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DESIGN METHOD FOR OPERATIONAL IMPROVEMENT OF RESTAURANT
BY KANSEI FACTOR ANALYSIS
BASED ON CUSTOMER SATISFACTION

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Abstract: The aim of this research is to determine a design methodology for operational improvement of a restaurant by identifying the specific factors of concern to consumers that influence customer satisfaction ("Kansei factors"), quantify the level of influence of these factors and use these to construct a suitable logical model using the "QSCmix" concept, and also to verify the effectiveness of this logical model. Specifically, the logical model is constructed from a multi-variable analysis model as used in psychology and other fields. The effectiveness of the model was verified by using secondary data to identify the three elements of QSC and verify their formulation as a quantitative model, and by verifying the operational effectiveness at an actual restaurant in Japan over a fourteen month period. The results of the analysis showed that, by identifying and categorizing the factors of concern to consumers that influence customer satisfaction (satisfaction influence factor group, referred to as "Bf factors"), the factors were able to be systematized and divided into five categories by characterizing the attractiveness factors that are also "QSCmix" factors. Also, the composite equation for establishing the groupings and level of influence for the combinations of "Bf factors" for each of these influential categories (referred to as "Bfp factors") was calculated using a satisfaction evaluation formula based on the each of the grouping "Bfp factors" for each examinee, and this established three groups of identification categories together with their levels of influence. The order of new categories that influence satisfaction (desirable "Bf factor" combinations) was determined to be, 1st: guest service, 2nd: portion volume, 3rd: cleanliness, 4th: price affordability, 5th: taste, 6th: food presentation, 7th: ambience, 8th: membership privileges, and 9th: menu variety. A successful result in the form of an improving trend for patrons to make repeat visits and increasing monthly turnover was achieved in the restaurant for verification used to trial the "QSCmix" concept design process based on the satisfaction structure obtained from the "QSCmix" concept design identified by this research. These results demonstrate that the proposed logical model is effective as a quantitative model for the analysis of satisfaction factors and that it can be applied to "QSCmix" concept design.

Keywords: Customer satisfaction, Foodservice, Customer relationship management, Structural equations, Multivariable analysis

1. INTRODUCTION

Due to stiffer competition among restaurants, foodservice industry in our country has been seeing an increased percentage of first-time customers and facing more difficulties in finding out certain factors that would attract repeat customers than in the past. Q (quality), S (services) and C (cleanliness) [1, 2] are the three factors determining restaurant operation level (e.g., menu structure, price range, interior/exterior designs, events, showmanship and promotion strategies that would directly affect customer satisfaction), and appropriate combination of Q, S and C will play important roles in improving restaurant operations (hereinafter, the combination of Q, S and C is referred to as "QSCmix").

This means that successfully identifying appropriate QSCmix that would continuously attract customers would be an important issue in improving restaurant operations through prevailing against competitive restaurants and establishing competitive advantage aimed at stable restaurant business management.

However, when setting a QSCmix concept for improving restaurant operations, developers and restaurant operators are heavily dependent on their own know-how, feelings, and information, such as mystery shopper surveys [3] and case studies on competitive restaurants. Basically, QCSmix concepts are depending on their target customers’ preferences or their competitive positions, but they have not standardized mathematic statistics-based logical approaches, such as design systems in line with analysis on customer satisfaction factors.

In addition, only a very limited number of analysts are focusing on qualitative factors, such as customer satisfaction factors of consumers’ concerns that would represent consumption awareness or characteristics of target customers [4-5]. There is no empirical analysis that pays attention to trend of actual restaurant operations.

2. PURPOSES

From these perspectives, the aim of this research is to determine a design methodology for operational improvement of a restaurant by identifying the specific factors of concern to consumers that influence customer satisfaction ("Kansei factors"), quantify the level of influence of these
factors and use these to construct a suitable logical model using the QSCmix concept, and also to verify the effectiveness of this logical model. Specifically, the logical model is constructed from a multi-variable analysis [6-9] model as used in psychology and other fields. The effectiveness of the model will be verified by using the result of customer needs survey that we have conducted on actual restaurants in Japan.

3. RESEARCH METHODS

3.1 Approaches and basic assumptions on satisfaction factor analysis

Our logical model for quantifying consumption sensitivity factors is designed in order to identify the following factors a, b, and c by using a composite model combining principal component analysis, factor analysis and quantification theory III approache for questionnaire survey data. By doing so, we will identify the effects of QSCmix on customer satisfaction and will apply it as a QSCmix concept design model for improving restaurant operations.

a. Identifying and sorting out certain factors that would influence customer satisfaction (hereinafter, referred to as “Bf factors”); Identifying QSCmix’s various appealing factors that would influence customer satisfaction, and sorting them out in a systematical manner.

b. Identifying combinations of highly influential Bf factors (hereinafter, referred to as “Bfp factors”), and calculating a composite equation that indicates their influences (theoretical values).

c. Calculating a composite equation that indicates customer satisfaction, this is an overall influence (theoretical values) of Bf factor combinations.

3.2 Method of demonstrating the effectiveness of our model

When demonstrating the effectiveness of our logical model suggested in this paper, we used French cuisine restaurants in our country [12]. We have experimented with 14-month long actual restaurant operations. Here is the outline of our processes and research procedures.

3.2.1 Survey measurement process

When establishing out logical model for identifying customer satisfaction structure, we have collected published secondary data as industrial de-facto standard. For demonstrating the QSCmix concept, we collected our own primary data by conducting questionnaire survey on restaurants that participated in our project. Here is how we have collected the data.

[Industrial standard base: Secondary data]
(1) Measuring method: We collected the secondary data by conducting questionnaire survey and mystery shopper survey on major restaurant chains.

(2) Measuring items: We measured major data related with QSC, which are the three factors that would determine restaurant operation level as mentioned earlier.

(3) Evaluation method: We used a five-grade evaluation approach. The criteria are as follows. “5” represents good, “4” rather good, “3” fair, “2” rather bad, and “1” bad.

[Spot investigation basis]
(1) Measuring method: We conducted a questionnaire survey on participating restaurants.

(2) Measuring items:
* Basic data: Address, Name, Age, Gender, Generation, Birthday, Wedding anniversary, Mobile phone number, Occupation
* Visiting data: RFM factors [10]
* Competitive restaurants within same market area
* Membership customer: Evaluation to the privilege
* Impression after a meal: Free answer

(3) Effective numbers of sampling: 2,500

3.2.2 Data analysis process

In this process, we analyzed the secondary data collected from the preceding process and identified specific consumption sensitivity factors that would influence customer satisfaction. By quantifying their influences, we identified how QSCmix design would have impacts on customer satisfaction.

3.2.3 QSCmix designing process

When reorganizing QSCmix, we designed new QSCmix based on the results of the secondary data analysis process. We have designed a new QSCmix as a CRM (customer relationship management) promotion strategy and have implemented it and evaluated its effectiveness for 14 months.

Table 1: Survey form for industrial standard base

<table>
<thead>
<tr>
<th>Age</th>
<th>Judgement ( 5 ranking score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1</td>
</tr>
<tr>
<td>taste</td>
<td></td>
</tr>
<tr>
<td>portion volume</td>
<td></td>
</tr>
<tr>
<td>menu varieties</td>
<td></td>
</tr>
<tr>
<td>price affordability</td>
<td></td>
</tr>
<tr>
<td>guest service</td>
<td></td>
</tr>
<tr>
<td>food presentation</td>
<td></td>
</tr>
<tr>
<td>ambience</td>
<td></td>
</tr>
<tr>
<td>cleanliness</td>
<td></td>
</tr>
<tr>
<td>membership privileges</td>
<td></td>
</tr>
<tr>
<td>overall judgement</td>
<td></td>
</tr>
</tbody>
</table>
3.2.4 Effectiveness verification process

In relation with our logical model for identifying how the QSCmix design would influence customer satisfaction as mentioned in 3.1 as well as the concept design approach that we conducted as an application experiment, we have examined restaurant’s competitive advantage by evaluating repeaters’ reservations and restaurant’s sales trend based on the hypothesis described in 3.3 below. Then, based on such evaluation results, we have verified the effectiveness of our model and its feasibility to apply to the QSCmix designing approach.

3.3 LOGICAL MODELS

Here are descriptions on our logical model that identifies how the QSCmix design would influence customer satisfaction.

3.3.1 Hypothesis

If restaurants are able to successfully find out specific factors that would appeal customers and influence customer satisfaction and to quantify their influences, then they are able to design an appropriate QSCmix that would provide competitive advantage.

In this hypothesis, we evaluate the following aspects.

1) Satisfaction factor analysis model: Identifying specific factors that would influence customer satisfaction through consumption sensitivity factors, and verifying their quantified influences
2) Feasibility of programming QSCmix design: Feasibility of putting the QSCmix design to practical use based on the customer satisfaction structure as identified through the satisfaction factor analysis model

3.3.2 Logic for verifying the hypothesis

As for the satisfaction factor analysis model as mentioned earlier in the section 3.3.1, we will verify its effectiveness as a quantitative model based on the aforementioned three factors: 3.1.1), 3.1.2) and 3.1.3).

As for the feasibility of programming QSCmix design as mentioned earlier in the section 3.3.1, see the section 3.2.4 above for more information on verification method.

3.3.3 Concept of logical model

We have the following concepts about our logical model that identifies how QSCmix design would influence customer satisfaction.

When identifying the QSCmix that would yield higher customer satisfaction, we used the questionnaire survey data Table 1, on major restaurant chains as secondary data because of the following two reasons: 1) We were not able to conduct a similar questionnaire survey on participating restaurants; 2) In the secondary data we obtained, the principal component analysis has worked best. From these viewpoints, when evaluating the effectiveness of our satisfaction factor analysis model as a quantitative model mentioned earlier in 3.3.2, we have identified customer satisfaction structure at data source major restaurant chains, rather than at participating restaurants.

We actually used the following nine factors from the adopted secondary data. They include 1) tastes, 2) portion volume, 3) menu varieties, 4) price affordability, 5) guest service, 6) food presentation, 7) ambience, 8) cleanliness, and 9) membership privileges. In this context, the factors 1), 2), 3) and 6) represent cuisine-related functions that influence customer satisfaction; the factor 4) represents price effects; the factor 7) and 8) is an environment function coming from restaurant interior, design, BGM, lightings and restaurant cleanliness that influences customer satisfaction. As the factor 9) is directly linked to CRM-type royalty promotion through customer permission, we regard the factor 9) as a benefit function that influences customer satisfaction.

From these 9 types of data, we have designed our logical model to extract QSCmix factors that would give favorable customer impression, in other words, factors that yield higher customer satisfaction and in turn improve restaurant’s competitive advantage and to derive their common characteristics.

3.3.4 Analytical method for our logical model

We used the principal component analysis as main analytical approach. This is a measurement equation-type analytical approach that seeks for common and independent latent factors among different satisfaction factors and also combines new variables, such as factors that give customers favorable impressions. We summarize needs of many customers by take in the composite variables the actually observed variable data selected from Bf categories and their combinations as much as possible.

In other words, we employed the primary principal components for identifying overall evaluation purpose (by deriving a composite equation that calculates customer satisfaction, which is overall influence (theoretical values) resulting from combinations of Bf factors as described earlier in 3.1.c), while using the secondary and lower principal components for series-specific evaluation purposes (by identifying combinations of highly influential Bf factors, and deriving a composite equation that calculates the degree of influence as described earlier in 3.1.b). We also conducted series-specific evaluation by using factor analysis and quantification theory III approaches in order to compare with primary component analysis results and improve its accuracy.

When identifying and sorting out the Bf factors
described in 3.1.a, we extracted these factors by sorting out survey results (as explained earlier in 3.3.3). By doing so, when conducting follow-up survey on the participating restaurants, we will be able to easily establish structural equation-type analytical model [11] for calculating causalities among common factors, independent factors and further latent variables in the identified categories.

4. SURVEY RESULTS AND OBSERVATIONS

4.1 Identifying and sorting out Bf factors

We have identified various highly appealing QSCmix factors that would influence customer satisfaction, and have systematically organized them as a new category.

By sorting out common appealing factors, we have identified and organized the highly satisfactory QSCmix factors extracted from the secondary data. These factors are sorted out into the five categories as shown in Italics in Table 2.

4.2 Identifying highly influential Bfp factors and calculating composite equation of influence

The five categories of Bf factors as described above in 4.1 represent 4 categories of cuisine-related categories, 1 category of price function, 1 category of service, 2 categories of environment functions, and 1 category of customer benefit. From this viewpoint, there theoretically exist 8 types (4x1x1x2x1) of QSCmix, which means the total 64 patterns (Bfp) in a simple combination matrix.

To identify highly influential Bfp (common factors) on customer satisfaction from these patterns and calculate a composite equation for quantifying their influences, we employed principal component analysis, factor analysis and quantification theory III approaches based on the observed variables as shown below in 4.2.1. Here are the results of our principal component analysis, which is the main analytical approach.

4.2.1 Setting the observed variables

Based on the Bf factors mentioned in 4.1.1 to 4.1.5, we have set simple aggregate data as the following nine observed variables as shown in Table 3.

4.2.2 Identifying and sorting out Bfp

Figure 1 graphically shows eigenvectors of the secondary principal components. Paying attention to each variable’s eigenvector size and its polar distribution, variable clusters in each series are grouped into the three categories: 1) a positive direction: membership privileges, ambience, food presentation; 2) zero vicinity: volume, cleanliness, and services; and 3) a negative direction: taste and menu varieties. In this context, highly satisfactory Bfp factors are divided into the following three categories.

1) Bfp-1: PDL type (combination of membership privileges, ambience and food presentation)
2) Bfp-2: VCSH type (combination of portion volume, cleanliness, guest service and price affordability)
3) Bfp-3: KT type (combination of menu varieties and Taste)

In addition, the results of factor analysis and quantification theory III models are almost the same as that of the secondary principal component.

As for secondary or lower primary components, if the variable cluster comes near zero (the origin), it is possible to interpret it as an important common factor that would have impact to both positive and negative directions. In this sense, Bfp-2 as mentioned earlier represents a common factor that influences both of Bfp-1 and Bfp-3. In other words, Bfp-2 that consists of portion volume, cleanliness, services and price factors is the most powerful Bfp that commonly influences restaurant customers.
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Therefore, Bfp-2 is regarded as the most important in customer satisfaction (the prerequisite factor that restaurants should thoroughly maintain and improve the current level), while other Bfps (except for Bfp-2) restaurants should improve in order to enhance customer satisfaction would belong to either of the category Bfp-1 or Bfp-3 as mentioned earlier.

From these viewpoints, this paper focuses on the aforementioned Bfp-1 (membership privileges, ambience, food presentation) and Bfp-3 (menu varieties and taste) in terms of designing an appropriate QSCmix for improving restaurant operations.

4.2.3 Composite equation of Bfp influence

As mentioned earlier, the secondary principal components would not only represent the function formula (as shown in Formula-1 below) that combines evaluated values for grouping Bfp series into applicable categories, such as Bfp-1 or Bfp-3 going to opposite directions (+ or -) or Bfp-2 that stays near zero (the origin), but also indicate an absolute value of each variable’s coefficient (i.e., influence on customer satisfaction).

In this sense, the composite scores derived from Formula-1 below will indicate series-specific weight of each examinee, or in other words the corresponding ratio of latent Bfp that would have impacts on each examinee’s customer satisfaction. In addition, Formula-1 itself is also used for determining customer satisfaction evaluation categories based on each examinee’s series-specific Bfp.

The evaluated values have the following meanings.

1) If the composite score is positive and takes a larger absolute value, the examinee attaches a higher value (or higher customer satisfaction) to Bfp-1.
2) If the composite score is negative and takes a larger absolute value, the examinee attaches a higher value (or higher customer satisfaction) to Bfp-3.

In addition, the absolute value of each variable shows influence priority among variables. From Formula-1, the influence priority on customer satisfaction is as follows:

3) Bfp-1 > Bfp-3; Bfp2 is a common influencing factor of Bfp-1 and Bfp-3.

[Formula-1] Customer satisfaction discriminant formula of each examinee’s series-specific Bfps

\[
Z_2 = 0.46x1 - 0.38x2 - 0.41x3 + 0.27x4 + 0.59x5 + 0.09x6 - 0.03x7 - 0.09x8 - 0.18x9
\]

4.3 Calculating a composite equation of overall customer satisfaction resulting from combinations of Bfp factors

At the primary principal components (see Figure 1.), all eigenvector in a positive direction and indicate overall evaluation of customers (overall customer satisfaction resulting from QSCmix; functional equation that combines competitive advantage; see Formula-2 below). In other words, as a common factor that influences customer satisfaction, we are able to identify latent variables of a newly-formed QSCmix (= combination of preferred Bf factors) and also find out their influences. By using composite scores, we are able to use it as a discriminant for evaluating QSCmix’s impacts on each examinee’s overall customer satisfaction. In addition, the absolute value of each variable’s coefficient indicates the influence priority among variables.

[Formula-2] Customer satisfaction discriminant formula of each examinee’s QSCmix

\[
Z_1 = 0.50x1 + 0.42x2 + 0.01x3 + 0.28x4 + 0.40x5 + 0.03x6 + 0.28x7 + 0.45x8 + 0.24x9
\]

5. CONCLUSIONS

5.1 Verifying the Hypothesis 1) customer satisfaction factor analytical model

In the sections 4.1, 4.2 and 4.3 above, we’ve done the survey measurement process (3.2.1) and the data analysis process (3.2.2) for evaluating the effectiveness of the logical model suggested in the section 3.2. In the section 3.1, we have identified the following three factors of a, b and c as mentioned earlier in 3.1, so we’ve found out how the QSCmix would influence customer satisfaction. In other words, we’ve verified if or not the Hypothesis 1) customer satisfaction factor analytical model would work effectively as a quantification model. However, it should be noted that the identified relationship between customer satisfaction and QSCmix is based on the secondary data as industrial standard from major restaurant chains.
5.2 Characteristics of impacts of Bf factor combination (observed variables) on overall customer satisfaction

From the primary principal component’s eigenvectors, the observed variables that have larger impacts on customer satisfaction would have the following priority.

1st: S (guest service), 2nd: V (portion volume), 3rd: C (cleanliness), 4th: H (price affordability), 5th: T (taste), 6th: L (food presentation), 7th: D (ambience), 8th: P (membership privileges), and 9th: K (menu variety).

High priority variables are Bfp-2 as VCSH type as stated at 4.2.2, which plays the most important roles among the secondary principal components.

5.3 Characteristics of impacts of each Bf factor category on overall customer satisfaction

As shown from the primary principal components, Bf factor series have the characteristics as follows in terms of their impacts on overall customer satisfaction (competitive advantage).

1) Bf factor-1: Impacts to cuisine function are as follows, \( V > T > L > K \).
2) Bf factor-2: Impacts to price function don’t have comparison factors.
3) Bf factor-3: Impacts to service function don’t have comparison factors.
4) Bf factor-4: Impacts to environment function are as follows, \( C > D \).
5) Bf factor-5: Impacts to benefit function don’t have comparison factors.

5.4 Applicable rules in relation with quantification and factors

In the sections 4.1 to 4.4 above, we have demonstrated the effectiveness of the quantitative model suggested in the section of 3.3.1 Hypothesis 1) customer satisfaction factor analytical model and we’ve also defined quantitative factors necessary for our analysis. As for applying the model to actual projects, we could generalize the following rules/steps from the viewpoint of our past experiences in actual projects, such as our past evaluations on how much logical models would work on actual restaurants.

5.4.1 Identifying and sorting out Bf factors

It is important to measure appropriate factors in line with the three factors of Q, S and C that would determine the restaurant operation level (i.e., measurement-use questionnaire designs in the survey measurement process). Categories in this research are based on the secondary data available from major restaurant chains. If we successfully sort out other secondary data based on these three factors, we are able to identify very similar Bf factors and also reorganize and sort out them in a systematic manner.

In some cases, we would measure restaurant appealing points and propriety of reasons by using Yes/No answer-based dummy variables to calculate influences of appealing factors. In these cases, we would be able to apply discriminant analysis approach as well as quantification theories I and II.

5.4.2 Identifying highly influential Bfps and calculating composite equation of influence

We could generalize the following steps to identify highly influential Bfps and to calculate composite equation of influence.

1) Setting the observed variables:
   As for simple aggregate data for evaluating the three factors that would determine restaurant operation level, it is necessary to sort out and reorganize them in line with the combinations based on Bf factor categories and try to reduce the observed variables as much as possible. This process will lead to easier interpretation of Bfps.

2) Identification of Bfp and analysis for grouping them into series categories:

3) Calculating composite equation for Bfp series-specific influence:
   If applying the principal component analysis approach, it is necessary to identify and exclude certain variables that would prevent calculation of overall evaluation. In addition, it is not a proper approach to exclude factor analysis and quantification theory III.

When identifying Bfps and calculating composite equation of influences, the following rules will apply.

1) Principal component analysis: Adopt principal components that have characteristic value \( \geq 1 \) and cumulative contribution \( \geq 10\% \), and use them as series-specific evaluation scale of Bfp that stays around zero or goes to opposite directions in a positive or negative direction.

2) Factor analysis: Adopt factors with larger cumulative contribution, focus on variables of factor loadings that have larger absolute values, and use a single formula as evaluation scale for each Bfp series.

3) Quantification theory III: Adopt an axis that has larger correlation coefficient, and use it for series-specific evaluation scale of Bfp that goes to opposite directions in a positive or negative direction.

5.4.3 Calculating composite equation that indicate a Bf factor combination would affect overall customer satisfaction

Apply the principal component analysis approach only and apply the following rules.
1) Adopt principal components that has a positive value, characteristic value ≥ 1 and cumulative contribution ≥ 10%, and use them for evaluation scale of overall customer satisfaction resulting from each Bf factor combination.

2) Even if a principal component has a characteristic value < 1 and cumulative contribution < 10%, it is possible to adopt it as long as it only takes positive values.

5.5 Verifying actual examples of applicable rules on quantification factors

Based on the customer satisfaction structure resulting from QSCmix as illustrated in the sections 5.1, 5.2 and 5.3 above, we've actually conducted the QSCmix design process at participating/test restaurants [12] and evaluated its effectiveness for 14 months. The results show that an increased restaurant visitors as illustrated in Figure 3 has resulted in an increased reservations by repeated customers. As illustrated in Figure 4, monthly sales have been taking an upward trend, sending up overall sales at restaurants.

From these perspectives, we are able to demonstrate not only the effectiveness of the quantitative model for analyzing the Hypothesis 1) customer satisfaction factors (section 3.3.1) but also feasibility of the Hypothesis 2) QSCmix design approach for putting it into practical use as QSCmix concept design approach.

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