MEASURING CUSTOMER SATISFACTION USING ORDINAL VARIABLES: AN APPLICATION IN A SURVEY ON A CONTACT CENTER

Sergio Zani[*], Lara Berzieri[**]

[*] *Dipartimento di Economia, Università degli Studi di Parma, sergio.zani@unipr.it*
[**] *Ufficio di Statistica, Comune di Parma, l.berzieri@comune.parma.it*

Abstract

This paper deals with the problem of measuring Customer Satisfaction using several ordinal variables with different number of categories. Some multivariate methods are applied to the results of a survey on the users of the Contact Center of the Municipality of Parma, in order to measure the quality of the service and the citizen satisfaction. Different approaches for the quantification of ordinal responses are considered and compared. The results show that the multidimensional approach yields a more appropriate estimate for classes of unsatisfied, fairly satisfied and very satisfied respondents.

Keywords: *Quantification of ordinal variables, Nonlinear Principal Component Analysis, k-means clustering, overall satisfaction.*

1. INTRODUCTION

Customer Satisfaction (CS) is a key performance indicator of the activity of a firm or a corporation (for a recent review see e.g. Fornel, 2008). CS is an abstract term and can be considered as a latent variable. The usual measures of CS involve a survey with a set of questions. The overall satisfaction may be measured by a single direct question or by several manifest variables relating to the different domains of satisfaction (Montinaro and Chirico, 2006). These variables are often on ordinal scale with different numbers of categories (binary, Likert scale with 5 or 7 modalities, scores from 1 to 10, and so on) (De Luca, 2007).

Generally, the responses to the items are scored 0, 1 (for two ordered categories); or 1, 2, 3 (for three ordered categories); or 1, 2, 3, 4, 5 (for Likert scales) and so on, to indicate increasing levels of CS.

In the literature different approaches have been suggested to analyze this kind of data:

- a priori quantification of each ordinal variable before applying multivariate methods (see e.g. Rizzi, 2008, for the Italian contributions to this topic, and for recent works: Gallo, 2007; Manisera, 2007);
- the estimation of scores of qualitative variables within iterative algorithms of statistical modelling (Tenenhaus and Young, 1985; Lauro and Esposito Vinzi, 2002; Tenenhaus *et al.*, 2005; Lauro *et al*., 2008);
- latent variables models with ordinal variables (Gifi, 1990; Joreskog and Moustaki, 2001; Cagnone and Mignani, 2009; Ferrari and Manzi, 2010);
- Rasch Analysis (Rasch, 1980; Andrich, 1988; Brentari *et al*., 2007; De Battisti *et al*., 2010);
- a class of stochastic models for ordinal variables (Piccolo and D'Elia, 2008; Piccolo, 2009; Iannario and Piccolo, 2010);

This paper deals with the problem of measuring the perception of public service quality (Lauro *et al*., 1997; Gori and Vittadini, 1999; Istat, 2001; Office of Public Service Reform, 2002; Carpita *et al*., 2006). We analyze the results of a survey on a sample of 1,200 users of the Contact Center of Parma Municipality. The purpose is to answer to the following questions:

1) What is the association between the different "dimensions" (items, attributes) of the citizen satisfaction?
2) Which are the most important manifest variables to set the perceived quality of the services of the Contact Center?
3) How the manifest variables can be weighted in order to obtain a synthetic indicator of customer satisfaction?
4) What are the features of the clusters of the very satisfied, satisfied and unsatisfied citizens?

Therefore, this research may be considered in the context of VIR (Verification of Impact of Regulation), because it deals with the ex post evaluation of the effectiveness and efficiency of the choices of the Public Administrations.

The paper is organized as follows. Section 2 briefly presents the IQUEL national research project and the features of the survey on citizen satisfaction. Section 3 shows the main results of the survey using a new simple graphical method: the pyramid of customer satisfaction. The level of association between pairs of variables is also presented. In section 4 overall indicators of customer satisfaction are obtained, applying linear and nonlinear principal component analysis to the manifest variables; the scores of these techniques are compared with the scores of the direct question on total quality. In Section 5 a new criterion of quantification of the ordinal variables is suggested. Section 6 proposes a classification of the users into homogeneous clusters using *k*-means algorithm. Section 7 concludes.

2. THE IQUEL NATIONAL PROGRAM AND THE CUSTOMER SATISFACTION SURVEY

The acronym IQUEL means "Innovazione e Qualità per gli Enti Locali" (Innovation and quality for local government agencies) and it is a national program, financed by the Italian Council of Ministers in 2008. The work group leader is Parma Municipality. The group is formed by several local governments: the Region Emilia-Romagna, the Municipalities of Bologna, Firenze, Modena, Piacenza, Reggio-Emilia; the Provinces of Padova, Brescia, Chieti, Parma, Pesaro-Urbino, Rimini, Vicenza and also the Department of Economics of the University of Parma and the Departments of Statistics of the University of Firenze and Padova).

The principal aim of the project is to define a monitoring system to evaluate the public service quality, by using a peculiar software and other information and communication technologies.

The tools created will be used to control the performance achieved, in terms of efficacy, efficiency and customer satisfaction and also to promote a benchmarking process among local governments, to identify and share the results with the best practices. Thanks to standardized methodologies, IQUEL will help local government agencies to learn from first-class experiences.

One step of the project is to create a system of Customer Relationship Management (CRM) suitable for Public Administration, in order to collect all the data, coming from different sources (telephone, e-mail, sms), related to citizens and companies, using all the information to satisfy the needs of the citizens. That's why Parma Municipality opened in 2008 a Contact Center, that is more than a call center: it is a real CRM instrument.

In this context, a sample survey was planned in order to measure the satisfaction of the users of the Contact Center. The questionnaire was prepared and initially tested on about 100 users. It is divided into 3 sections: the first contains general questions on the service used; the second is based on the reason for calling, which can be a request of information, a request of a specific person or office, a communication of a problem; the third one refers to a summary judgment (opinion) on the Contact Center service and also contains a few data of the respondent.

Stratification is the sampling method used, so that the sample composition reflects the whole structure of the population of the study. The subpopulations (strata) are defined on the basis of 2 variables: type of user (citizen or organisation) and reason for calling.

The random sample was extracted from the list of the users calling the Contact Center, in February and March 2009 .

The survey was conducted by Delos, a company operating in Bologna, using the method CATI (Computer Assisted Telephone Interview).

The total amount of interviews was fixed at 1,200; this wide sample size permits to obtain reliable information for each municipality department, such as demographic and social services, building, trade, and so on. The respondent rate was 58% of the contact attempts. The remaining 42% was separated into 2 groups: people who refused the interview (19%) and persons not found, even after a few telephone calls. Non respondents were replaced by other names belonging to the same stratum.

Examining the main features of the respondents, we can notice that citizens are about 85% and companies about 15%; females 64% and males 36%. About 48% of the respondents are in the age class 40-64. These features are very similar to the ones of the whole population of the Contact Center users.

3. VISUALIZATION OF THE MAIN RESULTS AND RELATIONS BETWEEN THE "DIMENSIONS" OF CS

The data set of 1,200 respondents is partitioned into three groups with reference to the reason for the telephone call: request of information, search of a specific office or person, communication of a problem (in public services). The analysis is carried out for the whole sample and for each group of respondents.

For lack of space, in this paper we examine only the first subset, formed by 704 units calling for information. See Zani, Riani and Berzieri (2009) for a complete analysis.

The general questions on the quality of the service are:

- Contact at the first call (no, yes) (CONTACT)
- Waiting time (too long, normal, fairly short) (WAITING)
- Courtesy of the operator (COURTESY)
- Skill of the operator (SKILL)
- The specific questions for this subset of respondents are:
- Quality of the information provided by the operator (QUALITY)
- Speed of the information (SPEED)
- Complete answer (no, partly, yes) (COMPLETE)

All the variables whose modalities are not specified are measured on a Likert scale (very dissatisfied, dissatisfied, neither satisfied nor dissatisfied, satisfied, very satisfied).

In addition, the overall satisfaction for the service of the Contact Center is measured by a direct question with scores from 1 to 10 (OVERALL).

A simple figure can show the main results of the survey for the subset of citizens asking for information. We order the variables with reference to their number of modalities (from 2 to 10) and represent each variable by a proportional

bar. At the top there is the variable CONTACT with two categories, at the bottom the variable OVERALL with ten scores, whose bar is about five time longer than the first. We call this plot "the pyramid of the customer satisfaction" (Fig. 1) because it shows the different aspects of the quality, highlighting the number of categories of each item. The very dissatisfied and the dissatisfied respondents are on the left side, the satisfied and very satisfied users are on the right. Using different colours instead of grids (e.g. green for very satisfied, red for very dissatisfied, and other suitable colours for intermediate categories) the figure is much more expressive: the area of satisfaction with reference to the different dimensions is immediately visualized.

Tab. 1 presents the values of the Kendall's τ association index between pairs of variables representing the different aspects of the satisfaction and Tab. 2 shows the correlation ratios between such variables and the scores of the overall satisfaction (e.g. Zani and Cerioli, 2007, chapter IV).

Tab. 1: Kendall's τ association indexes.

	CONTACT	WAITING	COURTESY	SKILL	QUALITY	SPEED	COMPLETE
CONTACT	1	0.234	0.134	0.186	0.158	0.246	0.213
WAITING		1	0.238	0.254	0.266	0.284	0.217
COURTESY			1	0.639	0.482	0.523	0.198
SKILL				1	0.641	0.607	0.312
QUALITY					1	0.714	0.448
SPEED						1	0.417
COMPLETE							1

Tab. 2: Pearson's correlation ratios of the aspects of CS with OVERALL

CONTACT	0.240
WAITING	0.351
COURTESY	0.426
SKILL	0.544
QUALITY	0.552
SPEED	0.555
COMPLETE	0.428

The higher values of association are between QUALH*f*Y and SPEED, SKILL and QUALITY, COURTESY and SKILL. The variables CONTACT and WAITING are poorly associated with the other dimensions of CS because 91% of the users get the link at the first call and only 3.5% consider "too long" the waiting time.

The variables SPEED, QUALITY and SKILL have the larger influence on the overall CS. We point out that the variables with the smaller number of categories are those which show the weakest association.

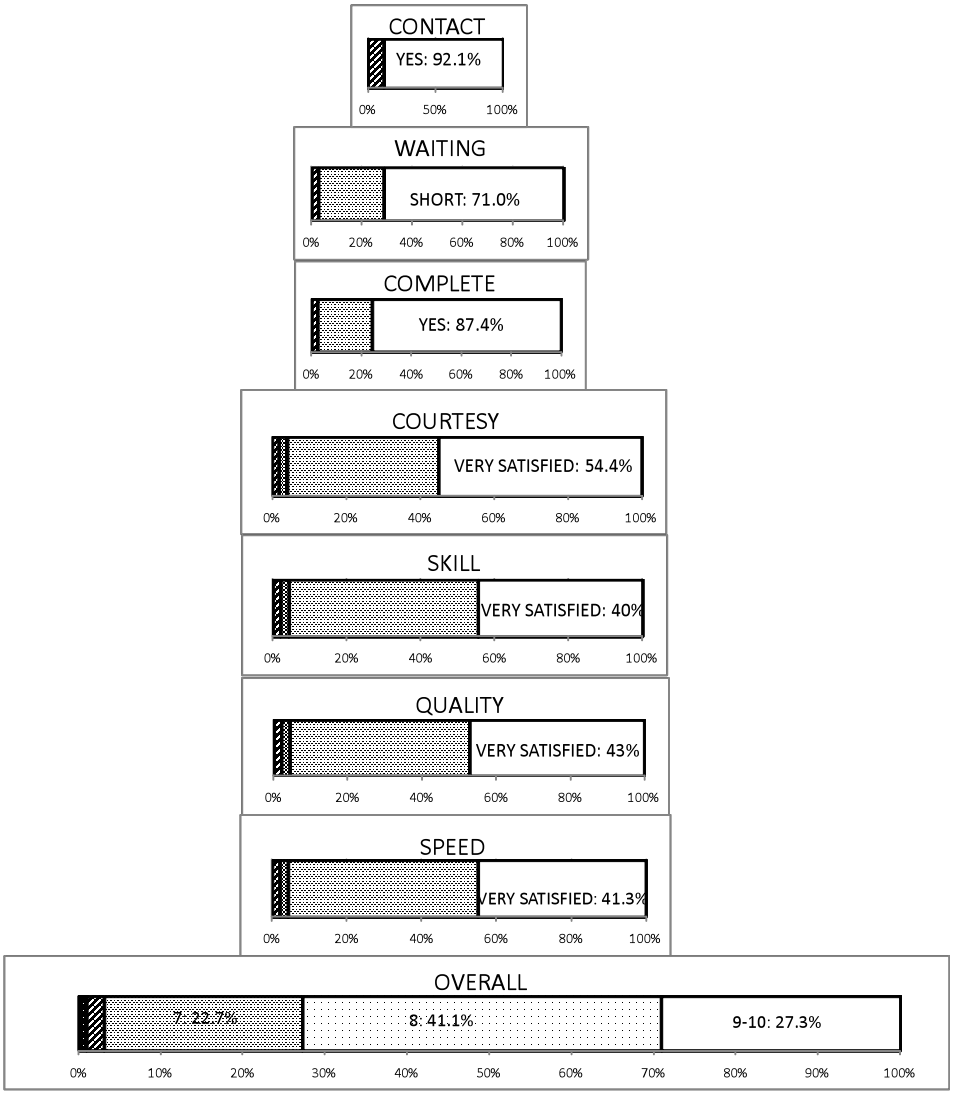

Fig. 1. The pyramid of the satisfaction for the users of the Contact Center

4. METHODS FOR SUMMARIZING THE DIMENSIONS OF SATISFACTION

In order to obtain a synthesis of the different dimensions of customer satisfaction several methods can be applied. A popular method for the reduction of the dimensions is principal component analysis (PCA) (Jolliffe, 2002). With respect to ordinal variables, the simpler choice is using the numbers 1, 2, 3, … for representing the ordered categories of the variables. Though this approach does not take proper account of the ordinal nature of the variables (Joreskog and Moustaki, 2001), it may be introduced as first step of the analysis.

The variable CONTACT is deleted becouse of the very poor relation with the other variables and with OVERALL, as shown in n. 3. So PCA is carried out on 6 standardized variables. Using the listwise deletion for missing values, the numbers of units is 682. The first PC account for the 57.48% of the total variance, the second PC is not considered because its eigenvalue is equal to 0.841. Tab. 3 presents the correlation coefficients between each variables and the first PC.

Tab. 3: Correlation coefficients of the dimensions of satisfaction with the first PC

WAITING	0.493
COURTESY	0.692
SKILL	0.835
QUALITY	0.879
SPEED	0.877
COMPLETE	0.699

The variables QUALITY, SPEED and SKILL are the most important for the first PC, on the contrary the variable WAITING has a poor influence on it. The scores of the first PC may be considered as an evaluation of the global satisfaction of respondents, based on a linear combination of the 6 items with different weights.

The second approach is based on Nonlinear PCA (Gifi, 1990), i.e. a method of dimension reduction applied to categorical (ordinal) variables. This approach seems particularly suitable because it preserves the ordinal nature of variables, without assuming equal difference between subsequent categories. Each of the p ordinal variables is monotonically transformed in order to obtain the best fit of the first k components to the p items ($k<<p$). Further information on this method can be found in Michailidis and De Leeuw (1998); Vermunt and Magidson (2005), Ferrari and Manzi (2010).

In this application we use the CATPCA procedure of SPSS. We select the ordinal scaling level and we obtain the one dimensional and two dimensional

solution. In the first procedure the percentage of the total variance explained by the first dimension is 59.49% and in the second procedure is 58.92% (and 15.59% for the second dimension). Both are slightly higher than the one of PCA.

We have also determined Cronbach's α. This index measures how much a set of items corresponds to a single latent phenomenon. We give below the formula for the standardized Cronbach's alpha:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

where N is equal to the number of items, c-bar is the average of all covariances between the items and v-bar equals the average variance. Cronbach's alpha increases with the average correlation between items and its maximum value is 1.

In our application, Cronbach's alpha is 0.864 in one dimensional solution of CATPCA and in two dimensional solution is equal to 0.861 (for the first dimension). The hypothesis that the observed variables are related to a single latent phenomenon can be accepted. Furthermore, the loadings of the first dimension of the variables in the two procedures presented in Tab. 4 are very similar: the correlation between the scores of the procedures is 0.99. So we retain only the one dimensional solution. The scores of the first component may be used as measures of customer satisfaction, because they fulfil the following requirements (Ferrari and Manzi, 2010):

1) the first eigenvalue is much large than the others;

2) all the weights are positive;

3) the solution is stable.

Tab. 4: Loadings of the variables in the first dimension of CATPCA in one dimensional and two dimensional solution.

	One dimensional solution	Two dimensional solution
WAITING	0.551	0.548
COURTESY	0.629	0.591
SKILL	0.822	0.815
QUALITY	0.887	0.881
SPEED	0.883	0.880
COMPLETE	0.793	0.820

These results confirm the previous ones of PCA: the correlation between the two set coefficients is 0.930 and the Spearman rank correlation is 1. Fig. 2 shows

the scatterplot of the scores of the two procedures: a light non-linearity and a larger dispersion for the negative values are pointed out.

Furthermore, it is interesting to calculate the correlation between OVERALL and the scores of the first component of PCA and CATPCA (Tab. 5).

Tab. 5: Correlation matrix for OVERALL and the scores of the first component of PCA and CATPCA.

	OVERALL	First PC	First CATPC
OVERALL	1	0.623	0.612
First PC		1	0.950
First CATPC			1

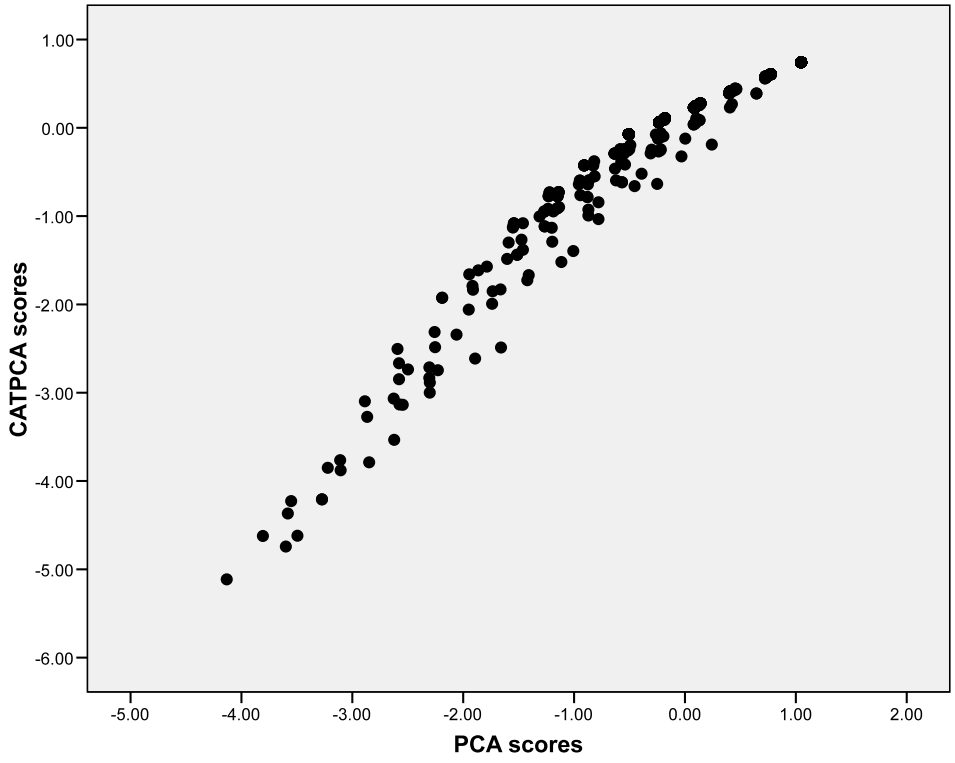

Fig. 2: Scatterplot of the scores of first PC and of the first dimension of CATPCA (solution in one dimension).

The results of the two procedures of PCA are very similar, but the OVERALL scores directly stated by the respondents are fairly different from the synthesis of different items of satisfaction. This means that the directly perceived total quality cannot be expressed as a simple linear combination of the items.

This result may be partially produced by a few non coherent answers to the single items and to the overall satisfaction question. In Fig. 3 the scatterplot of OVERALL and first dimension of CATPCA is presented (scores 1, 2, 3 of OVERALL are all considered as 3).

For the subset of units of each score of OVERALL the outliers are identified using the boxplots (not shown for lack of space). Using this procedure we can identify 22 atypical observations which we delete. In this "clean dataset" of 660 units the correlation between OVERALL and the scores of CATPCA is 0.673 and it is slightly higher than the previous one influenced by the bivariate outliers.

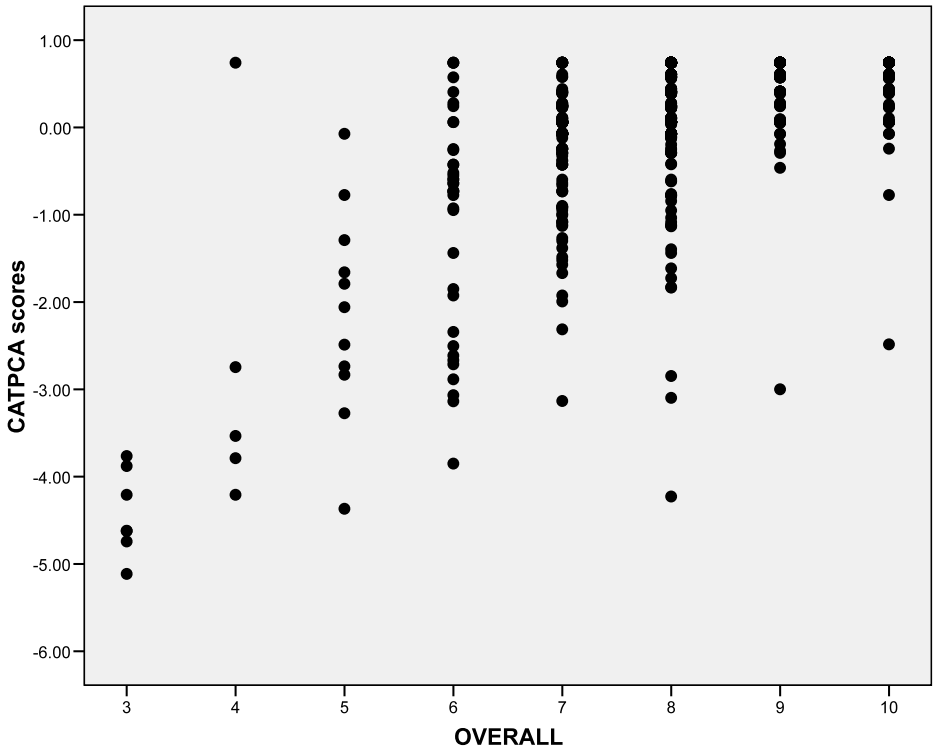

Fig. 3: Scatterplot for the scores of OVERALL and the scores of first dimension of CATPCA (one dimensional solution).

5. A SIMPLE CRITERION OF QUANTIFICATION OF THE ORDINAL VARIABLES

The level of customer satisfaction may be considered as a *continuum*, that cannot be directly observed (see, among others, Manisera, 2007). It can be conventionally rescaled in the range from 0 to 1: zero is the score of the most dissatisfied respondents and one is the score of the most satisfied users.

For each question related to the customer satisfaction, the score of the categories of the corresponding ordinal variables may be fixed taking account of the (relative) frequencies. If the frequency of the first category (very dissatisfied) is small, its score may be stated near to zero; on the contrary, if there are several very dissatisfied customers for this item, the score of this category must be higher, because its relative frequency corresponds to a longer interval in [0, 1]. And so on for the other categories of the variables.

Therefore, a simple criterion of quantification is the mid-point of the cumulative function of the observed ordinal categories of the item.

With this criterion the scores of the categories present values in the interval [0, 1], their weighted mean is equal to 0.5 and they are equidistant if and only if their frequencies are equal. Otherwise, the scores are asymmetrical: the distance between two subsequent scores of the lower (higher) categories is high if the quality of the item is poor (rich), i.e. when the respondents are concentrated on the first (latest) categories.

In the literature different criteria (e.g. Rasch model, see Bond and Fox, 2007) and other probability distributions have been suggested (see Montinaro and Chirico, 2006), but the method we propose is very simple, intuitive to understand and easy to use.

Tab. 6 presents for the 6 variables used in Section 4 the quantification of the categories with natural numbers and the scores obtained by CATPCA and by the suggested criterion based on the cumulative function. (For the variables COURTESY and SKILL nobody is very dissatisfied).

The weighted mean of the scores of CATPCA is equal to 0; on the contrary, the weighted mean of the mid-points of the cumulative function is 0.5.

Tab. 6: Quantification of the 6 ordinal variables with 3 criteria

WAITING

Categories	*Frequencies*	*Numbers*	*CATPCA Quantification*	*Mid-point of the Cumulative function*
Too long	19	1	-5,464	0.014
Normal	179	2	-0.477	0.159
Fairly short	484	3	0.391	0.654

COURTESY

*Categories**	*Frequencies*	*Numbers*	*CATPCA Quantification*	*Mid-point of the Cumulative function*
Dissatisfied	5	2	-6.231	0.003
Neither satisfied nor dissatisfied	29	3	-3,191	0.024
Satisfied	277	4	-0.400	0.251
Very satisfied	371	5	0.632	0.728

* No one very dissatisfied.

SKILL

*Categories**	*Frequencies*	*Numbers*	*CATPCA Quantification*	*Mid-point of the Cumulative function*
Dissatisfied	19	2	-3.582	0.014
Neither satisfied nor dissatisfied	75	3	-1.263	0.089
Satisfied	315	4	0.000	0.375
Very satisfied	273	5	0.597	0.800

* No one very dissatisfied.

QUALITY

Categories	*Frequencies*	*Numbers*	*CATPCA Quantification*	*Mid-point of the Cumulative function*
Very dissatisfied	5	1	-3.720	0.003
Dissatisfied	25	2	-3.439	0.025
Neither satisfied nor dissatisfied	58	3	-1.103	0.086
Satisfied	301	4	-0.011	0.306
Very satisfied	293	5	0.586	0.785

SPEED

Categories	*Frequencies*	*Numbers*	*CATPCA Quantification*	*Mid-point of the Cumulative function*
Very dissatisfied	5	1	-5.889	0.003
Dissatisfied	22	2	-3.572	0.023
Neither satisfied nor dissatisfied	54	3	-1.410	0.080
Satisfied	319	4	0.000	0.353
Very satisfied	282	5	0.578	0.794

COMPLETE

Categories	*Frequencies*	*Numbers*	*CATPCA Quantification*	*Mid-point of the Cumulative function*
No	36	1	-3.858	0.026
Partly	50	2	-1.249	0.089
Yes	596	3	0.268	0.563

The scatterplot in Fig. 4 shows the relationship between the pairs of the 3 kinds of scores e.g. of the variable QUALITY: the monotonic but non-linear relations of the scores obtained by the cumulative function are highlighted.

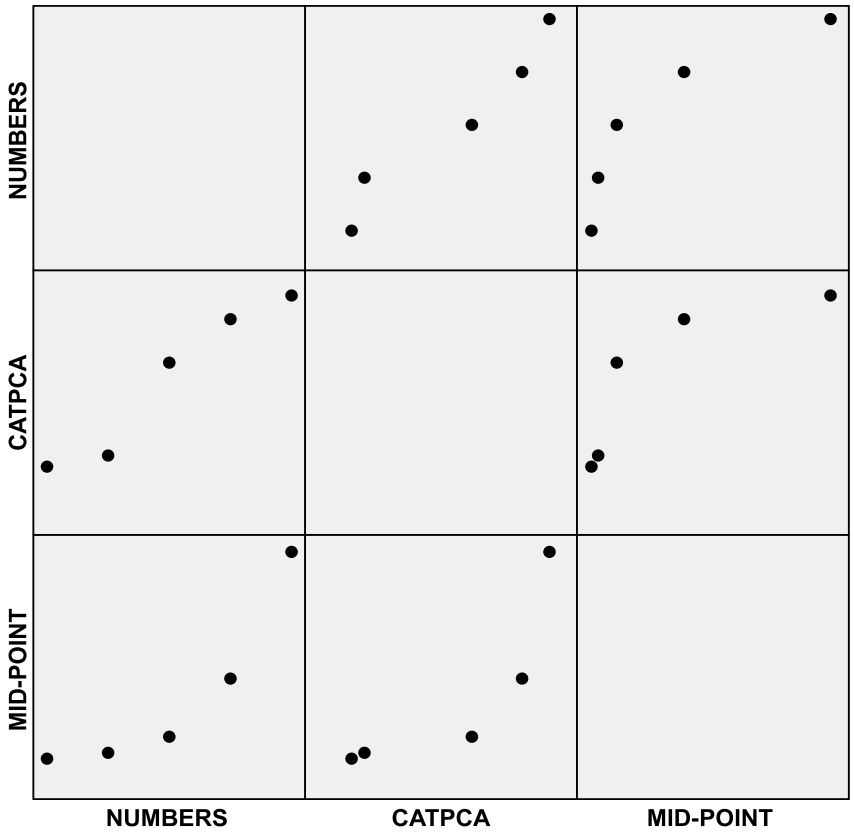

Fig. 4: Scatterplot of the 3 kinds of quantification of the variable QUALITY.

We apply the standard PCA to the 6 variables transformed with the suggested criterion. Though in this case the values of all the variables are in the range [0, 1], we standardize them, in order the take account of the different variability and to make easy the comparison with the results of the other procedures. The first PC account for the 52.86% of the total variance, slightly inferior with respect to the previous procedures. Tab. 7 presents the correlation coefficient of each transformed variable and the first PC. The results are fairly similar to the ones of Table 3. However, there is an inversion in the ranking of COURTESY and COMPLETE. The variable WAITING has always the smallest weight in the linear combination representing the global customer satisfaction.

Fig. 5 shows the relations between the scores of the customer satisfaction obtained by the 3 procedures. The suggested criterion highlights a clear non-linear relation with the two other analysis, especially in the lower values, and points out a few potential bivariate outliers.

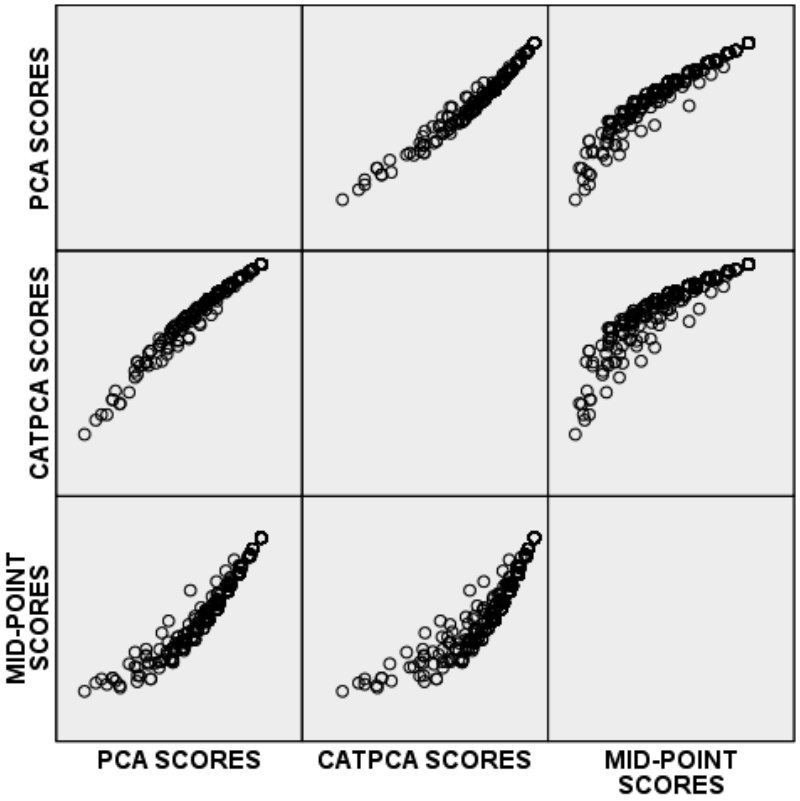

Fig. 5: Scatterplot of the scores of he first dimension obtained by reduction methods using 3 kinds of quantification.

Tab. 7: Factor loadings of the first PC of the transformed variables.

WAITING	0.418
COURTESY	0.755
SKILL	0.835
QUALITY	0.860
SPEED	0.851
COMPLETE	0.515

6. CLUSTER ANALYSIS OF THE RESPONDENTS

The methods of dimension reduction described in the previous sections point out different rankings of the customers, from the most dissatisfied to the very satisfied ones. Further information may be reached by clustering the users of the Contact Center into homogeneous groups. The two procedures can also be compared, computing the mean values of the scores of PCA and CATPCA in each cluster.

Therefore, we have applied *k*-means clustering algorithm (Quick Cluster procedure of SPSS) to the clean data set of 660 units (see n. 4), in order to obtain homogeneous classes of the users of the Contact Center. We have used the same 6 variables of customer satisfaction previously considered in PCA and CATPCA and for the sake of brevity we have applied only the simpler criterion of quantification of these ordinal variables, i.e. the natural numbers of the categories. A priori we have chosen k=3, in order to identify the classes of dissatisfied, neither satisfied nor dissatisfied, satisfied respondents. The three groups (listed in increasing order of satisfaction) are respectively of 58, 295 and 307 units and the centers of the 6 variables in each cluster are presented in Tab. 7. (Remember that WAITING and COMPLETE have three categories and the other variables five categories).

Tab. 7: Centers of the final clusters (k=3).

	Cluster		
	1	2	3
WAITING (1-3)	2.26	2.63	2.84
COURTESY (1-5)	3.90	4.17	4.92
SKILL (1-5)	2.98	3.90	4.82
QUALITY (1-5)	2.71	4.00	4.85
SPEED (1-5)	2.81	4.01	4.81
COMPLETE (1-3)	1.86	2.92	2.97

In order to evaluate the validity of the classification, we use the R^2 coefficient (e.g. Zani and Cerioli, 2007, p. 394):
$R^2 = 1 – W/T$,
where W = within cluster sums of squares of deviations; T = total sums of squares of deviations.
The R^2 coefficients for the 6 variables are:
WAITING: 0.108
COURTESY: 0.454
SKILL: 0.659
QUALITY: 0.689
SPEED: 0.633
COMPLETE: 0.438
and the total R^2 is equal to 0.497.

Therefore, the groups are rather homogenous with respect to the variables QUALITY, SKILL and SPEED, but absolutely not for WAITING.

The mean of the scores of the OVERALL variable in the three clusters of respondents are respectively 5.97; 7.69 and 8.57. So the first group can be identified as the one of dissatisfied respondents, the second cluster is really formed by fairly satisfied users (rather than by neither satisfied nor dissatisfied users) and the third group corresponds to the most satisfied customers. The means of the PCA scores in the three groups are respectively -2.24, -0.42 and 0.83 and the means of the CATPCA scores are: -2.22, -0.21 and 0.75. Theses results confirm the previous interpretation of the features of the clusters.

Then we have fixed k=5, in order to improve the validity of the classification measured by R^2 coefficient. The units in each of the 5 clusters are (in increasing order of satisfaction) are 20, 5, 58, 276 and 301. The R^2 coefficients for the 6 variables are:
WAITING: 0.154
COURTESY: 0.484
SKILL: 0.673
QUALITY: 0.738
SPEED: 0.711
COMPLETE: 0.596
and the total R^2 is equal to 0.559.

The homogeneity within the groups remains very unsatisfactory with respect to the variable WAITING, but there is an improvement for all the others variables.

The cross-classification in Tab. 8 shows that the increased number of clusters has poor effects on the two classes of fairly satisfied and very satisfied users, but it

splits in 3 sub-classes the group of dissatisfied respondents. As already shown in Fig. 2, this subset of respondents has a larger dispersion and is more heterogeneous than that of the satisfied users.

Tab. 8: Contingency table of the two classifications with 3 and 5 groups

		Clusters: *k*=5					**Total**
		1	2	3	4	5	
Clusters:	1	20	5	33	0	0	58
k=3	2	0	0	25	270	0	295
	3	0	0	0	6	301	307
Total		20	5	58	276	301	660

7. CONCLUDING REMARKS

There are many approaches for understanding and measuring customer satisfaction. We have focused our paper on highlighting what we think are useful elements for the analysis of the results of a survey on this topic. As it is usual in this kind of applications, most of the variables are ordinal with different numbers of categories.

Initially we have suggested a simple graphical method – the pyramid of satisfaction – for visualizing the entire set of variables, showing at a glance the numbers of categories and the shares of each class of respondents.

Then we have compared linear and non linear methods for summarising the level of satisfaction as function of several variables and we have also related the scores of PCA and CATPCA with the scores (ranging from 1 to 10) of the direct answers to the global level of satisfaction. The correlation coefficients are about 0.65 and it points out that the customer satisfaction cannot be completely understood using only a single direct question. The combination of direct questioning and multivariate techniques provides a deeper understanding of the so called “key drivers” of satisfaction. Furthermore this comparison is useful for identifying and deleting inconsistent answers (multivariate outliers), i.e. users with high (low) PCA or CATPCA scores and low (high) OVERALL scores.

A simple criterion of quantification of ordinal variables, based on the mid-points of the cumulative function, has been suggested, removing the unrealistic assumption of equal distance between subsequent categories. Standard PCA applied to these nonlinear scores of the variables is an alternative method with respect to CATPCA and in this application it has emphasized the degree of nonlinearity.

Finally a non-hierarchical clustering with 3 and 5 groups has pointed out the features of the homogeneous classes of the users of the Contact Center with respect to their satisfaction.

ACKNOWLEDGEMENTS

The authors thank Marco Riani, Andrea Cerioli and an anonymous referee for helpful comments on a previous draft of this paper.

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MISURE DI SODDISFAZIONE DEL CLIENTE BASATE SU VARIABILI ORDINALI: UN'INDAGINE SUL CONTACT CENTER DEL COMUNE DI PARMA

Riassunto

In questo lavoro si considerano le elaborazioni dei dati forniti da indagini campionarie sulla customer satisfaction*, esaminando il caso d'una ricerca sugli utenti del Contact Center del Comune di Parma. Com'è abituale in applicazioni di questo tipo, le variabili (risposte al questionario) sono su scala ordinale, ma con un differente numero di modalità (binarie, scale di Likert a 5 modalità, voti da 1 a 10, etc.).*

Per una visualizzazione immediata dei risultati dell'inchiesta, si propone un grafico – la piramide della customer satisfaction *– che pone in evidenza sia il numero di modalità di ogni variabile, sia i livelli di soddisfazione-insoddisfazione per ciascun aspetto rilevato.*

Si costruiscono quindi degli indicatori sintetici di soddisfazione, funzione delle diverse risposte, utilizzando metodi lineari e non lineari di riduzione delle dimensioni: PCA e CATPCA. Gli scores *di ciascun utente forniti da questi metodi sono confrontati con le risposte dirette (voti da 1 a 10) alla domanda sulla soddisfazione globale. La correlazione tra i due tipi di misure della* customer satisfaction*, dell'ordine di circa 0.6, segnala che – almeno in questa applicazione – il grado di soddisfazione del cliente non può essere colto in maniera completa semplicemente formulando al riguardo una domanda diretta, ma deve essere valutato considerando le varie "facce" del problema. Questo confronto è anche utile per individuare eventuali risposte incoerenti (voto elevato, ma bassi giudizi di soddisfazione sui vari aspetti, o viceversa), che rappresentano potenziali* outliers*.*

Si propone altresì un nuovo metodo di quantificazione delle variabili ordinali, che tiene conto delle frequenze relative cumulate, e presenta una relazione monotona, ma non lineare con il più semplice criterio di attribuzione di codici 1, 2, 3,… alle modalità ordinate in senso crescente d'una variabile. L'applicazione della tradizionale PCA alle variabili

così quantificate rappresenta una procedura alternativa alla CATPCA.

Infine, una classificazione degli utenti con il metodo di clustering *delle* k-*medie consente d'individuare i gruppi di clienti insoddisfatti, parzialmente soddisfatti e completamente soddisfatti, ponendo in luce la composizione e le caratteristiche di ciascuna di tali categorie. Per ogni gruppo omogeneo si calcolano anche i valori medi degli* scores *ottenuti con l'analisi delle componenti principali, lineari e non lineari, stabilendo un nesso tra la procedura di classificazione e quelle di riduzione delle dimensioni.*

Il complesso delle analisi effettuate fa emergere i "fattori chiave" che determinano la soddisfazione dell'utente, la cui conoscenza può essere di grande aiuto nella definizione delle strategie aziendali.