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Measuring Customer Satisfaction Using a Collective Preference Disaggregation Model*

Y. SISKOS[1], E. GRIGOROUDIS[1], C. ZOPOUNIDIS[1] and O. SAURAIS[2]
[1]*Technical University of Crete, Decision Support Systems Laboratory, GR 73100 Chania, Greece.*
[2]*Management of Strategic Resources, Av. Lavaux 101, 1009 Pully, Lausanne, Switzerland.*

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Abstract. A new model to assess customer satisfaction is developed through this paper. The proposed model is based on the principles of multicriteria analysis, using ordinal regression techniques. The procedure uses survey's data on customer satisfaction criteria and disaggregates simultaneously all the global satisfaction judgments via a linear programming disaggregation formulation. The model provides collective global and partial satisfaction functions as well as average satisfaction indices. These results sufficiently describe customer behavior and they can be used in the strategic planning of an organization. The implementation of the model in three real world applications is used for illustration and for testing the model's reliability. Finally, several extensions and future research in the area of customer satisfaction analysis are discussed.

Key words: Multiple criteria, linear programming, disaggregation method, ordinal regression analysis.

1. Introduction

Measuring customer satisfaction is a major problem for every firm or organization, especially within the frame of marketing management practice. Satisfaction of customer needs is the main objective according to the principles of modern marketing science. Furthermore, a customer satisfaction measure is considered necessary by a lot of methods and techniques. Extensive research in marketing has defined in detail several processes of consumer behavior [6]. Using mainly survey techniques, customer satisfaction can be calculated by the estimation of brand loyalty of a set of customers [3].

The confirmation/disconfirmation of expectations method [11] is a consumer-based model used to measure customer satisfaction. In particular, Oliver [10] describes the satisfaction process associated with the disconfirmation paradigm as follows:

i. Buyers form expectations of product performance prior to purchase.
ii. Consumption reveals a perceived performance level which is compared to expectation levels which are either confirmed or disconfirmed.

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iii. If negative or positive disconfirmation occurs, then customer satisfaction decreases or increases accordingly.

According to Yi [14] the confirmation or disconfirmation of expectation about product quality plays a key role in determining whether or not an individual is satisfied.

Another approach similar to the aforementioned one, is to examine the links between customer-based measures of firm performance, such as perceived quality and customer satisfaction, and traditional accounting measures of business performance, such as market share and profitability [2]. Satisfaction level is then evaluated using econometric tools.

Classical statistical methods, as multiple linear regression analysis may not be applicable in measuring customer satisfaction because of the qualitative form of customer's preferences. Input data in linear regression analysis should not follow an ordinal scaling. Other statistical tools based on categorical data analysis, as loglinear models [8] and logit analysis [1] were developed in order to overcome the problem mentioned before. Loglinear models describe association patterns among categorical variables modeling cell counts in a contingency table in terms of associations among these variables. Unfortunately, loglinear models do not distinguish between response and explanatory variables (i.e. global and partial clients' satisfaction respectively). On the other hand, generalized logit models for categorical variables are equivalent to loglinear models for multiway contingency tables.

Data analysis techniques, as conjoint analysis were also applied in measuring customer satisfaction. Conjoint analysis is a survey-based method for measuring customer's trade-offs among product and service attributes [7]. According to this method, respondents are shown profiles of product or service offering, which are made up of a set of attribute levels. Each respondent receives a set of profiles and evaluates each profile's "worth" to him/her on some type of preference or likelihood-of-purchase scale. In traditional conjoint analysis, conventional dummy variable regression is used to find parameter values.

Another approach in measuring customer's satisfaction problem is the analysis of questionnaire data using simple graphical display tools like difference histograms and probability plots [4]. This method considers the difference between the scores for "best" attribute and "real" attribute as an indicator for customer satisfaction.

The objective of this paper is to present a multicriteria disaggregation model in order to construct a mathematical function representing customer satisfaction criterion, which is a function of multiple criteria. The model is an ordinal regression-based approach in the field of multicriteria analysis used for the assessment of a set of marginal satisfaction functions in such a way that the global satisfaction criterion becomes as consistent as possible with the customer's judgments. Section 2 presents the mathematical model. Three real world applications are given in Section 3 and extensions of the model are discussed in Section 4. Finally, Section 5 presents some concluding remarks and future research in the area of customer satisfaction analysis.

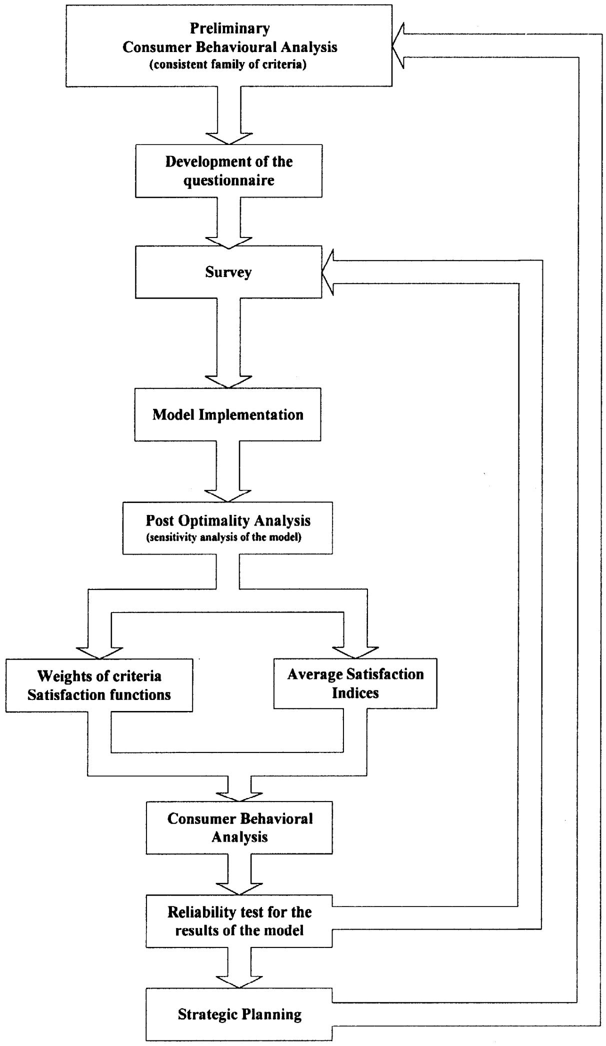

Fig. 1. General methodological frame.

2. Development of the Model

Methodological frame

Implementation of the model must follow in general the methodology presented in Figure 1 which consists of the above main stages:

1. **Preliminary consumer behavioral analysis**: the customer's consistent family of criteria as well as the qualitative satisfaction scales must be specified in this particular stage.

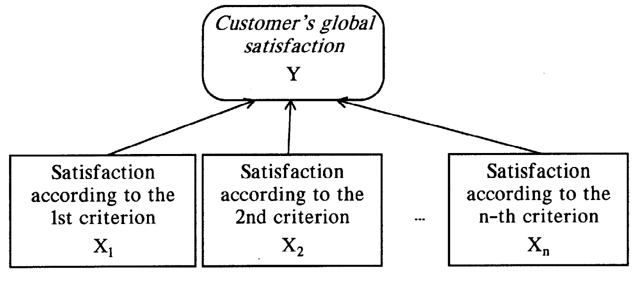

Fig. 2. Aggregation of customer's preferences.

2. **Development of the questionnaire and survey conduct**: in this stage the questionnaire must be conducted and the survey must be carried out in order to collect the input data.
3. **Main analyses**: the implementation of the model is included in this stage providing several results (weights of criteria, satisfaction curves, average satisfaction indices).
4. **Results testing**: reliability testing for the results of the model is included in this stage.
5. **Strategic planning**: in this final stage the strategic planning of the firm can be supported using the results of the model.

Main principles and notations

The main objective of the proposed model is the aggregation of individual preferences into a collective value function. More specifically, it is assumed that the client's global satisfaction can be explained by a set of criteria or variables representing its characteristic dimensions (Figure 2). The problem of measuring customer's satisfaction can be perceived as a multicriteria evaluation problem, assuming that customer's global satisfaction depends on a set of customer's criteria $\underline{X} = (X_1, X_2, \ldots, X_n)$. According to the model, each customer is asked to express his/her judgments, namely his/her global satisfaction and his/her satisfaction with regard to the set of discrete criteria.

The model uses the following variables:

Y :client's global satisfaction
α :number of global satisfaction levels
y^m :the m-th satisfaction level ($m = 1, 2, \ldots, \alpha$)
n :number of criteria
X_i :client's satisfaction according to the i-th criterion ($i = 1, 2, \ldots, n$)
α_i :number of satisfaction levels of criterion i
x_i^k :the k-th satisfaction level of the i-th criterion ($k = 1, 2, \ldots, \alpha_i$)
Y^* :value function of Y
y^{*k} :value of Y^k level

X_i^* :value function of X_i
x_i^{*k} :value of X_i^k level

Given Y and X_i, the presented method assesses the satisfaction functions Y^* and X_i^*, global and partial satisfaction functions respectively; in multiattribute utility theory these satisfaction functions correspond respectively to the global and marginal value or utility functions concepts. The model follows the principles of ordinal regression analysis under constraints using linear programming techniques [9,12,13]. The ordinal regression analysis equation has as follows:

$$\begin{cases} Y^* = \sum_{i=1}^{n} b_i X_i^* \\ \sum_{i=1}^{n} b_i = 1 \end{cases} \tag{1}$$

where Y^* and X_i^* are normalized between 0 and 100 and b_i is a weighting factor of the i-th criterion. According to equation (1), the following properties generally hold for functions Y^* and X_i^*:

$$\begin{cases} y^{*1} = 0 \\ y^{*\alpha} = 100 \end{cases} \tag{2}$$

$$\begin{cases} x_i^{*1} = 0 \\ x_i^{*\alpha_i} = 100 \end{cases} \quad \text{for } i = 1, 2, \ldots, n \tag{3}$$

Furthermore, because of the ordinal nature of Y and X_i the following preference conditions are assumed:

$$\begin{cases} y^{*m} \leq y^{*m+1} \Leftrightarrow Y^m \preceq Y^{m+1} & \text{for } m = 1, 2, \ldots, \alpha - 1 \\ x_i^{*k} \leq x_i^{*k+1} \Leftrightarrow X_i^k \preceq X_i^{k+1} & \text{for } k = 1, 2, \ldots, \alpha_i - 1 \end{cases} \tag{4}$$

where $\preceq$ means “less preferred or indifferent to” (monotonicity condition; see Figure 3).

Model development

The model tries to assess a function Y^* and a set of functions X_i^* with the maximum compatibility between Y and Y^*. Introducing a double error function σ^+ and σ^- in equation (1) we have:

$$\tilde{Y}^* = \sum_{i=1}^{n} b_i X_i^* - \sigma^+ + \sigma^- \tag{5}$$

This double error function consists of an overestimation error σ^+ and an underestimation error σ^- for each client, as shown in Figure 4.

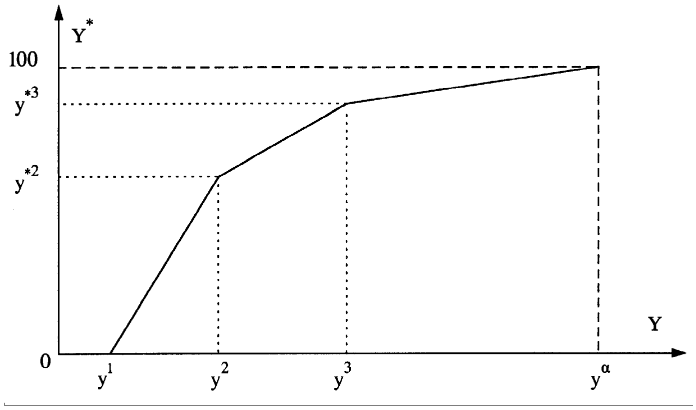

Fig. 3. Form of a satisfaction function.

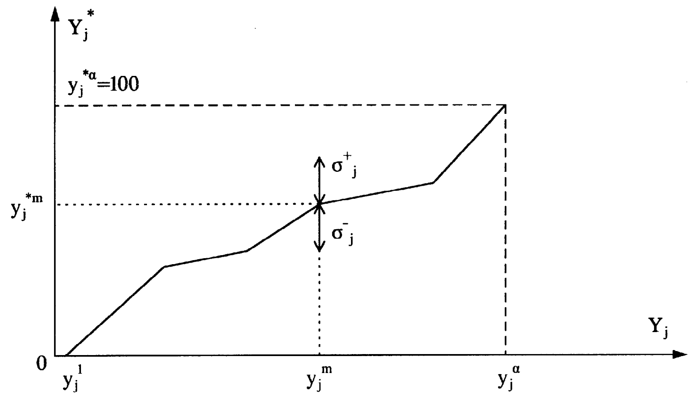

Fig. 4. Error functions for the j-th customer.

According to the aforementioned definitions and assumptions, the problem can be formulated as a linear program in which the goal is the minimization of the sum of errors under the constraints:

i. Equation (5) for each client,
ii. normalization constraints of Y^* and X_i^* in the interval [0, 100],
iii. monotonicity constraints for Y^* and X_i^*.

It should also be noted that it is better to use the differences in the functions Y^* and X_i^* in order to reduce the size of the linear program, avoiding the monotonicity constraints. Thus, each one of these functions has the following form (see also Figure 5):

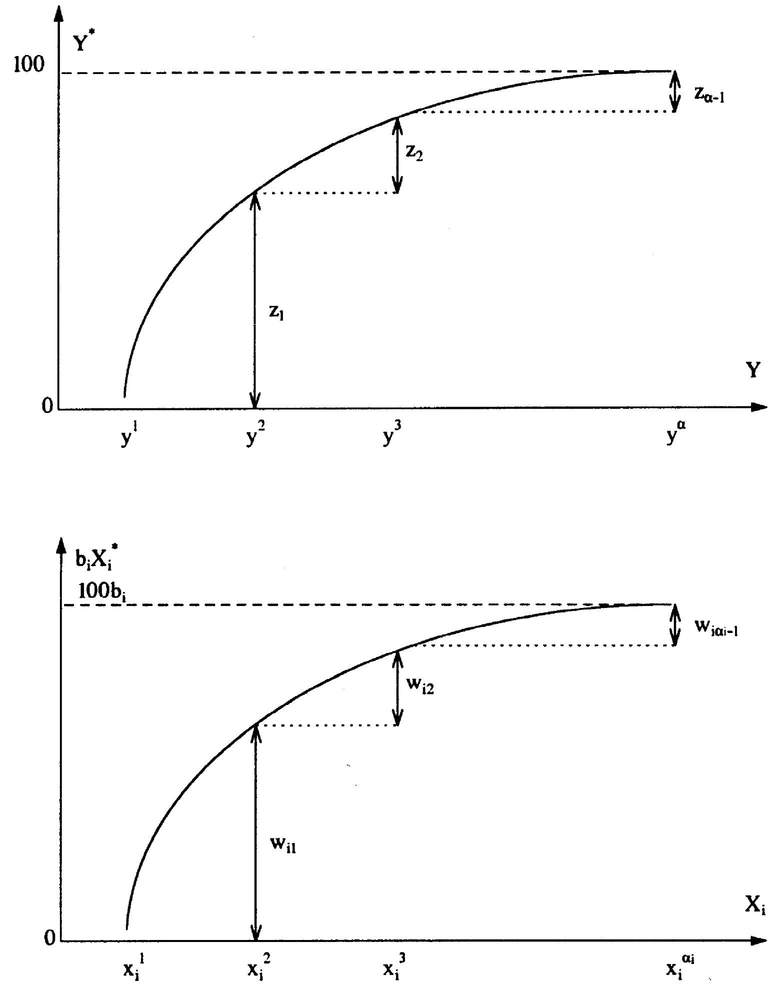

Fig. 5. z_m and w_{ik} variables.

$$\begin{cases} y^{*m} = \sum_{t=1}^{m-1} z_t & \text{for } m = 2, 3, \ldots, \alpha \\ b_i x_i^{*k} = \sum_{t=1}^{k-1} w_{it} & \text{for } k = 2, 3, \ldots, \alpha_i \text{ and } i = 1, 2, \ldots, n \end{cases} \tag{6}$$

According to Equations (2), (3) and (6), the variables z_m and w_{ik} can be written as follows:

$$\begin{cases} z_m = y^{*m+1} - y^{*m} & \text{for } m = 1, 2, \ldots, \alpha - 1 \\ w_{ik} = b_i x_i^{*k+1} - b_i x_i^{*k} & \text{for } k = 1, 2, \ldots, \alpha_i - 1 \text{ and } i = 1, 2, \ldots, n \end{cases} \tag{7}$$

Considering Equations (6) and (7), Equation (5) can be written

$$\sum_{m} z_m = \sum_{i} \sum_{k} w_{ik} - \sigma^{+} + \sigma^{-} \tag{8}$$

Moreover, in order to estimate x_i^{*k} and b_i using the variables of the linear program the following equations are used:

$$\begin{aligned} b_i &= \frac{\sum_{t=1}^{\alpha_i-1} w_{it}}{100} \\ x_i^{*k} &= 100 \frac{\sum_{t=1}^{k-1} w_{it}}{\sum_{t=1}^{\alpha_i-1} w_{it}} \end{aligned} \quad \text{for } i = 1, 2, \ldots, n \text{ and } k = 2, 3, \ldots, \alpha_i \tag{9}$$

Suppose now that the j-th customer has expressed his/her preferences using the predefined ordinal scales y^m and x_i^k. Let also y^j be the customer's global satisfaction and x_i^j be the customer's partial satisfaction according to the i-th criterion (for $i = 1, 2, \ldots, n$). Thus the following conditions can be written:

$$\begin{cases} y^j \in \{y^1, y^2, \ldots, y^{\alpha}\} \\ x_i^j \in \{x_j^1, x_j^2, \ldots, x_i^{\alpha_i}\} \quad \text{for } i = 1, 2, \ldots, n \end{cases} \tag{10}$$

Then, the model can be described by the following linear program:

$$\begin{cases} [\min] F = \sum_{j=1}^{M} \sigma_j^{+} + \sigma_j^{-} \\ \text{under the constraints :} \\ \sum_{i=1}^{n} \sum_{k=1}^{x_i^j-1} w_{ik} - \sum_{m=1}^{y^j-1} z_m - \sigma_j^{+} + \sigma_j^{-} = 0 \quad \text{for } j = 1, 2, \ldots, M \\ \sum_{m=1}^{\alpha-1} z_m = 100 \\ \sum_{i=1}^{n} \sum_{k=1}^{\alpha_i-1} w_{ik} = 100 \\ z_m \geq 0, w_{ik} \geq 0 \quad \forall m, i \text{ and } k \\ \sigma_j^{+} \geq 0, \sigma_j^{-} \geq 0 \quad \text{for } j = 1, 2, \ldots, M \end{cases} \tag{11}$$

where M is the number of customers and n is the number of criteria. The optimal value F^* for the objective function of LP (11) can be considered as an index of the

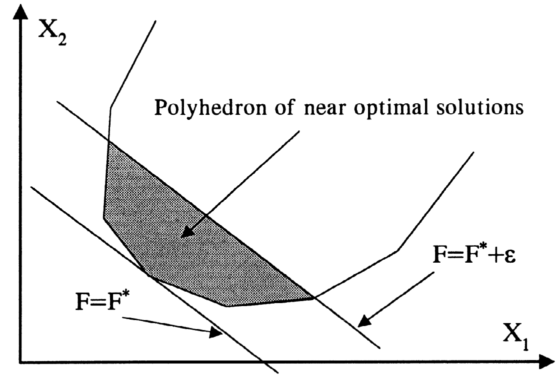

Fig. 6. Post optimality analysis (Jacquet-Lagrèze and Siskos, 1982).

estimation quality but the estimated solution has to be discussed from the point of view of its uniqueness and its stability (see below).

Post optimality analysis

The problem of model stability may be viewed as a post optimality analysis problem in linear programming (Figure 6). Therefore, in order to face the problem of multiple optimal solutions or the existence of near optimal solutions, n linear programs (equal to the number of criteria) are formulated and solved. Each linear program maximizes the weight of a criterion; remember that the weight of the i-th criterion equals $\sum_j w_{ij}$.

These linear programs have the following form:

$$\begin{cases} [\max] F' = \sum_{k=1}^{\alpha_i - 1} w_{ik} \quad \text{for } i = 1, 2, \ldots, n \\ \text{under the constraints} \\ F \leq F^* + \varepsilon \\ \text{all the constraints of LP (11)} \end{cases} \tag{12}$$

where ε is a small percentage of F^*.

The solutions obtained by the LPs (12) show how much stable the satisfaction model to be constructed is. However, as final solution the average of the solutions given by the n LPs (12) may be taken. In case of non stability this average solution is less representative.

Average satisfaction indices

The results of the model are sufficient enough to describe in detail the behavior of a group of customers, as they include not only the weights of the criteria but also the global and partial satisfaction functions. Nevertheless, in some cases the assessment of an average satisfaction index could be very useful in the strategic planning of an organization. The average global satisfaction index can be assessed according to the following equation:

$$S = \sum_{m=1}^{\alpha} p^m y^{*m} \tag{13}$$

where

S :average global satisfaction index,
p^m :frequency of customers belonging to the y^m satisfaction level,
α :number of global satisfaction levels,
y^{*m} :value of y^m level.

The average partial satisfaction indices can be assessed similarly for each one of the criteria, according to Equation (14)

$$s_i = \sum_{k=1}^{\alpha_i} p_i^k x_i^* \tag{14}$$

where

s_i :average partial satisfaction index according to the i-th criterion,
p_i^k :frequency of customers belonging to the x_i^k satisfaction level,
α_i :number of satisfaction levels for the i-th criterion,
x_i^{*k} :value of x_i^k level.

These average satisfaction indices are somehow the mean value of the functions Y^* and X_i^*. This information can indicate the criteria that are “responsible” for the high or low value of the global satisfaction index. In this way, a decision maker can concentrate his interest in the improvement of specific product’s characteristics.

3. Real World Applications

In this section three different real world applications are presented. These applications concern different types of firms (commercial, industrial, service) and for this reason it is very interesting to compare results concerning clients satisfaction. By this way it is shown that the proposed model can be applied in a large variety of real world problems dealing with customer satisfaction analysis. In all three studies the same evaluation scale was used to measure customer’s judgments:

– Completely unsatisfied
– Unsatisfied
– Satisfied
– Very satisfied
– Completely satisfied

Table 1. Weights of the criteria.

Criteria	**Weight**
Image of the store	0.133
Service facilities	0.255
Personnel	0.160
Products	0.452
Total	**1.000**

Application in a commercial firm

This study concerns a group of commercial firms selling shoes and similar products. Almost 850 customers participated in the survey conducted for the collection of input data. It is important to mention that sales volume is very satisfying and the possible expansion of the variety of products for sale is considered favorably.

Preliminary analysis has indicated the set of criteria concerning customers of this firm. These criteria are:

1. Image of the store: This criterion refers mainly to the appearance of the stores (decoration etc.).

2. Service facilities: This criterion includes the location of the store, the parking facilities, the working hours and the store's comforts.

3. Personnel: Personnel's friendliness and service is very important for the customers of any commercial firm. This criterion includes all the characteristics concerning personnel (availability, behavior, information offered etc.).

4. Products: Product's quality and variety as well as support services are included in this last criterion.

Applying the developed model, the weights of each criterion can easily be calculated using Equation (9), as shown in Table 1. The most important criteria seem to be the quality and variety of the products (45.2%) and the service facilities (25.5%). The other criteria seem to play a less important role to customers' preferences.

Post optimality analysis showed a low relative stability because the weights of the criteria presented an average variation of 46%. This instability was mainly due to the criteria of service facilities and products.

Similarly, the global and partial satisfaction functions can be calculated; the graphs of these functions have been normalized in the interval [0, 100], and they are presented in Figure 7. In particular, the graph for the global satisfaction presents the theoretical as well as the effective curve. The effective satisfaction curve is more representative according to customer's preferences because it takes into account the values of the double error variable.

The set of customers looks quite satisfied, as shows Figure 8 from where it can be observed that the average global satisfaction index has a very high value (93.2%). This can be explained by the fact that customers are very satisfied according to

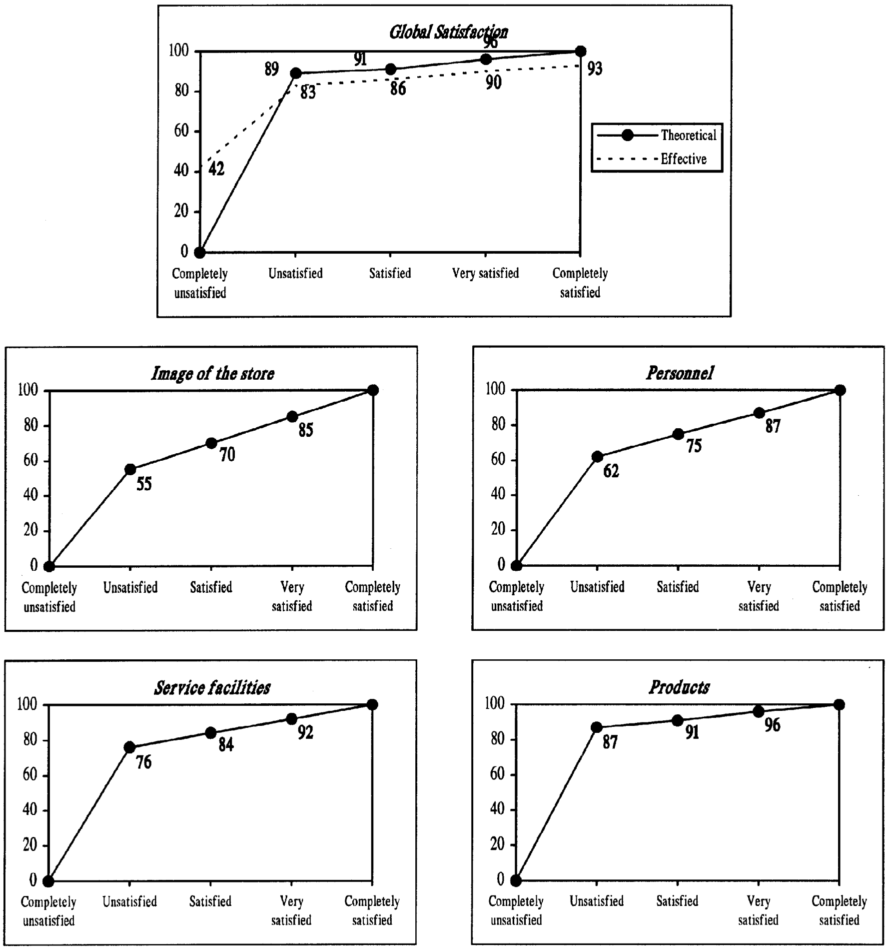

Fig. 7. Global and partial satisfaction functions.

all of the criteria (all of the average partial satisfaction indices have values greater than 75%). For this reason, the expansion of the variety of products for sale is considered necessary, in order to take advantage of the results maintained before.

Application in an industrial firm

This application concerns an industrial firm producing palettes and containers. Almost 150 industries/customers participated in the survey conducted for the collection of input data. Exploring customers' satisfaction is considered to be necessary before the expansion of the firm to the European market. The set of criteria describing customers' behavior being indicated by preliminary analysis, is:

1. Punctuality: The first criterion concerns the way that orders are carried out.

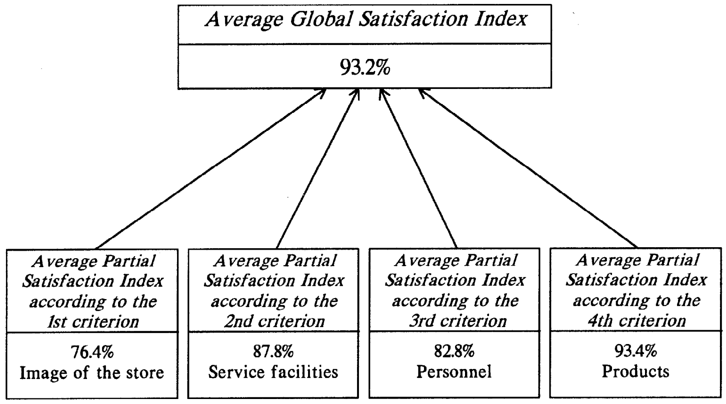

Fig. 8. Global and partial satisfaction indices.

Table 2. Weights of the criteria.

Criteria	**Weight**
Punctuality	0.134
Product's quality	0.174
Service	0.391
Administrative services	0.127
Added value	0.174
Total	**1.000**

2. Product's quality: The quality of the products produced by the company, palettes and containers is included in this criterion.
3. Service: This criterion concerns generally the way customer is treated by the company and the collaboration between themselves.
4. Administrative services: The criterion concerns the whole administrative services of the firm, including the pricing system.
5. Added value: The last criterion is referring to the added value given to the customers' product by the firm.

Similarly to the previous section, applying the model, the estimated weights are shown in Table 2. The most important criterion is the service offered to the customers (39.1%), while all the other criteria have almost an equal relevant importance according to client's judgments. The weights of the criteria numbered 2, 3 and 5 presented an average variation of 38% during the phase of post optimality analysis, while the other are more stable.

The graphs of satisfaction functions are presented in Figure 9, from where it can be observed that global satisfaction function is an S-type curve. Moreover, the theoretical and the effective satisfaction curve are almost identical especially

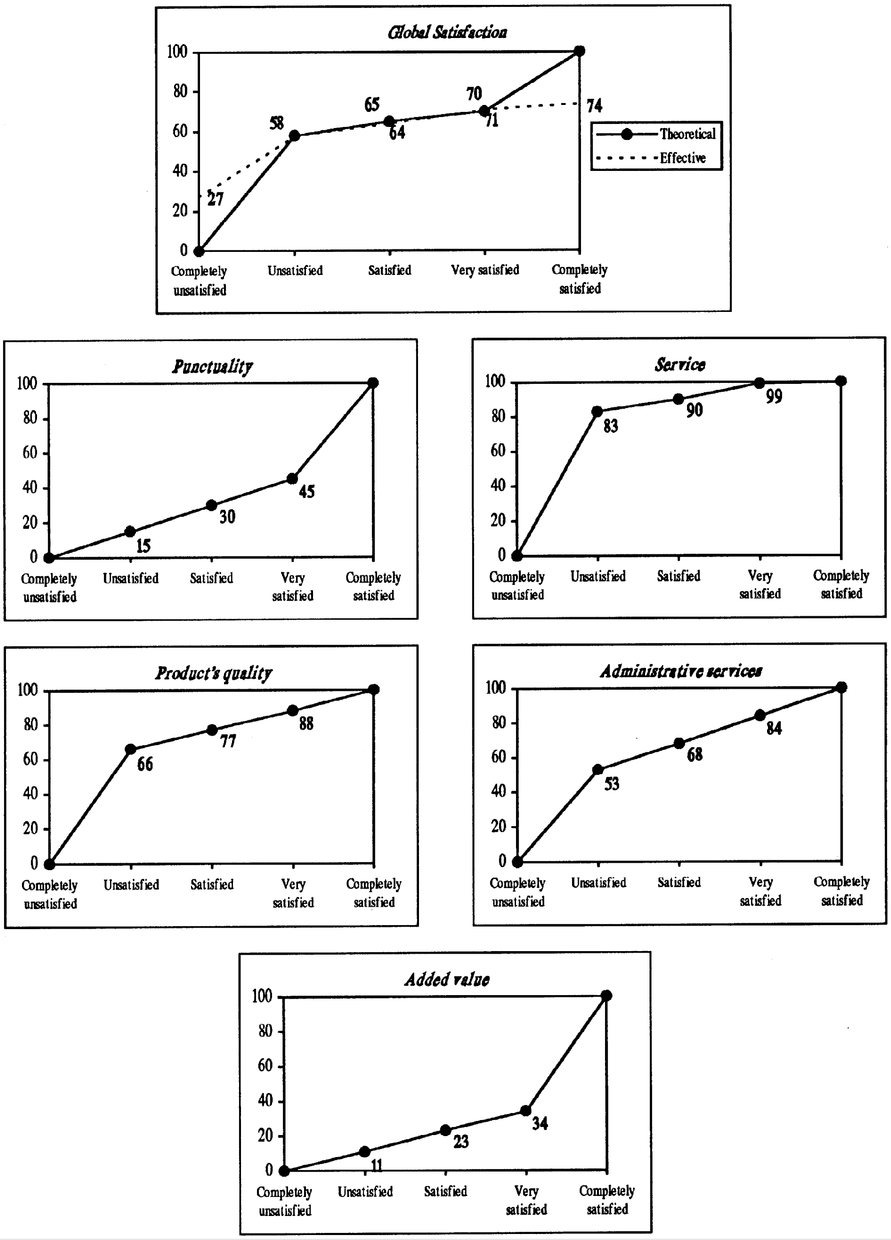

Fig. 9. Global and partial satisfaction functions.

for the middle levels of the satisfaction scale. Firm's customers do not seem to be satisfied enough, as Figure 10 shows. From the same figure it can be observed that the average global satisfaction index has a value of almost 65%. This is because customers are not satisfied according to the criteria of added value (19.8%) and

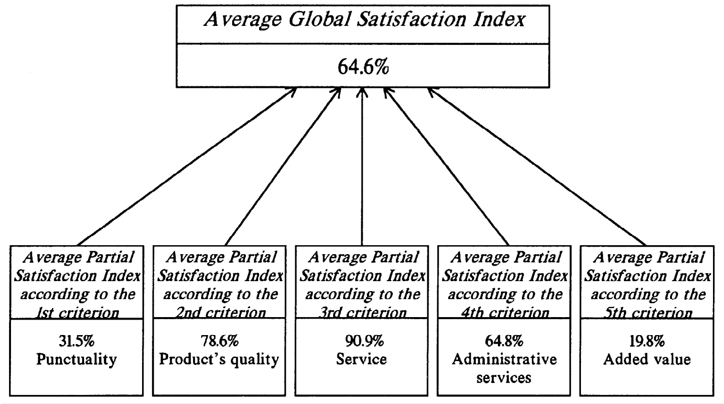

Fig. 10. Global and partial satisfaction indices.

punctuality of the company (31.5%). For this reason managers of the firm must pay more attention to the improvement of these characteristics, prior to the development of a European network and the expansion of company's services.

Application in an office

The last study concerns an office specialized to renting apartment for business or leisure. The customers have differentiated preferences and the office tries to find the most convenient apartment in order to satisfy their needs. During the survey conducted for the collection of input data, only 50 customers have answered the questionnaire. It is very important to note that managers of the firm were interested in analyzing their customers' satisfaction in order to explore ways of obtaining a more loyal clientele. The set of criteria used in the implementation of the proposed method is:

1. Seeking an apartment: This criterion concerns the phase of seeking an apartment which is as close as possible to customer's needs.

2. Service: It concerns generally the way customer is treated by the company and the collaboration between themselves.

3. Condition of the apartment: It refers to the condition of the apartment as well as to the facilities offered (washing machine etc.).

4. Caretaker service: Caretaker services are very important when choosing an apartment and they are usually offered in almost all of the apartments.

5. Maintenance: The maintenance of the apartment is in the responsibility of the office.

Table 3 presents the weights of the criteria. From this table it can be observed that the first criterion concerning the phase of seeking an apartment is much more important than the other ones (almost 65%). The remaining criteria do not seem to play an important role to customers' preferences. Post optimality analysis showed

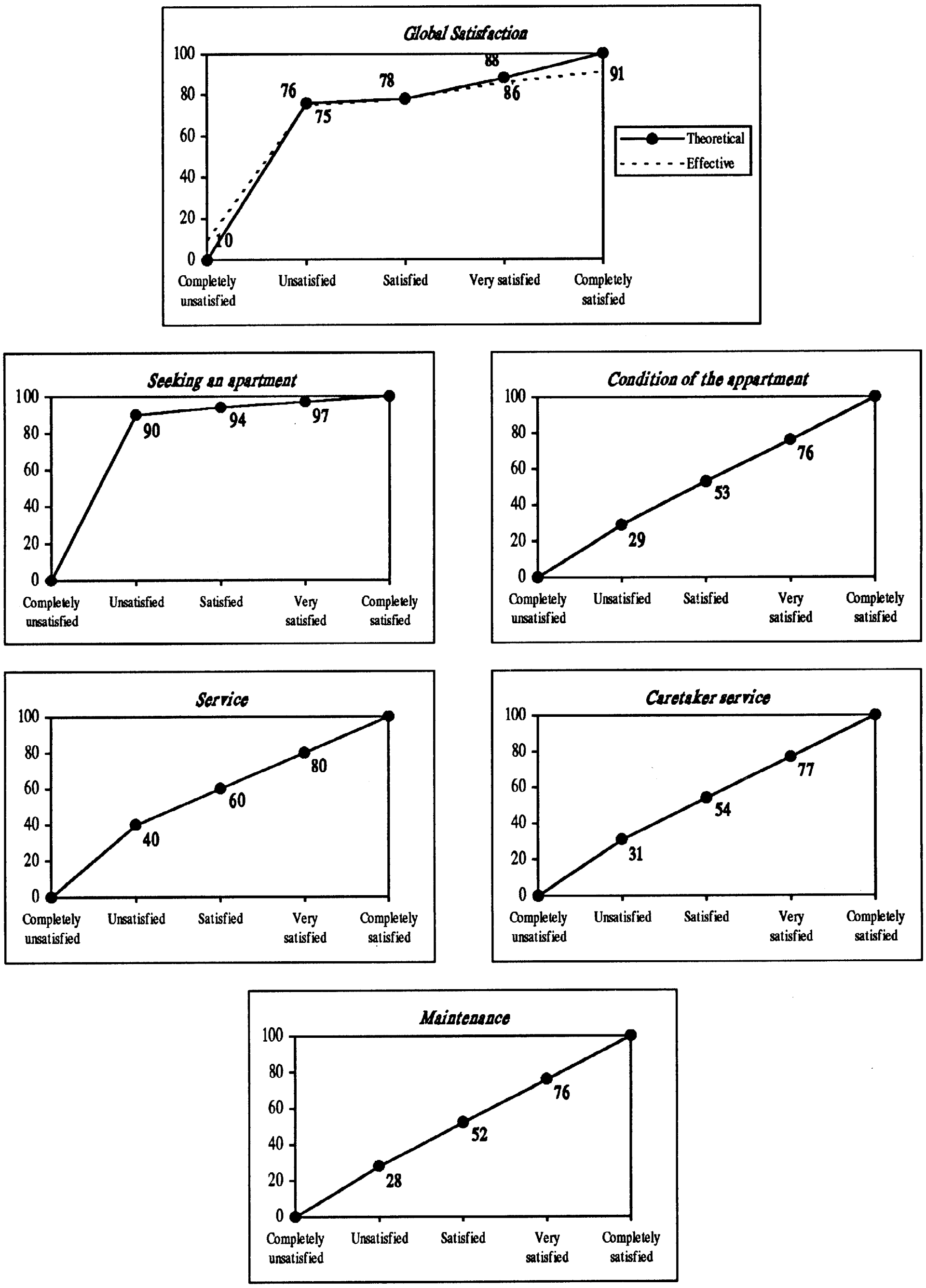

Fig. 11. Global and partial satisfaction functions.

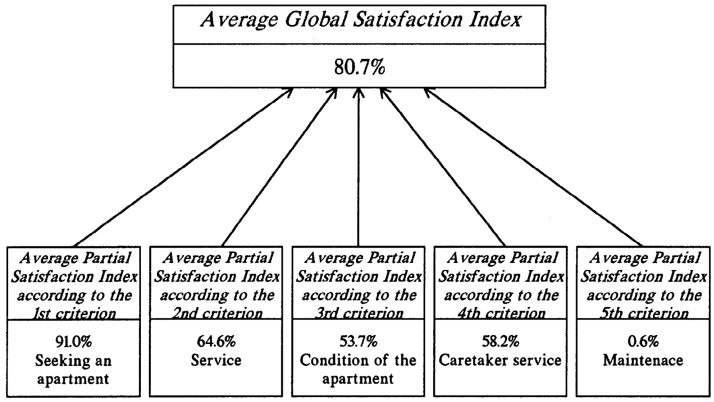

Fig. 12. Global and partial satisfaction indices.

Table 3. Weights of the criteria.

Criteria	**Weight**
Seeking an apartment	0.645
Service	0.100
Condition of the apartment	0.085
Caretaker service	0.087
Maintenance	0.083
Total	**1.000**

a significant high relative stability because the weights of the criteria presented an average variation of only 5.5%. Similarly, Figure 11 presents the global and partial satisfaction functions, where it can be observed that there is no difference between the theoretical and the effective satisfaction curve indicating that the total estimation error is small in this particular application.

Customers seem to be quite satisfied because the average global satisfaction index has a very high value (over 80%), as shown in Figure 12. This can be explained only by the company's performance according to the criterion of seeking an apartment. Customers do not seem to be satisfied in regard with the other criteria. Simultaneously, the weights of all the other criteria are extremely low (less than 10%), so they do not seem to be very important. Company seems to pay much attention to new customers, trying to satisfy their needs at the stage of searching for the most convenient apartment. That is the reason why it does not have a loyal clientele. If managers pay more attention to the other criteria as well, company will achieve an improvement of its customers satisfaction.

4. An Extension of the Model

In some cases it is useful to assume that Y^* and X_i^* are monotone and strictly increasing functions in order to respect the strict preferential order of the scales of some or all the criteria in the questionnaire. Taking into account the hypothesis of strict preferences, the conditions of Equation (4) become as follows:

$$\begin{cases} y^{*m} < y^{*m+1} \Leftrightarrow Y^m \prec Y^{m+1} & \text{for } m = 1, 2, \ldots, \alpha - 1 \\ x_i^{*k} < x_i^{*k+1} \Leftrightarrow X_i^k \prec X_i^{k+1} & \text{for } k = 1, 2, \ldots, \alpha_i - 1 \end{cases} \quad (15)$$

where $\prec$ means "strictly less preferred".

According to Equation (15), the following inequalities must be satisfied

$$\begin{cases} y^{*m+1} - y^{*m} \geq \beta \\ x_i^{*k+1} - x_i^{*k} \geq \delta_i \quad \text{for } i = 1, 2, \ldots, n \end{cases} \quad (16)$$

where β and δ_i are preference thresholds and $\beta, \delta_i > 0$. In the model presented in Section 2, these thresholds have been chosen as $\beta = \delta_i = 0$. In this section, the extension of the model is presented with the aforementioned thresholds chosen due only to simplicity as

$$\beta = \delta_i = \gamma \quad \text{for } i = 1, 2, \ldots, n \quad (17)$$

Introducing threshold γ and using Equations (6), (13) and (14) the following relations are obtained:

$$\begin{cases} z_m \geq \gamma \\ w_{ik} \geq \gamma \end{cases} \Rightarrow \begin{cases} z_m - \gamma \geq 0 \\ w_{ik} - \gamma \geq 0 \end{cases}$$
$$\Rightarrow \begin{cases} z'_m \geq 0 & \text{for } m = 1, 2, \ldots, \alpha - 1 \\ w'_{ik} \geq 0 & \text{for } i = 1, 2, \ldots, n \text{ and } k = 1, 2, \ldots, \alpha_i - 1 \end{cases} \quad (18)$$

where it is set $z_m = z'_m + \gamma$ and $w_{ik} = w'_{ik} + \gamma$.

Using the previous equations in the LP (11), the following linear program is obtained as an extension of the model presented in Section 2.

$$\begin{cases} [\min] F = \sum_{j=1}^{M} \sigma_j^+ + \sigma_j^- \\ \text{under the constraints :} \\ \sum_{i=1}^{n} \sum_{k=1}^{x_i^j - 1} w'_{ik} - \sum_{m=1}^{y^j - 1} z'_m - \sigma_j^+ + \sigma_j^- = \gamma[(y^j - 1) - n(x_i^j - 1)] \\ \quad \text{for } i = 1, 2, \ldots, M \\ \sum_{m=1}^{\alpha - 1} z'_m = 100 - \gamma(\alpha - 1) \\ \sum_{i=1}^{n} \sum_{k=1}^{\alpha_i - 1} w'_{jk} = 100 - \gamma n(\alpha_i - 1) \\ z'_m \geq 0, w'_{ik} \geq 0 \quad \forall m, i \text{ and } k \\ \sigma_j^+ \geq 0, \sigma_j^- \geq 0 \quad \text{for } j = 1, 2, \ldots, M \end{cases} \tag{19}$$

It should be emphasized that threshold γ should be selected such as to exclude negative values for the variables z'_m and w'_{ik} of LP (19). From normalization constraints of the above linear program, the following inequalities must be satisfied

$$\begin{cases} 100 - \gamma(\alpha - 1) \geq 0 \\ 100 - \gamma n(\alpha_i - 1) \geq 0 \end{cases} \Rightarrow \gamma \leq \min\left\{ \frac{100}{(\alpha - 1)}, \frac{100}{n(\alpha_i - 1)} \quad \text{for } i = 1, 2, \ldots, n \right\} \tag{20}$$

Obviously, one may choose different thresholds β and δ_i for the functions Y^* and X_i^*, although the formulation of LP (19) will become more complex.

5. Concluding Remarks and Future Research

The model presented in this paper belongs to the family of ordinal regression analysis methods. Its development provides the assessment of global and partial satisfaction functions that explain customers' judgments. Furthermore, global and partial satisfaction indices can be used in the strategic planning of an organization. The model can be characterized as a consumer-based method because it requires input data collected by a survey through a questionnaire of a certain type. The main advantages of the proposed methodology are:

1. The model requires a rather simple and short questionnaire in order to collect input data.
2. Customer' judgments are collected using qualitative satisfaction scales.

3. Using linear programming techniques, the model is very flexible and powerful, while its development is quite simple.
4. Stability testing can be easily performed due to the post optimality analysis introduced into the model.
5. Results of the model are sufficient to describe in detail customer's behavior because they consist of:
   - global and partial satisfaction functions,
   - weights of the criteria (relative importance of the criteria),
   - average satisfaction indices.

Several extensions of the model are proposed through the paper assuming that satisfaction functions are strictly non-decreasing. Nevertheless, in some cases it is useful to assume that customer preferences are non-monotone according to a specific criterion. The problem of non-monotone preferences is treated by Despotis and Zopounidis [5]. In this case, a more general model could be obtained.

According to the shape of satisfaction functions different customers' profiles can be determined. In this way customers can be classified in these typical behavioral groups. Exploring the existence of a "critical" satisfaction level might give important information about customer reaction. A "critical" satisfaction level could be assessed as the value of Y^* indicating a rather small probability of re-buying a specific product. This way, the loss of customers may be predicted and explained by the proposed model. Furthermore, the application of simulation techniques to the set of customers seems to be useful in order to predict customers reactions if a specific characteristic of a product is changed.

Another extension of the model may be achieved assuming that customer's preferences follow a known probability distribution function. In this case, it seems useful to compare the results with the ones given by the proposed model. Also, comparative analysis may be conducted in combination with other mathematical methods (as those mentioned in section 1), using mainly simulation techniques. Furthermore, future research may be directed to the examination of the links between accounting measures of business performance and results of the model concerning satisfaction for the firm's customers.

Finally, the development of a Decision Support System could be based not only on the presented model but also on other methodologies.

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