and services. This novel engineering differs in the definition of value from Value Engineering [Miles, 1971], where value is defined as function over cost. Conventional design methodology [Rodenacker, 1971], [Pahl, 1988] also deals with only functions of the object rather than satisfaction of the consumers by the functions.
However, in the service engineering, the design method for high quality products and services is not enough proposed using the proposed modelling methods and the evaluation methods. Therefore, the designers design high quality products and services with many trials and errors using the model and the evaluation.

1.2 Objective

In this paper, we propose systematic design method for high quality products and services using the concept of optimization. In the service engineering, both products and services are considered as the contents of the products and the services and parameterized in the same model. The “contents parameters (CoPs)” are related to the states of the consumers and can change the satisfaction of the consumers. Therefore, the integrated design of the quality of the contents parameters leads to the high quality products and services.

1.3 Approach to the objective

To achieve the objective, some issues should be solved. The difficulties of this design problem are follows;
(i) The integrated design is very complicated because of the complex relations between the satisfaction and the quality of the contents parameters.
(ii) It is difficult to find the optimal solution because of the large problem with many parameters.
(iii) All the quality of the contents parameters cannot improve because of the limitation of the resources which the companies have.

We solve this difficult design problem which includes many contents parameters with the constraints of the resources for the high satisfaction of the consumers. For this objective, we should divide the limited resources into the many contents parameters to improve the quality.
In this paper, the service value for the satisfaction of the consumers is calculated using the modelling methods in service engineering. To obtain the high service value, the quality of the products and the services are design under the constraints of the company's resources. Therefore, the issues corresponding to the above difficulties and the approaches are follows,

- Representation between the company's resources and the quality of the products and the services: we represent the relations using sigmoid functions.
- Quality of the product and the services should be designed under the constraints of resources: we define the resource as monetary one and time one and divide them into the each content as the summations of the resources are within certain values.
- For the high service value under the constraints, the resource distributions are designed using Genetic Algorithm (GA), because of the complicated design problem.

In Section 2, we explain the concept, the models and the parameters in service engineering. In Section 3, the details of our proposed method are described. And in Section 4, we verify the proposed method through examples and conclude this paper in Section 5.

2. Service modelling in service engineering

2.1 Service engineering [Arai, 2004]

In this subsection, we introduce the concept and modelling method of the service engineering [Arai 2004]. For clear explanation, the following description in this subsection is citied from [Arai 2004].

2.1.1 The outline of a service model

Let us define the design procedure of a set of services. In the argument regarding the design process (for example, [Suh, 1997], [Umeda, 1996], and [Shimomura, 1998]), it is widely accepted that design might be a search for a physical structure matching the required function. The design of a service is also a search for both physical and non-physical structure, but it differs from the conventional design in terms of evaluation. Conventional design regards mainly the performance of the channels; it does not consider the state change of the receiver except for a happiness that comes with owning the products. The design of a service is based on the degree of satisfaction with the state change of the receiver. Therefore, it is necessary to express state changes by means of the received contents.

2.1.2 Receiver's state

Change of a receiver is represented by a set of receiver state parameters (RSPs). Thus, a service can be represented by a set of RSPs necessarily and sufficiently. Since a RSP consists of quantitative values, including Boolean logic and multi-value logic, the service engineering can compute any comparison between two RSPs. In addition, [Arai 2004] introduced a new assumption that all RSPs are observable and controllable. This assumption has been unproven with human receivers because [Arai, 2004] has not had a reliable method to measure the consumer behaviour.
The RSPs change by received contents as shown in Figure 1. Hence, in the service engineering, [Arai 2004] assume that contents consist of various functions, whose name is Function Name (FN), whose operating objects are Function Parameters (FPs) and whose effect is represented by Function Influences (Fls). Since both channels and contents are described by the functions with FPs and Fls, RSPs also belong to functions.
As the receiver's states may change with respect to supply of contents, RSPs can be written as functions of contents. Parameters expressing contents are called content parameters (CoPs). In the same way, the parameters of channel, which make the flow of CoPs change and thus influence RSPs indirectly, are called channel parameters (ChPs). Hence, in this research, we assume that both contents and channels consist of various functions.

These parameters create a network with one another. We studied several examples and chose different sets of parameters; some of the examples are from daily life such as restaurants, travel agents, and laundries. Other studies are from manufacturing sectors such as disposable camera suppliers, copy services and elevator maintenance services. The details are not discussed in this paper but we need to point out that the selection of contents within various parameters is subjective. It seems the greatest reason that services have not been dealt with in engineering issues.

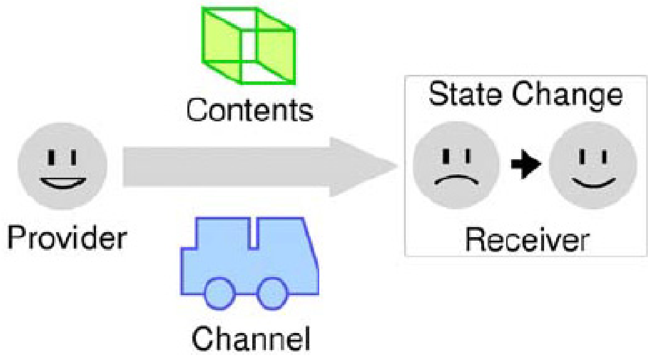


Figure 1. RSP Changing in Service [Arai 2004]

2.1.3 View model

Receiver state parameters (RSPs) change according to how the receiver evaluates subjectively the received contents. A single RSP may consist of several CoPs because the receiver evaluates the contents. The CoPs may be supported by several ChPs existing in the chain of several agents. A view model is defined as a tree of CoPs and ChPs with a single RSP at its root.

An example is shown in Figure 2. The view model is expressed in a directed graph that consists of nodes and arcs. The entities in Figure 2, i.e. nodes, are functions, which are expressed by FNs as lexical expressions and FPs. The body of each function is expressed by function influence (FI). In the current implementation, both positive and negative influence can be implemented.

The view model illustrates visually the relationships among the parameters (RSP, ChP, and COP) by means of directing arcs. Thus, it helps the improvement of RSP by changing FPs.

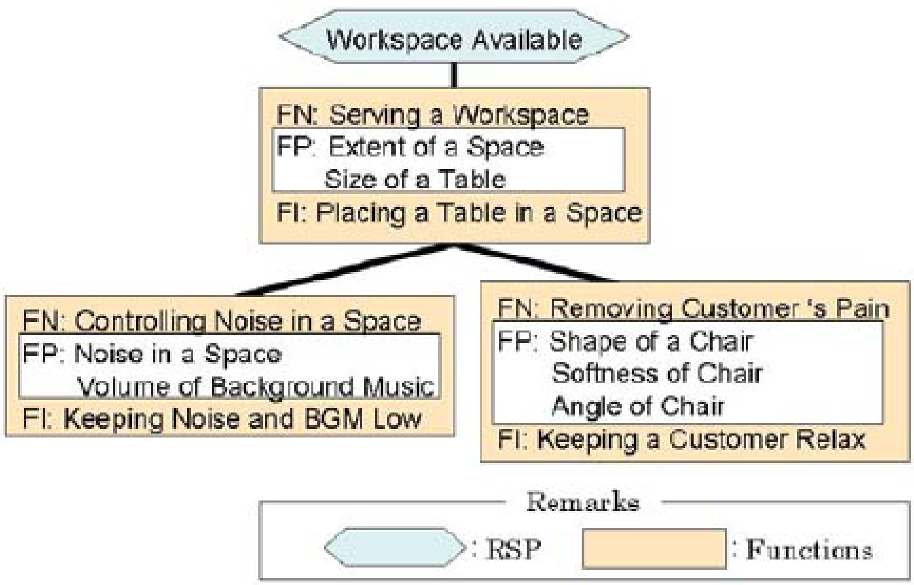


Figure 2. An example of a view model [Arai 2004]

2.2 Content parameters

As above mentioned, the CoPs change the RSPs on the model in the service engineering. Therefore, the quality of the CoPs should be improved for the high satisfaction of the consumers. In this paper, we design the quality of the CoPs which contribute the satisfactions represented to RSPs in this model. In other words, the service value of the product and the service can be measured using this model.
In one service product, the consumers have some RSPs which have several types of concreteness. Therefore, in this paper, the RSPs are divided into two layers. In this structure, the abstract RSPs in high layer are the summation of the concrete RSPs in low layer.

2.3 AHP weight calculation method [Satty 2008]

For the measurement of the service value in this model, the relation between the CoPs, the RSPs and the satisfaction should be obtained. The relation can be obtained using Analytic Hierarchy Process (AHP) method. This method has also been very popular in the service science and engineering. For example, the degree of importance of a CoP to a RSP is represented as weights between nodes in this model. The same way is carried out on the relation between the high layered RSPs and the low layered RSPs and the relation between the service value and the high layered RSPs. One example is shown in Figure 3. All the arcs in this figure indicate the weights between nodes.
The weights of these relations are calculated with AHP method based on questionnaire analysis.

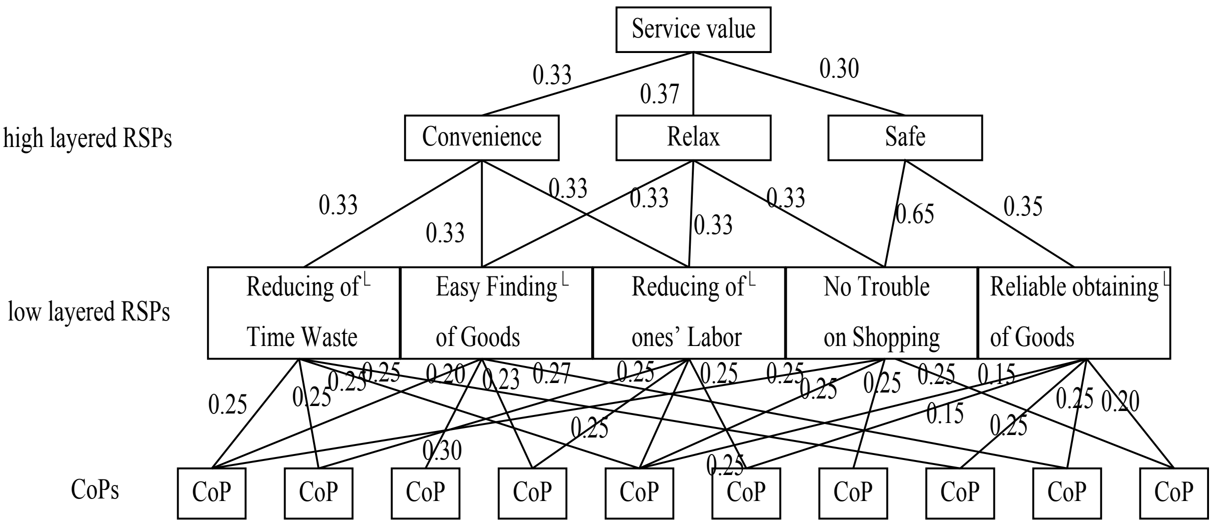


Figure 3. Example of multi-layered CoPs-RSPs-Service value structure

3. Contents quality design

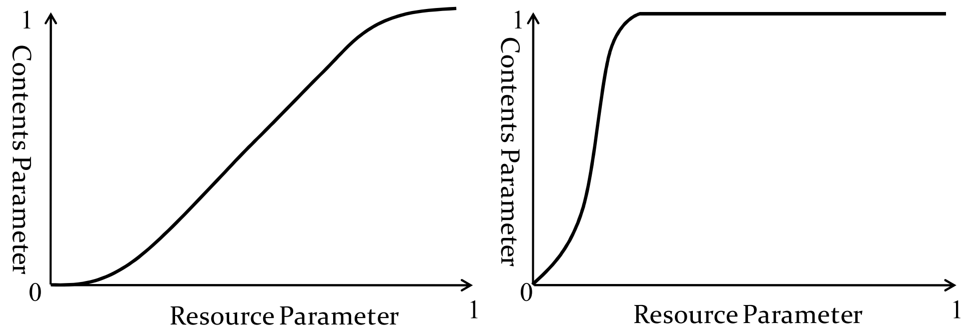
3.1 Contents parameters and resource constraints

The view model and the weights in the service engineering mentioned above can illustrate the relation between the quality of the CoPs and the Service value. Therefore, we can have ideas that which CoPs should be improved for high service products.
However, in general, companies have limited resources which can be utilized for the improvement. If the company had unlimited resources, it is the best solution to improve all quality of the CoPs. Therefore, companies should make decision how to utilize the limited resources with the highest effectiveness to the high service products.
In this paper, we propose the resource distribution method for the high service products with optimization method under the constraints of the company's resources. At first, the relation between the quality of the CoPs and the resources will be represented. And then, the resource distribution is optimized using GA.

3.2 Relation representation using sigmoid function

For the representation between CoPs and resources, we utilize sigmoid function in this paper. In general, the relation between CoPs and resources is that much use of the resource makes the quality of CoPs improve. However, the degree of the improvement depends on the kinds of CoPs and resources. For example, “large shop space” needs much monetary and time resource to improve, but “good greeting” need small them.

The sigmoid function is appropriate to represent such a relationship. In the sigmoid function, several relations can represent with the parameters of center and gain value. The examples are shown in Figure 4. The sigmoid function is monotone increasing. Low center means quick grow-up and low gain means slow increasing of the CoPs quality. For instance, the CoP in which the effect appears in binary is represented by the setting of very high gains in the sigmoid function.



(a) low center and low gain **(b) high center and high gain**

Figure 4. Examples of the relation between the quality of CoP and invested resources

3.3 Optimization of service value with GA

Once resource distribution is decided, the view model, the weights with AHP and resource-CoP relations with sigmoid function make it possible to calculate the Service value of a certain service product.

However, the resource distribution is not easily designed, because the search space is very large and the problem is very complicated because of the sigmoid functions and the tree structure with many nodes and many arcs. Therefore, it is very difficult for the designers to find the optimal value of the invested resources and finding the optimal value is very significant for designers.

We propose the method to find the optimal value of the resource distribution. In this paper, we apply Genetic Algorithm (GA) from many optimization methods to the design problem because this problem is very large and very complicated.

In GA, the inverse problem must not be solved and the solution is improved with the iterative solving of the direct problem. As the character of GA, GA is effective to solve the problem with local minimum and multimodal search space. Therefore, this optimization method is appropriate to this design problem.

In this optimization, the gene (design parameters) is the ratio of the resources for the distribution design of the resources.

The detailed process of the method is shown as follows:

1. The genes of individuals are randomly setting from 0 to 1 as the temporary resource values to every Cop.
2. The temporary resource values are normalized to meet the constraints of the resource summation.
3. The qualities of the CoPs are calculated with the normalized resources and the sigmoid functions.
4. The Service value is calculated through the view model with the structure and the weights.
5. Each individual is evaluated and set the fitness value based on the Service value.
6. The individuals evolve based on the fitness values.

7. The optimization is terminated when the number of generations is a certain number (the number of generations). Otherwise, go to 2.

4. Verification through rental CD/DVD shop design

4.1 Rental CD/DVD shop

To verify the proposed method, rental CD/DVD shop service is utilized as an example in this paper. In this example, the sale CD/DVD shop tries to be improved to the rental CD/DVD shop.

The view model and the weights have been calculated based on the service engineering in previous research. The weights and the structure are shown in Figure 5. The values on the arcs indicate the weights with the summation to 1.0.

These factors of RSP in Figure 5 are based on the human state corresponding to CD/DVD rental service and the factors of functions are given from the relation between entities and states based on General Design Theory. We think these factors are comprehensive about the CD/DVD rental service for all customers.

The weights are obtained from a questionnaire survey to customers using AHP and QFD. Therefore, the weights are average of customers. In this questionnaire, customers sometimes make new factors of states and functions in addition to our prepared factors.

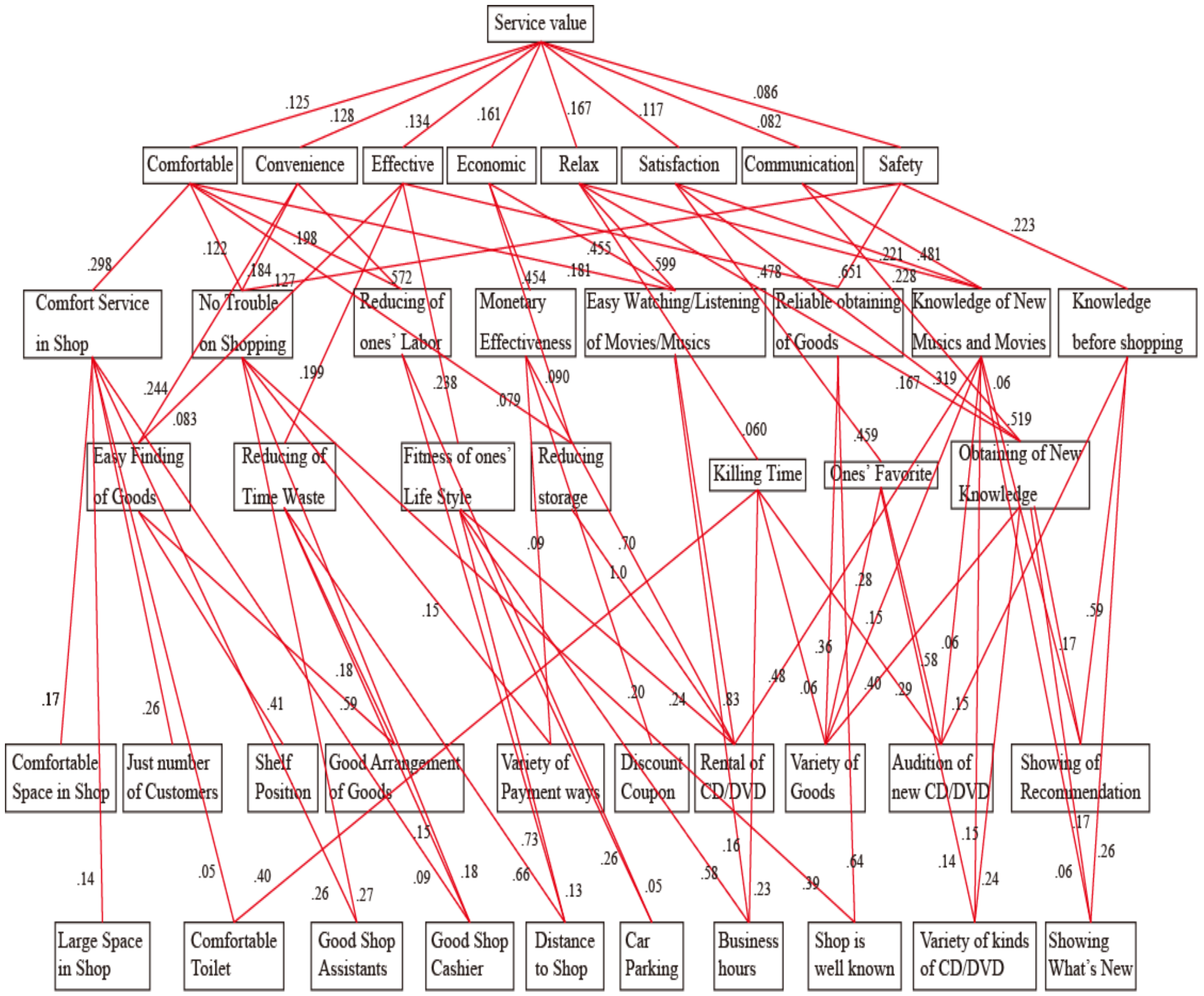


Figure 5. View model and the weights on rental CD/DVD shop

4.2 Settings of verification

In this verification, two kinds of the resources are considered; monetary resource and time resource. Therefore, quality of one CoP depends on the two resources. The relations between a CoP and two resources are represented with two sigmoid functions respectively. When the invested resources are decided, the quality of the CoP is the product of two sigmoid functions. For instance, if the monetary resource is much utilized to one CoP and the time resources is 0.0, the quality of the CoP will be 0.0 because the time resource is 0.0.

The settings of the parameters of the resources are shown in Table 1. The center and gain values are set to each CoP.

In this verification, we prepare two kinds of volume of the resources. One example is 1.0 for both monetary and time resources. Another example is 3.0 for both monetary and time resources. Former means that the company aims little money and short term improvement and later means that the company tries to improve the products and services with much money and time drastically.

The resource is represented as relative values in this verification. Of course, designers or companies can input the real value in this method.

And, the settings in GA are as follows;

- Fitness value equals to Service value.
- Possibility of crossover is 0.7.
- Possibility of mutation is 0.01.
- Number of individuals is 200.
- Number of generations is 10000
- One point crossover and elite selection is applied.

Table 1. Parameters in sigmoid function on resources-CoPs

Parameter	center (monetary)	gain (monetary)	center (time)	gain (time)
Comfortable Space in Shop	0.4	7	0.2	1
Large Space in Shop	0.9	2	0.9	10
Just number of Customers	0.9	10	0.5	3
Comfortable Toilet	0.7	8	0.9	10
Shelf Position	0.2	9	0.7	8
Good Shop Assistants	0.1	9	0.5	1
Good Arrangement of Goods	0.1	9	0.2	5
Good Shop Cashier	0.1	9	0.5	1
Variety of Payment ways	0.6	4	0.7	2
Distance to Shop	0.7	10	0.9	10
Car Parking	0.9	5	0.9	10
Discount Coupon	0.3	1	0.1	1
Rental of CD/DVD	0.6	10	0.5	7
Business hours	0.7	2	0.1	5
Variety of Goods	0.5	1	0.3	3
Shop is well known	0.8	8	0.5	1
Audition of new CD/DVD	0.7	10	0.5	9
Variety of kinds of CD/DVD	0.5	1	0.3	3
Showing of Recommendation	0.3	3	0.1	8
Showing What's New	0.3	3	0.1	5

4.3 Results of verification

To follow the settings mentioned above, we obtain the results of the designs. With 1.0 volume on both resources, the result is shown in Figure 6 and the design result with 3.0 volume on both resources is shown in Figure 7. In the figures, the horizontal axis corresponds to the distributed resources and the vertical axis corresponds to the list of the CoPs. The upper value is the monetary one and low one indicates designed time one.

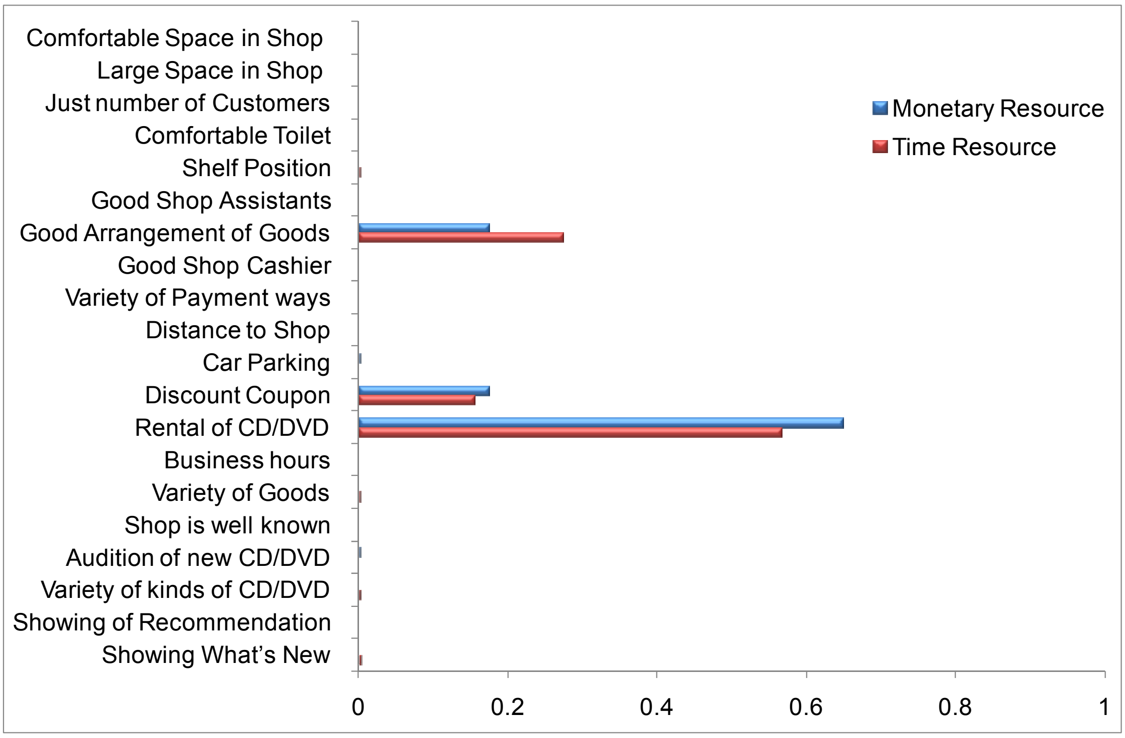


Figure 6. Design result of resource distribution within 1.0 volume

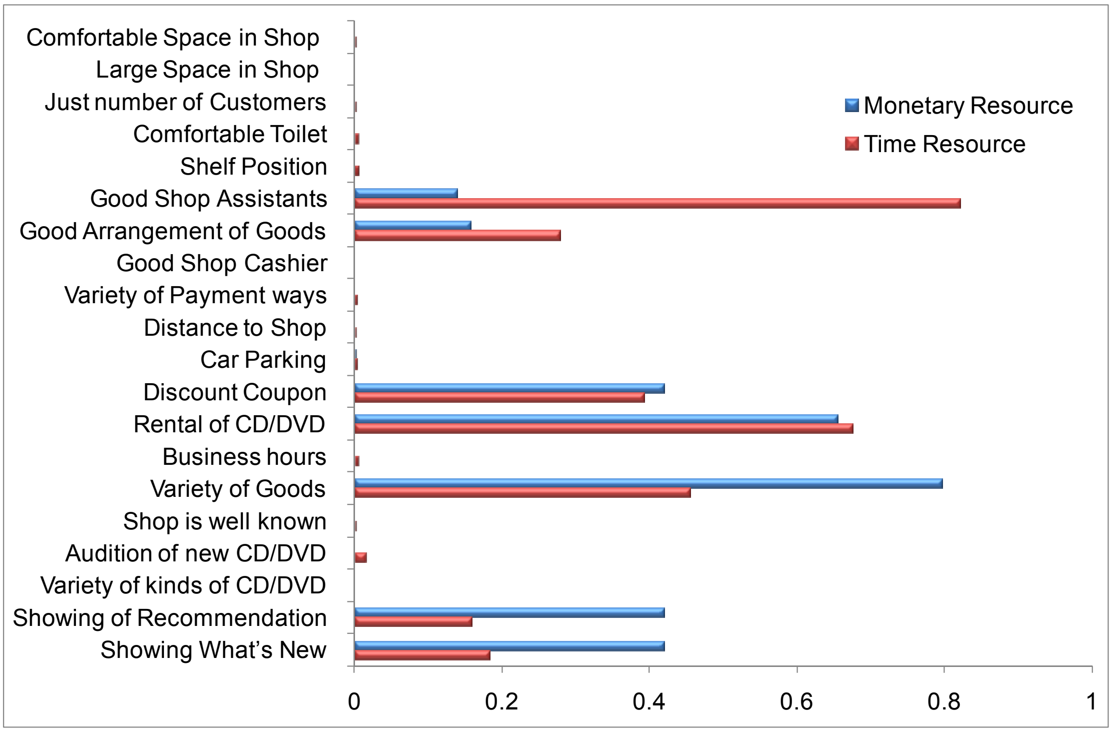


Figure 7. Design result of resource distribution within 3.0 volume

4.4 Discussion

From these results, the proposed method is effective for the design of the high value products and services, because the high weighted CoPs are invested much resource and the low weighted ones are nearly 0 resource. In both figures, almost the same resources spend on the CoP "Rental of CD/DVD" which has the highest weight in the view model. Moreover, at the sigmoid function of the CoP "Rental of CD/DVD", the centers are middle and the gains are very high, in which the CoP can be increased without so much resources.

The results differ from each other because of the different resource volumes. In Figure 7, the CoP "Good Shop Assistants" is invested much time resource to increase the quality. The gain in the time resource function is very low in this CoP, in which it should spend much time to increase the quality of this parameter. However, at the large volume, the CoPs can be increased with much resource because this large volume setting means that company has enough time to improve the shop.

In this design process, quality of a CoP is calculated by the product of two sigmoid functions which correspond to monetary resource and time resource. Therefore, effective solution is that both resources are invested to the same CoP, because the quality will be very small if one resource is very small. From this point of view, almost improved CoPs are invested both resources in the results without useless resource investment.

Hence, from these results of this verification, we can obtain the proper solutions to improve products and services with our proposed method.

In this verification, we utilize the simple example to see whether the proposed design method works well or not. In general service product design, the view model and the weight must be more complicated. The weights must be not only positive ones but also negative ones. There must be constraints with many kinds of resources. However, from these results, we find that our method can work well in such a design problem because the method is based on the optimization in which design process utilize only Service value as the output. If the weights and the structure are different, the effective solution can be obtained with our method.

5. Conclusion

In this paper, we design the contents quality with the proposed design method for high quality service products under the constraints of company's resources. In this method based on the "service engineering", the relations between CoPs and resources are represented with sigmoid functions. And the distribution of the resources is designed using Genetic Algorithm, which is appropriate optimization to this kind of problem, for the high quality of CoPs and high service products. In the verification with an example, we consider the two kinds of resources, monetary and time resources, and show the effectiveness of our method in different volume on the resources. It can be found that the solutions are very reasonable.

To the next step, we should consider that the weights in the view model must depend on the personal character and life style (called Persona). The shop owners and designers would like to know what kinds of persons will come to their shop with the designed good contents design. To meet this demand, we will design the weights in the view model with a certain optimization method.

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