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論 文

A Study on Customer-Oriented Strategic Pricing By Utilizing Compound Effect of Functions

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Abstract

Manufacturers often make distinctive products as their strategy to establish competitive advantage. They improve the performance of the basic functions or add new functions. These new functions are called "added functions. " This study has been made to propose a new method for setting up representative prices for these added functions. The procedure is as follows: First, people to be researched are selected as representative of potential customers. They are asked to answer questionnaires to determine the price zones for the added functions according to their subjective evaluation. Secondly, these price zones are integrated by a linear integration model to obtain the representative price for the potential customers as evaluators. It is rare that a single added function is adopted in developing new products but usually multiple added functions are adopted simultaneously. From the simultaneous adoption of such multiple added functions, some beneficial new functions for customers are sometimes produced as the result of their interactions. This will be called "the compound effect of functions" in this study.

This study also touches upon this compound effect of functions and proposes two new indices, " the recognition rate of the functions' compound effect" and "the evaluated value ratio of the functions' compound effect." The analysis and evaluation of "the compound effect of functions" will be made by using these indices.

Key Words

strategic sales price, customer-oriented pricing, liner integration method, added function, compound effect of functions

顧客主導の戦略的売価設定に関する研究
―機能の複合効果を活用して―

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＜論文要旨＞

製造業においては競争優位性を確保するために製品差別化戦略が採用されることが多い．そのために基本機能の改善や機能の付加がはかられる．本研究では新たに追加される製品機能を「付加機能」と呼ぶことにする．初めにこれらの付加機能に対する売価の代表値を設定する方法を提案する．そのために，まず潜在顧客のなかから選定された評価者に対して，主観的評価に基づいて評価者ごとに購入価格の金額帯を調査する．次にこれらの金額帯を線形情報統合法を適用して統合することによって評価者として選定された潜在的顧客全体の評価額の代表値を算出する．ところで，新製品開発に際して，付加機能が単独で製品に組みこまれることは少なく，複数の付加機能が同時に採用される場合が多い．このとき複数の付加機能の相互作用によって顧客に有用な新たな機能が生み出されることがしばしばある．本研究ではこれを「機能の複合効果」と呼ぶことにする．

本研究では付加機能の複合効果に着目して，「複合効果認識率」と「複合効果額比率」という2つの評価指標を提案し，機能の複合効果の分析・評価を行う．

＜キーワード＞

戦略的売価，顧客主導の売価設定，線形情報統合法，付加機能，機能の複合効果

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1. Introduction

There are many cases in which added functions are supplemented as a policy to make the product distinctive in growing markets with many competitive products. There are two specific features in customers' pricing of added functions. The first point is that pricing includes vagueness shown with some range. The second is there are some variations in these price zones among potential customers as evaluators. Therefore, it is necessary for manufacturers to integrate these vague price zones with variations and obtain a representative price for all people as evaluators to set up the price based on customers' evaluations. A single added function is sometimes adopted, but in most cases multiple added functions are adopted simultaneously. When multiple added functions are adopted simultaneously, some beneficial new functions for customers are sometimes produced as the result of their interactions. This will be called "the compound effect of functions" in this study. When a compound effect is recognized, the customers' evaluated value of the added functions as a whole will become larger than the sum of the customers' individually evaluated values for the added functions.

The existence of the compound effect of functions will be clarified through case examples, and two new indices will be proposed for evaluating this compound effect. One is the recognition rate of the compound effect and the other is the evaluated value ratio of the compound effect. Next, the compound effect of functions will be tried to be grasped quantitatively by using these two indices and then the results will be utilized to make them useful to come up with a higher-valued product concept (Tanaka(1995)) and deciding a strategic sales price.

2. The Outline of Conventional Studies and This Study

2.1 Conventional studies

Most conventional methods for pricing added functions have been evaluated by comparing them to similar/competitive functions from the producers' viewpoint. The hedonic pricing approach has been also developed based on the regressions of property values with market analysis to estimate the willingness-to-pay for each property (Rosen(1974), Kanemoto(1986), Kanemoto(1988)). This approach is particularly attractive because it can be applied to nonmarket interactions such as externalities and public goods. In this study, however, the direct pricing survey for potential customers will be adopted as the desirable method for pricing the added functions based on their characteristics.

The studies which have achieved the leading role of evaluating added functions by potential customers are based on the application of the Delphi method or its further developed new Delphi method (Koshiba(1996)). However, these methods have the unsolved problem of the representative price of the evaluated values (price zones) which often do not converge within an allowable range. Although there also exists a study (Harada(1998)) by the authors which has improved these methods to set up the strategic sales price for the added functions, the above mentioned studies have so far been for evaluating the added functions individually and have not mentioned "the compounding functions."

This study focuses on this point and shows a new concept of "the compound effect of functions" as well as to propose its evaluation method for the first time, the purpose of which is to be utilized to create a higher- valued product concept. Furthermore, it shows a new viewpoint in studying the evaluation of added functions.

2.2 The outline of this study

The procedure in this study is shown in Fig. 1. In general, when a customer decides to purchase something, he will have already decided in his mind the highest purchasable price a and the lowest non-purchasable price b. Therefore, it has been considered in this study that there exists a drifting price zone between a and b where he has not yet made up his mind whether to purchase or not to purchase. Thus, the drifting price zone of each potential customer for the added function will be clarified by research. It is considered that each potential customer will purchase at some price within the price zone (between a and b). However, which price has the highest possibility of being purchased is not known. Therefore, it has been considered in this study that the possible price of being purchased is uniformly distributed between a and b (see Fig.2).

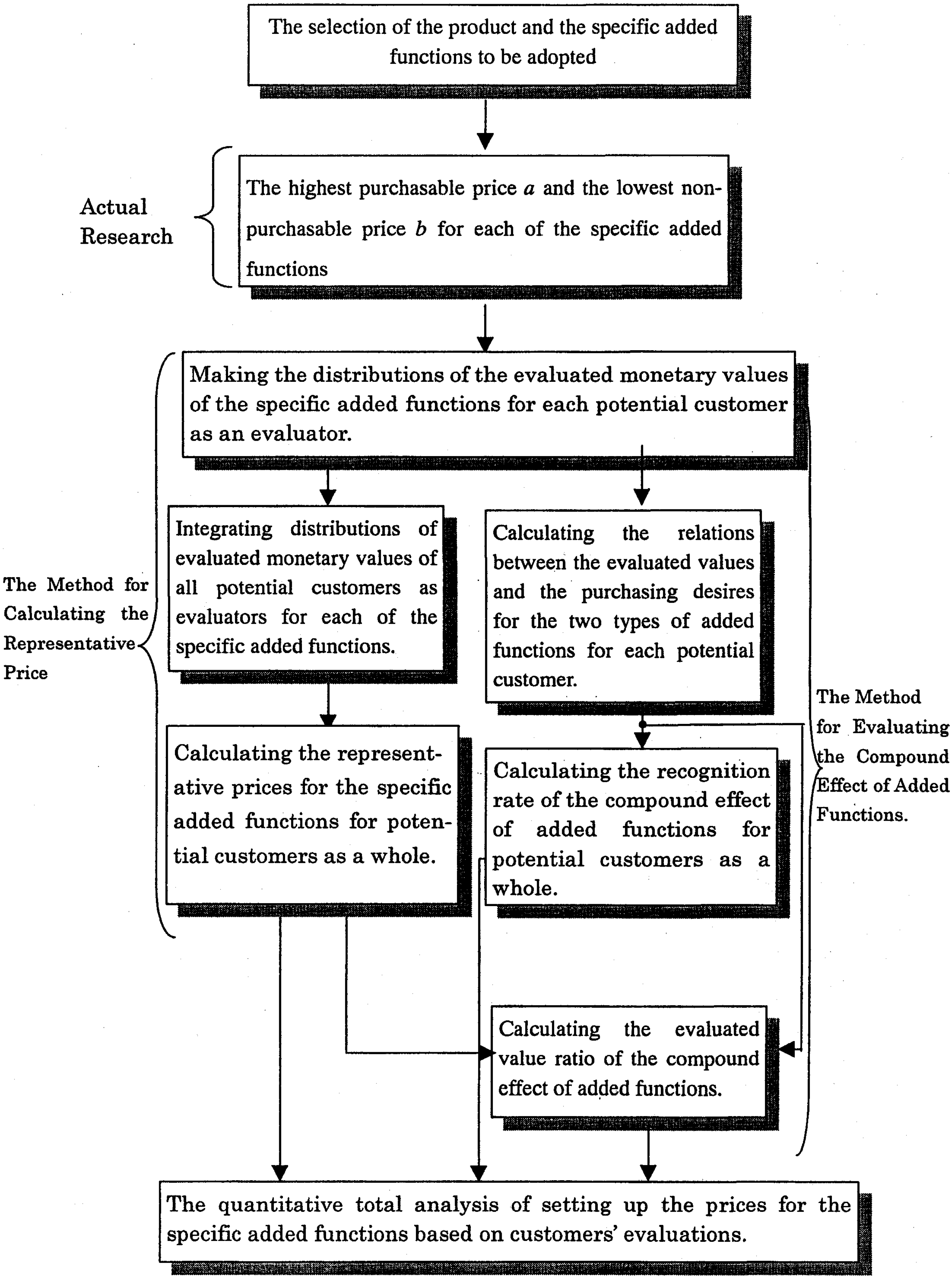

Fig.1 The procedure in this study

In this study, the evaluation value (the representative price) of the specific added function is calculated for the potential customers as a whole based on the linear integration method.

For each potential customer, the sum of the evaluated values for the individual added functions and the evaluated value of the added functions as a whole are compared and analyzed, then the relations between the evaluated values (the prices) and the purchasing desires of the individual potential customers are grasped.

The recognition rate of the compound effect of the added functions is calculated based on the relations between the evaluated values (the prices) and the purchasing desires for the individual potential customers.

The evaluated value ratio of the compound effect is calculated based on the value of the compound effect derived from the relations between the evaluated values (the prices) and the purchasing desires of the individual potential customers to the evaluated value (the representative price) of the customers as a whole.

Lastly, the quantitative methods of the setting up the prices for the specific added functions based on customers' evaluations are totally analyzed and the results of the analysis are utilized.

3. The Selection of the Added Functions and the Research of the Actual State

3.1 The selection of the product and the added functions to be adopted

It is desirable that the product to be chosen as the object in this study is such that it is a product in its mature stage and that many competitive products exist, so that it is considered important that some added functions are necessary to become distinctive from other products. As an example of such, a kitchen sink unit is selected. The following three added functions of the kitchen sink unit made by Company K are chosen as the added functions with a high possibility of having compound effects. Their functions and effects are as follows:

Draining plate function…
- makes it slide on top of the sink so as to put washed food on and drain it.
- slides on the other plane as a draining basket by a 2-stage sliding mechanism.

Draining basket function…
- makes it slide on top of the sink to put washed vegetables and food in for draining.
- slides on the other plane as a draining plate by a 2-stage sliding mechanism.

Chopping board function…
- makes it slide on top of the sink to cut food on.
- slides on the same plane as the draining plate.

3.2 The evaluation of the added functions by the actual research

It is very difficult to derive the evaluated values from potential customers for the added functions. Since potential customers think that it is better if the purchasing price is as low as possible for a specific added function, they are apt to show a somewhat low evaluated value. Thus, the customers were requested to make their evaluations for the specific added function by two values a and b as previously described. Potential customers mentioned the values for a and b with almost no hesitation. If the values a and b become known, it is possible to evade the trend of the evaluated values to become biased toward low values intentionally, although some ambiguity will remain. As a result of the research questionnaires, effective answers were obtained from 193 potential customers (housewives having a high possibility of purchasing) for the kitchen sink with the added functions.

4. The Method for Calculating the Evaluated Values (the representative prices) of the Added Functions for Potential Customers

The representative price with the highest precision should be determined by a weighted mean, rather than the simple mean, of all the evaluated values so as to give the weight coefficient according to each potential customer's degree of price sensitivity. To accomplish this, the linear integration method is used as the method for calculating a representative price for potential customers as a whole among many methods for calculating a representative price. The essence of the method is as follows:

A random variable Z is constructed by the linear combination of n random variables $X_1, X_2, \cdots, X_n$ as follows:

$$Z = c_1X_1 + c_2X_2 + \cdots + c_nX_n \tag{1}$$

The linear integration method (see references Ishihara(1993) , Ishihara(1995) and Harada(1998) for more details) used in this study is to determine $c_1, c_2, \cdots, c_n$ so as to minimize the variance of the random variable Z under the condition of the following equation (2), to obtain a representative value from Z for n potential customers with the highest precision.

$$c_1 + c_2 + \cdots + c_n = 1 \quad , \qquad c_i \geq 1 \tag{2}$$

The evaluated values of the potential customers for the each added function obtained from the questionnaires are considered as uniform random variables, and are integrated by the above mentioned linear integration method, and the integrated evaluation value is considered as the representative price for the potential customers as a whole. The procedure for calculating the representative price of an added function based on the linear integration method will be explained through the following temporary hypothetical example. The prices a and b of five potential customers for a specific added function of a certain product with their density functions in Fig.2 are as follows:

person 1 a_1=8.0 , b_1=10.5 person 2 a_2=6.0 , b_2=7.5 person 3 a_3=5.0 , b_3=12.0
person 4 a_4=9.0 , b_4=10.0 person 5 a_5=7.0 , b_5=13.0

The representative price Z based on $X_1, X_2, \ldots, X_5$, where $X_i = \{x | a_i \leq x \leq b_i\}$, i=1,2,$\cdots$,5, can be shown by Eq.(3).

$$Z=c_1X_1+ c_2X_2+ \cdots +c_5X_5, \quad c_1+ c_2+ \cdots +c_5=1, \quad c_1\geqq 0, c_2\geqq 0, \cdots, c_5\geqq 0 \tag{3}$$

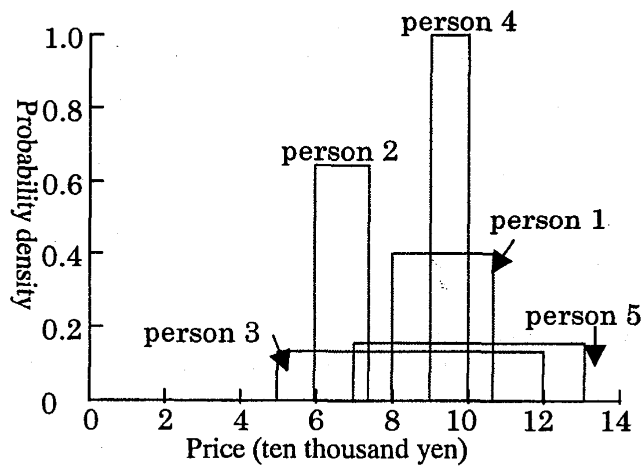

Fig.2 The distributions of the price zones decided by the potential customers

The thought behind the liner integration model is to obtain Z by linearly integrating $X_1, X_2, \cdots, X_5$ based on the weighted means as shown in Eq.(3), where the weight coefficients $c_1, c_2, \cdots, c_5$ are obtained so as to make the variance of Z minimum, in other words, to make the precision of Z maximum.

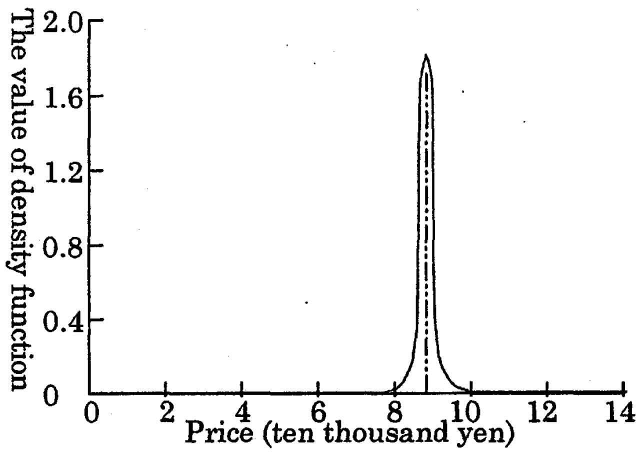

Fig.3　The distribution of the representative price

Let the means and the variances of the price zones $X_1, X_2, \cdots, X_5$ of the added function be $\mu_1, \mu_2, \cdots, \mu_5$ and $\sigma_1^2, \sigma_2^2, \cdots, \sigma_5^2$ respectively, then the weight coefficients $c_1, c_2, \cdots c_5$ in Eq.(3) which minimize the variance of the integrated representative price Z can be expressed by Eq.(4), where $\sigma_i^2 = (b_i - a_i)^2/12$, $i = 1, 2, \cdots, 5$.

$$c_i = \frac{1/\sigma_i^2}{1/\sigma_1^2 + 1/\sigma_2^2 + 1/\sigma_3^2 + 1/\sigma_4^2 + 1/\sigma_5^2} \quad ,i = 1,2,\ldots,5 \tag{4}$$

This shows that the narrower the range of the prices a_i and b_i is, or the more sensitive about the price the potential customer is, the higher weight coefficient c_i becomes.Therefore, the mean μ_Z and variance σ_Z^2 of the representative price Z can be expressed as follows:

$$\mu_Z = \frac{(1/\sigma_1^2)\mu_1 + (1/\sigma_2^2)\mu_2 + (1/\sigma_3^2)\mu_3 + (1/\sigma_4^2)\mu_4 + (1/\sigma_5^2)\mu_5}{1/\sigma_1^2 + 1/\sigma_2^2 + 1/\sigma_3^2 + 1/\sigma_4^2 + 1/\sigma_5^2}, \quad \sigma_Z^2 = \frac{1}{1/\sigma_1^2 + 1/\sigma_2^2 + 1/\sigma_3^2 + 1/\sigma_4^2 + 1/\sigma_5^2} \tag{5}$$

When the distribution is uniform, the mean μ_1 and σ_1^2 for person 1 can be calculated as follows:

$$\mu_1 = \frac{a_1 + b_1}{2} = \frac{8.0 + 10.5}{2} = 9.25 \qquad \sigma_1^2 = \frac{(b_1 - a_1)^2}{12} = \frac{(10.5 - 8.0)^2}{12} = 0.52$$

The means and the variances of the price zones for persons 2 and so on are obtained similarly and are put into Eq.(4) to calculate the weight coefficients for the individual persons. The result becomes as follows:

$$c_1 = 0.097 \quad , c_2 = 0.269 \quad , c_3 = 0.012 , \quad c_4 = 0.605 \quad , c_5 = 0.017$$

And when the means and the variances of the price zones for the individual persons are put into Eq.(5) to obtain the mean μ_Z and the variance σ_Z^2 for the persons 1 to 5, the following results are obtained.

$$\mu_Z = 8.732 \quad , \sigma_Z^2 = 0.050 \quad (\sigma_Z = 0.225)$$

The distribution of the representative price Z with the highest precision is shown in Fig.3. The price zones for the individual persons were uniformly distributed, but the distribution of the representative price becomes approximately a normal distribution (due to the central limit theorem of probability theory).The representative price becomes 87,300 yen, at which the standard deviation is 2,250 yen.

The evaluation values (representative prices) for the individual added functions of the kitchen sink unit obtained by the linear integration method are shown in Table 1.

Table 1 The representative prices of the added functions

Added functions	Evaluated values (representative prices) for potential customers as a whole
draining plate function	¥6,300
draining basket function	¥5,400
chopping board function	¥5,300

Furthermore, for the cases that the number of added functions is two (the draining plate function and the draining basket function), or three (the draining plate function, the draining basket function, and the chopping board function), the sum of the evaluated values of the individual added functions and the evaluated value of the compound added function composed of these added functions for the potential customers as a whole are shown in Table 2.

Table 2 Two types of the representative prices of the added functions.

Added functions	The sum of the evaluated values of independent functions(yen)	The evaluated value of the compound added function(yen)
draining plate draining basket	11,700	10,000
draining plate draining basket chopping board	17,000	12,200

The evaluated value of the added functions as a whole (the evaluated value of the compound function) has become smaller than the sum of the evaluated values of the independent added functions. This is the generalized tendency because many potential customers recognize that the multiple items purchased as a whole should be relatively cheaper. However, we cannot say that the actual state of the potential customers has been analyzed sufficiently from this result only. It will be necessary to analyze the potential customers individually, as mentioned below.

5. The Evaluation of the Compound Effect of Functions

5. 1 The relationship between the evaluated value and the purchasing desire for each potential customer

When we look at the evaluated average value for the potential customers as a whole, the sum of the evaluated values of the independent added functions is, in general, larger than the evaluated value of the compound function (the evaluated value of these added functions as a whole). However, when we compare the distribution of the sum of the evaluated values of the independent added functions with the distribution of the evaluated value of the compound function for each potential customer, there are some cases that the evaluated value of the compound function becomes larger than the sum of the evaluated values of the individual added functions.

This shows that there coexist potential customers who recognize the compound effect of functions and those who do not, when added functions are adopted simultaneously. To clarify this fact, it will be necessary to grasp the relations between the evaluated values of the added functions and the purchasing desires for each potential customer.

The strength of the purchasing desire will be expressed by the purchasing probability in this study. The distribution of the sum of the independently evaluated values of the added functions for each potential customer can be derived from the convolution method (Feller(1975)) in probability theory.

According to convolution method, the distribution of the sum of the evaluated values for the two added functions F_1 and F_2 expressed as uniform distributions can be derived as shown in Fig. 4. The lower limit and the upper limit of the distribution having a larger variance for two uniform distributions are expressed by a_1 and b_1, and those for the distribution having a smaller variance are expressed by a_2 and b_2.

A trapezoid form F_1+F_2 as shown in Fig.4 can express the distribution (probability density function) of the sum of the evaluated values for two added functions. Therefore, if we suppose that the sum of the evaluated values of two added functions F_1 and F_2 is a value of the compound function comprised of F_1 and F_2, then the relation between the evaluated value and the purchasing desire can be derived as shown in Fig.4.

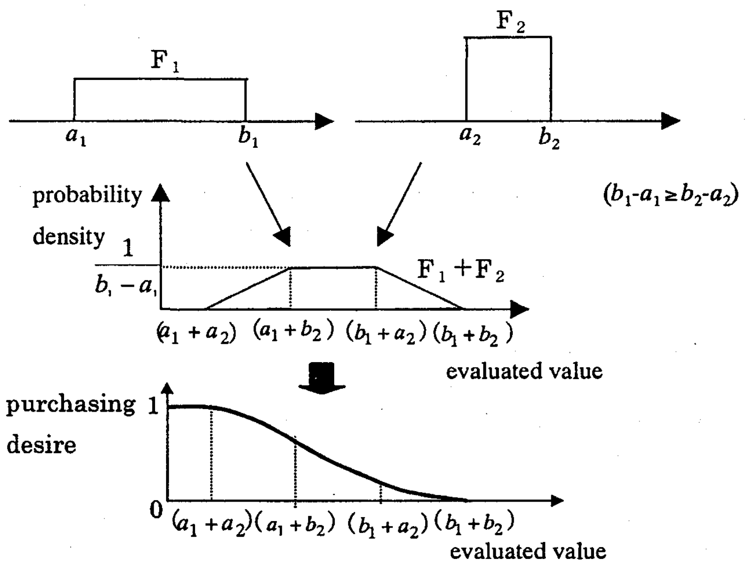

Fig.4 The relation between the evaluated value and the purchasing desire

When the evaluated value is equal to or larger than (b_1+b_2), then the purchasing desire is 0, but for the range between (b_1+b_2) and (b_1+a_2), the purchasing desire (purchasing probability) will increase with the decrease in the evaluated value following a positive quadratic curve.

Next, for the range between (b_1+a_2) and (a_1+b_2), the purchasing desire (purchasing probability) will increase linearly with the decrease in the evaluated value. Furthermore, when the evaluated value is within the range between (a_1+b_2) and (a_1+a_2), the purchasing desire (purchasing probability) will increase with the decrease in the evaluated value following a negative quadratic curve, and when the evaluated value is equal to or less than (a_1+a_2), the purchasing desire (purchasing probability) becomes 1.

On the other hand, the relation between the evaluated value of the compound added function and the purchasing desire can be derived as shown in Fig. 5.

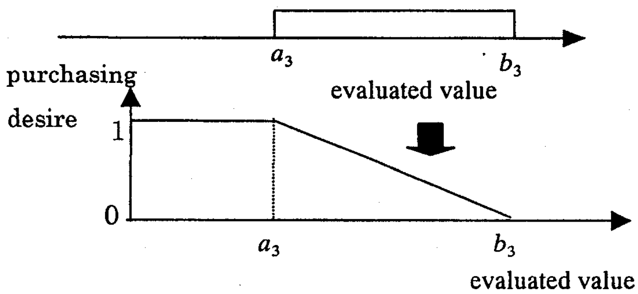

Fig. 5 The relation between the evaluated value of the compound function and the purchasing desire

The purchasing desire (purchasing probability) is 0 when the evaluated value is equal to or larger than b_3. And the purchasing desire (purchasing probability) will increase linearly with the decrease in the evaluated value when the evaluated value is in the range between b_3 and a_3, and the purchasing desire (purchasing probability) will become 1 when the evaluated value is a_3 or less.

The compound effect of the added functions can be grasped by comparing Fig. 4 with Fig. 5.

5. 2 The method for recognizing the compound effect

When multiple added functions are adopted simultaneously into new products, a division into several types as shown in Fig. 6 will be seen when we show the relation between the sum of the evaluated values of the individual added functions and the purchasing desire (purchasing probability)(Fig.4) and the relation between the evaluated value of the compound added function and the purchasing desire (purchasing probability) (Fig.5) on the same coordinate.

For type ① in Fig. 6, the sum (A) of the evaluated values of the individual added functions is always higher than the evaluated value (B) of the compound added function. This shows that the potential customer for this case completely ignore the compound effect of the added functions.

On the other hand, for type ④ in Fig. 6, the evaluated value (B) of the compound added function is always higher than the sum (A) of the evaluated values of the individual added functions. This means that the potential customer for this case has recognized that a new function has been created. That is, it shows that the potential customer for this case has recognized the compound effect of added functions.

For types ② or ③ in Fig. 6, the sum (A) of the evaluated values of the individual added functions and the evaluated value (B) of the compound added function cross each other. The type②-(a) and type②-(b) are categorized into the same type because each of them is the case that on most portion A is higher than B, so the vague compound effect is somewhat recognized. And the type③-(a) and the type③-(b) also belong to the same type because each of them is the case that on most portion B is higher than A, so the vague compound effect is considerably recognized. It is interesting that there is a mixture of potential customers who recognize and don't recognize compound effects (Harada(1999) , Harada(2000)). To verify this the classified results by the case of kitchen sink's added functions are shown in Table 3.

Table 3 The percentage of the potential customers classified into each of the four types in Fig. 6.

Type \ compound function	(draining plate, draing basket)	(draing plate, draing basket, chopping board)
type①	65%	73%
type②	12%	9%
type③	5%	3%
type④	18%	15%
total	100%	100%

Every potential customer classified into the type④ in Fig. 6 by compounding the draining plate function and the draining basket function shows that the evaluated value of these two added functions as a whole was completely higher than the sum of the separately evaluated values of these two added functions. In this case, 18% of the potential customers as evaluators were classified into the type④ as shown in Table 3. This shows that 18% of the potential customers recognized a new value (a compound effect) for the creation of the function of saving space without increasing cost because the sliding planes of the draining plate and the draining basket are able to go past each other without interfering with each other by a 2-stage sliding mechanism. However, 65%of the potential customers completely ignored the compound effect for the newly produced space-saving function because they are classified into type① as shown in Table3.Furthermore,the potential customers who recognized the vague compound effect for the space-saving function by a 2-tage sliding mechanism are 17%(=12%+5%)of all the potential customers because they were classified into type② or type③ as shown in Table 3.

On the other hand, for compounding the draining plate function, the draining basket function and the chopping board function, these three added functions are all designed and manufactured to fit the size of the sink surface, so a systematized feeling is created as a whole. It seems that the considerable potential customers recognized a new value (a compound effect) for it.

However, the chopping board function and the draining plate function slide on the same plane, so they interfere with each other, and cannot achieve any space-saving function. Therefore, the number of percentage of the potential customers who recognized the compound effect of these three added functions is less than that of the potential customers who recognized the compound effect of the draining plate function and the draining basket function as shown in Table 3.

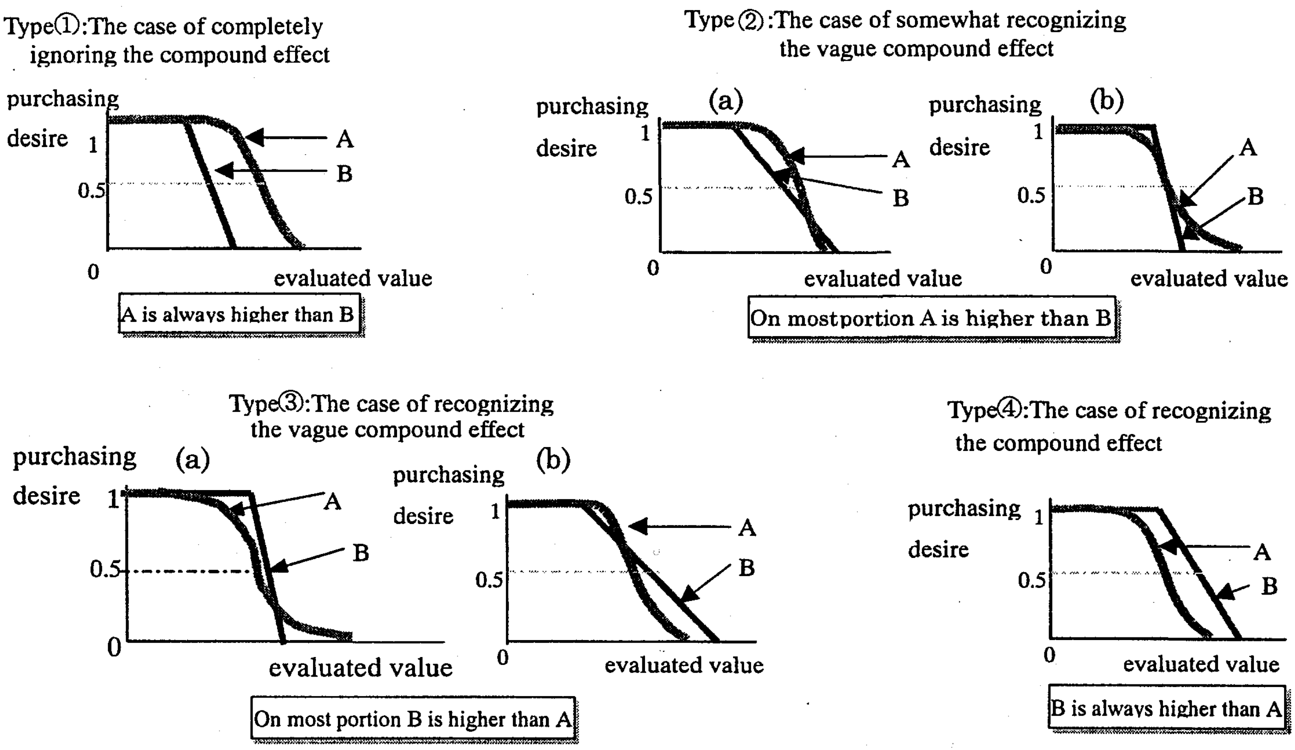

Fig.6 The types of the relationships between the evaluated values and purchasing desires

5. 3 The method for measuring the compound effect

5. 3. 1 The method for calculating the recognition rate of the compound effect

"The recognition rate of the compound effect" is defined as the rate of the potential customers who recognize it to the total number of potential customers. However, there exist, among the potential customers besides those either recognize or not recognize some compound effect, those who are indefinite about such recognition. For example, potential customers of type ④ in Fig.6 are those who clearly recognize the compound effect of the functions. However, types ② and ③ are the potential customers who are indefinite as to recognizing the compound effect. Therefore, the following method based on the likelihood principle is proposed here to calculate the recognition rate of the compound effect.

For type ④ in Fig. 7 (equivalent to type ④ in Fig. 6)where the evaluated value of the compound added function is larger than the sum of the individual added functions' evaluated values, the value of the probability ri of recognizing the compound effect is made to be 1. On the other hand, for the potential customers of type ① in Fig. 7 (equivalent to type ① in Fig. 6) where the evaluated value of the compound added function is smaller than the sum of the individual added functions' evaluated values, the value of the probability r_i of recognizing the compound effect is made to be 0. Furthermore, for the case that the sum of the evaluated values of the individual added functions and the evaluated value of the compound added function cross each other (types ② or ③ in Fig. 6), the value of the probability r_i of recognizing the compound effect is determined according to the rate of the evaluation value of the compound added function becoming larger than the sum of the individual evaluation values. For example, for the potential customer of type ③-(a) or type③-(b) in Fig. 7, the rate of the evaluation value of the compound added function being larger than the sum of the individual evaluation values is 70%, so r_i =0.7. And, for the potential customers of type ②-(a) or type②-(b) in Fig. 7, the rate of the evaluation value of the compound added function being larger than the sum of the individual evaluation values is 40%, so r_i=0.4.

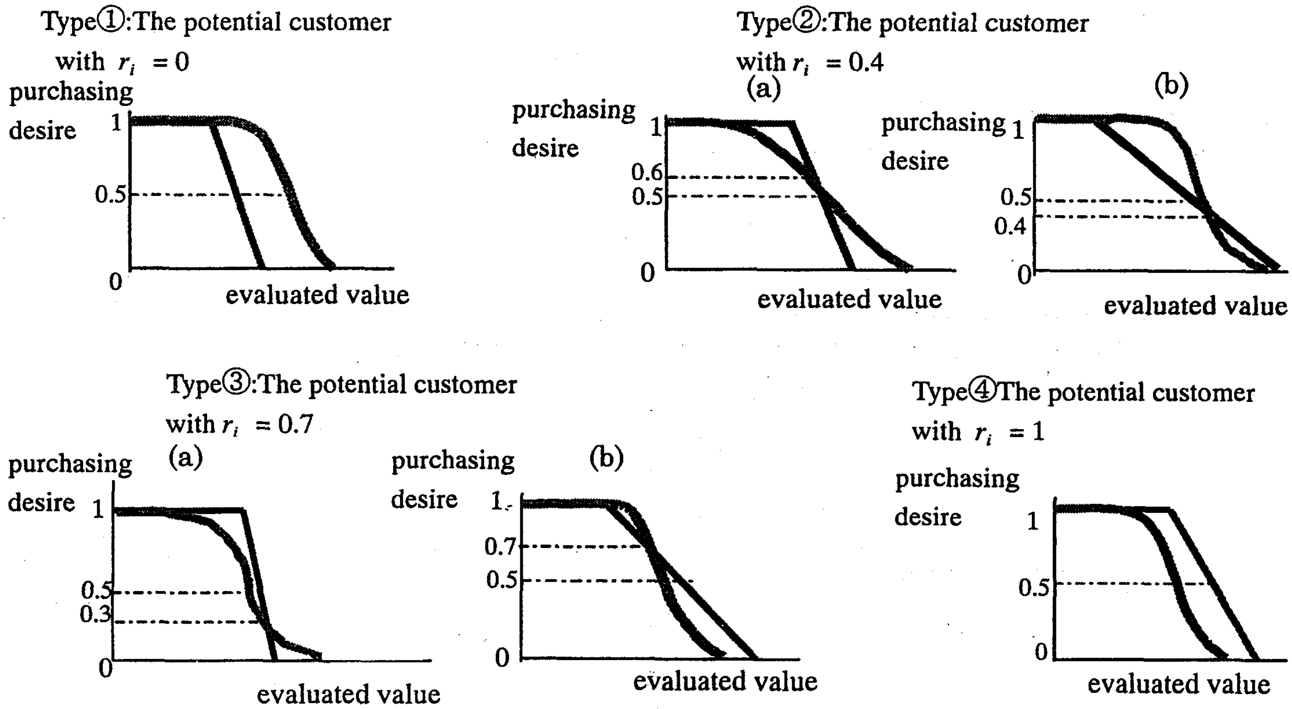

Fig. 7 Several recognition rates of the compound effects

Let θ be the recognition rate of the compound effect for the potential customers as a whole. Now, from the *i*th customer's uncertain judgements, when informations such that the probability of recognizing the compound effect (denoted with Y=1) is r_i and the probability of ignoring the compound effect (denoted with Y=0) is 1- r_i are derived, the posterior probability law $p(\theta|r_i)$ of θ by Bayes' theorem, is denoted as follows:

$$p(\theta|r_i) = \frac{p(\theta)p(r_i|\theta)}{p(r_i)} \tag{6}$$

In Eq.(6), $p(\theta)$ denotes the prior probability law of θ. The conditional probability law $p(r_i|\theta)$ in Eq.(6)is shown as the following equations (7),(8), and (9).

$$p(r_i|\theta) = p(r_i|Y=0)p(Y=0|\theta) + p(r_i|Y=1)p(Y=1|\theta) \tag{7}$$

$$p(r_i|Y=0) = \frac{p(r_i)p(Y=0|r_i)}{p(Y=0)} \tag{8}$$

$$p(r_i|Y=1) = \frac{p(r_i)p(Y=1|r_i)}{p(Y=1)} \tag{9}$$

Therefore, substituting Eq. (7),(8), and (9) into Eq.(6), we get $p(\theta \mid r_i)$ as follows:

$$p(\theta \mid r_i) = p(\theta)(\frac{p(Y=0 \mid r_i)p(Y=0 \mid \theta)}{p(Y=0)} + \frac{p(Y=1 \mid r_i)p(Y=1 \mid \theta)}{p(Y=1)}), \qquad (10)$$

where $p(Y=0|r_i) = 1-r_i$ $p(Y=1|r_i) = r_i$, $p(Y=0|\theta) = 1-\theta$, and $p(Y=1|\theta) = \theta$. So, the posterior probability law (the density function) is derived as follows:

$$p(\theta|r_i) = p(\theta)(\frac{(1-r_i)(1-\theta)}{p(Y=0)} + \frac{r_i\theta}{p(Y=1)}) \qquad (11)$$

If no prior information with regard to θ is obtained, the prior probability law has a uniform density function, and $p(Y=0) = p(Y=1) = 1/2$. Therefore, the following relation is derived from Eq.(11).

$$p(\theta|r_i) \propto (1-r_i)(1-\theta) + r_i\theta \qquad (12)$$

Hence, if the values of probabilities $r_1, r_2, \cdots, r_n$ which recognize the compound effect of function are obtained from n potential customers as evaluators, the likelihood function $L(\theta)(=l(\theta|r_1, r_2, \cdots, r_n))$ of the recognition rate of the compound effect θ is denoted as follows:

$$L(\theta) = \prod_{i=1}^{n}((1-r_i)(1-\theta) + r_i\theta) \qquad (13)$$

Therefore, the posterior density function $p(\theta|r_1, \cdots, r_n)$ of θ is derived as follows(see the references Harada(1983), and Harada(2000) for more details).

$$p(\theta|r_1, \cdots, r_n) = \frac{\prod_{i=1}^{n}((1-r_i)(1-\theta) + r_i\theta)}{\int_0^1 \prod_{i=1}^{n}((1-r_i)(1-\theta) + r_i\theta)d\theta} \qquad (14)$$

Let us consider the case of kitchen sink's added functions. The values of r_1, r_2, $\cdots$, r_{193} obtained by the method shown in Fig. 7 for 193 potential customers were substituted into Eq. (13), then the relation between θ and $L(\theta)$ was derived by varying the value of θ in small steps of 0.01 from 0 to 1 and calculating the relation between θ and the value of $L(\theta)$ numerically. The density function was derived through the normalizing L(θ).

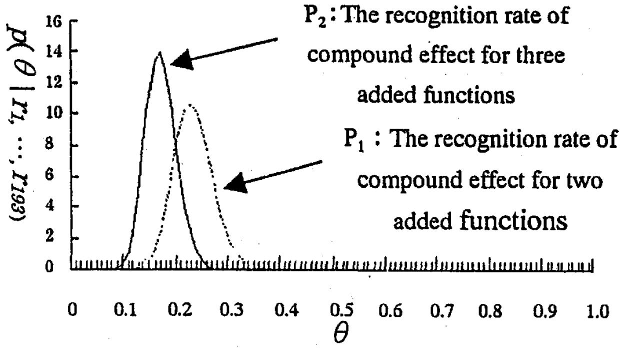

Fig. 8 The density functions of recognition rates of the compound effects

Two density functions of the recognition rates of compound effects are illustrated in Fig. 8 based on the above mentioned calculating method. One is the density function(denoted as P_1)of the recognition rate of compound effect of the draining plate and the draining basket, the other is that (denoted as P_2) of the draining plate, the draining basket, and the chopping board. It has been clarified that the maximum likelihood estimator for the recognition rate of compound effect of the above two added functions is 0.23 and that of the above three added functions is 0.17 based on the density functions P_1 and P_2 in Fig. 8.

When the compound effect of functions is adopted in the concept making of a new product, "the recognition rate of the compound effect" will become an effective index in grasping the degree of recognition of the compound effect by customers.

5.3.2 The method for calculating the monetary value of the compound effect and the evaluated value ratio of the compound effect

"The evaluated value ratio of the compound effect " is defined as shown in the following equation. It is defined as the ratio of the mean evaluated value of the compound effect to the evaluated value of the compound function.

$$R = \frac{\sum_{i=1}^{n} S_i / n}{T}, \tag{15}$$

where R, n, S_i, and T individually express the evaluated value ratio of the compound effect, the number of potential customers as evaluators, the evaluated value of the compound effect of ith potential customer, and the evaluation value of the compound function.

Now, the recognition rate of the compound effect expresses the rate of the number of potential customers who recognize the compound effect to the total number of potential customers. Compared to this fact, the evaluated value ratio of the compound effect is the index for showing the ratio of the evaluated value of the compound effect to the total evaluation value.

Let's show that for ith potential customer, when the relation (as denoted with $\Phi_1(\bullet)$) between the sum of the evaluated values for the individual added functions and the purchasing desire, and the relation (as denoted with $\Phi_2(\bullet)$) between the evaluated value of the compound function and the purchasing desire are shown in Fig.9, the area of the region in which $\Phi_2(\bullet)$ becomes larger than $\Phi_1(\bullet)$ (the area of the hatched portion of (a), (b), or (c) in Fig.9) corresponds to the evaluated value of the functions' compound effect for the potential customer.

Now, let $G_1(\bullet)$ and $g_1(\bullet)$ denote the distribution and density functions of the sum of the evaluated values of the individual added functions, $G_2(\bullet)$ and $g_2(\bullet)$ denote the distribution and density functions of the evaluated value of the compound added function respectively. $\Phi_1^{-1}(\bullet)$ and $\Phi_2^{-1}(\bullet)$ also denote the inverse functions of $\Phi_1(\bullet)$ and $\Phi_2(\bullet)$ respectively.

The evaluated value S_i of ith potential customer for the compound effect is the expected value of the difference of the evaluated values $\Phi_2^{-1}(\bullet)$ and $\Phi_1^{-1}(\bullet)$ in the domain of $\Phi_2(\bullet) \geq \Phi_1(\bullet)$ as shown in Eq. (16).

$$S_i = \int_{\{x|\Phi_2(x) \geq \Phi_1(x)\}} x(g_2(x) - g_1(x))dx \tag{16}$$

The domain of $\Phi_1(\bullet) > \Phi_2(\bullet)$is ignored in Eq. (16) because of having no relation to the compound effect. Therefore, it is so important for the strategic decision of sales price by utilizing the compound effect of added functions that the value of R in Eq. (15) is enlarged by the increase of S_i based on finding out the way to reduce the domain of $\Phi_1(\bullet) > \Phi_2(\bullet)$.

There exists the generalized relation between the distribution function $G(\bullet)$ and the density function $g(\bullet)$of some positive random variable with the expected value as shown in Eq. (17) (see reference Feller(1975) for more details).

$$E(x)=\int_0^{\infty} x\,g(x)dx=\int_0^{\infty}(1-G(x))dx \tag{17}$$

By applying the relation in Eq. (17) to Eq.(16), S_i is derived as follows:

$$S_i = \int_{\{x|\Phi_2(x)\geq\Phi_1(x)\}}((1-G_2(x))-(1-G_1(x)))dx$$

$$= \int_{\{x|\Phi_2(x)\geq\Phi_1(x)\}}(\Phi_2(x)-\Phi_1(x))dx \tag{18}$$

S_i in Eq. (18) corresponds to the area of the hatched portion of (a), (b), or (c) in Fig. 9.

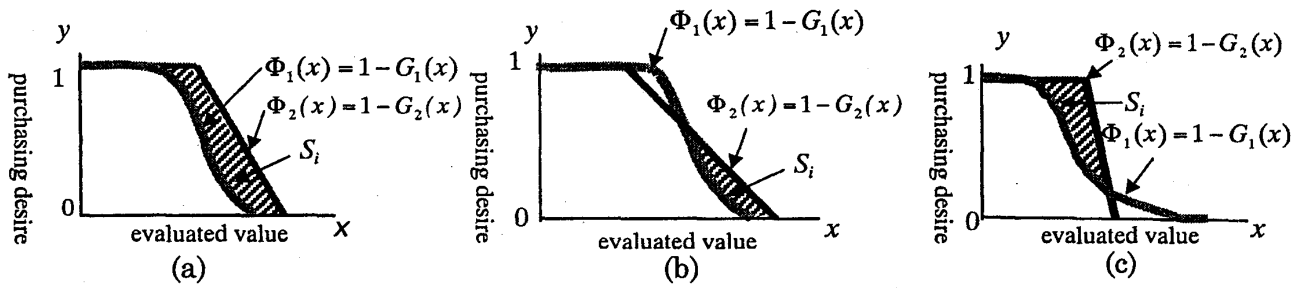

Fig. 9 An example of the distributions of the evaluated values of *i*th potential customer for the added functions

The evaluated value of the compound effect for the potential customer as a whole should be the simple mean, rather than a weighted mean, of the compound effect values because the compound effect values are indifferent to price sensitiveness itself.

We obtained the value of the compound effect of the draining plate function and the draining basket function (the value equivalent to the area of the hatched portion in Fig. 9) for each of 193 individual housewives (potential customers) who became the evaluators based on the method shown in Fig. 9. The total amount of the evaluated values of the compound effects for the 193 potential customers became ¥118,500. Therefore, the mean evaluated value of the compound effect for the potential customers as a whole (equivalent to the value of the numerator of Eq. (15)) becomes ¥614 (=¥118,500/193).

On the other hand, evaluated value of the compound function composed of the draining plate function and the draining basket function for the potential customers as a whole (equivalent to the denominator of Eq. (15)) was ¥10,000. Therefore, the evaluation value ratio of the compound effect R becomes 0.061 (=614/10,000). That is, 6.1% of the total evaluated value of the compound function composed of the draining plate function and the draining basket function is the value due to the compound effect. Similarly, we obtained ¥266 as the mean evaluated value of the compound effect for the three added functions (the draining plate function, the draining basket function, and the chopping board function). The evaluated value of the compound function composed of the three added functions for the potential customers as a whole was ¥12,200. Therefore, the evaluated value ratio becomes 0.022 (=266/12,200). That is, 2.2% of the total evaluated value of the compounded function composed of three added functions (the draining plate function, the draining basket function, and the chopping board function) is the value due to the compound effect.

The value of the compound effect and the evaluated value ratio of the compound effect will become strategically effective information in setting up the sales price of a new product having a compound added function.

6. Concluding Remarks

In this study a new method for calculating the representative price with the highest precision for the specific added function according to each potential customer's degree of price sensitiveness has been proposed to obtain the information for customer- oriented pricing through the case example of kitchen sink's added functions.

The concept of "the compound effect of functions" has also been proposed in this study and the method for evaluating it by deriving the two indices has also been proposed. These indices are "the recognition rate of the compound effect" and "the evaluated value ratio of the compound effect". Furthermore, the existence of the compound effect of functions has been clarified through the case of the added functions of kitchen sink .

The compound effect of functions can be utilized to make strategic concepts for new products. That is, it will be possible to make higher valued products by positively including in the concept making of new products beneficial new functions produced by the compounding functions. To accomplish this, the degree of the compound effect of functions being recognized by customers must be grasped by measuring the recognition rate of the compound effect. Furthermore, when the compound effect of functions is widely recognized, the decision of the strategic sales price should be made by using the information obtained by calculating the evaluated value of the compound effect or the evaluated value ratio of the compound effect.

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