Service Quality Design through a Smart Use of Conjoint Analysis

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Abstract

In the traditional use of conjoint analysis, in order to evaluate the relative importance of several elements composing a service, interviewed customers are asked to express their judgement about different scenarios (specific combinations of elements). In order to reduce the number of possible scenarios, design of experiments methodology is usually exploited.

Previous experiences show that, even a limited number of proposed scenarios cause difficulty in answering for the interviewed customer if the scenarios differ for elements of very low interest to him/her. Consequently, a high rate of abandon of the interview has been observed.

In this study it is assumed that a service can be decomposed in several improvable elements and/or enriched with new "optionals". In both cases, what under study is assumed to be a set of dichotomous attributes. For each of these attributes, its marginal contribution to customer satisfaction has to be modelled and estimated.

To obtain the required information, an opportune questionnaire is proposed to a sample of interviewed customers. An interviewing procedure consisting in a customer driven design of scenarios is followed, starting from the full-optional scenario and eliminating one by one the less satisfying elements. For each interviewed customer, a ranking of attributes is so obtained. Then, by asking the interviewed customer to evaluate on a metric scale the scenarios he previously selected, a rating of attributes can also be obtained.

A case study conducted in collaboration with a public transportation company is presented. Contrarily to previous experiences, the abandon rate proved extremely reduced.

1. Introduction. The conjoint analysis

The conjoint analysis is a technique aimed at evaluating the contribution on customer satisfaction of several features of a product or a service to be designed. As this methodology is generally addressed to both a material product and an immaterial service, we henceforth generically refer to a *system.*

The *features* are the system elements, potentially affecting customer satisfaction, which can be individually varied in the design phase, by setting them at different levels. They can be either physical components or subsets of them, or even non-physical characteristics.

A specific combination of the levels of the features defines a possible realistic system, called scenario, that will be evaluated as a whole by the customer. A set of different scenarios could be physically made and presented to the customer, or described by means of words, pictures or virtual reality devices.

Customers called to evaluate the scenarios are intended as a panel of experts or a sample of the target population of potential users.

The two mostly adopted methods for presenting the scenarios are the *partial-profile evaluation* and *full-profile evaluation* (Hauser and Rao, 2002).

Contrarily to the second method, in the first one the customer is required to choose among a reduced set of features. In this way simple choices are involved but many comparisons are generally required. A particular and commonly used method is the pair-wise comparison in which the customer is required to choose between two scenarios at a time.

About the nature of the response, two modalities are used: *ranking and rating.*

In the first case the customer is required to rank all the proposed scenarios. This method is generally applicable, but it becomes burdensome when the scenarios are presented to non-professional evaluators and their number exceeds a dozen.

The second method is easily applicable, but it requires defining a metric scale for the answer with many consequent problems well known in the literature.

In order to reduce the number of scenarios to be presented, usually design of experiments methodologies are applied. The adopted design is intimately related to the assumed statistical model linking the response (i.e. the customer satisfaction measure) to the system features.

If it is possible to assume that the features do not interact on the response (the increment of satisfaction due to the variation of a feature is independent from the levels of the other features), then *for each single interviewed customer* a simple *additive* model can be assumed:

$$Y_i = \beta_0+\beta_1 x_{i1}+\cdots \beta_m x_{im}+\varepsilon_i \qquad (1)$$

where:

Y_i $(i = 1, \cdots, n)$ is the observable random variable describing the response of the interviewed customer to the i-th scenario;

x_{ij} (i = 1, ⋯, n; j = 1, ⋯ , m) defines the level at which the j-th feature is set in the i-th scenario;

ε_i is the random variable representing the variability not explained by the model and that can be due to measurement modalities, presentation of scenarios, ⋯ ("within" variability).

In matrix notation the model (1) can be reformulated as:

$$\boldsymbol{Y} = \boldsymbol{X\beta} + \boldsymbol{\varepsilon}$$

where:

$$\boldsymbol{Y} = (Y_1, Y_2, \cdots, Y_n)^T$$
$$\boldsymbol{\varepsilon} = (\varepsilon_1, \varepsilon_2, \cdots, \varepsilon_n)^T$$
$$\boldsymbol{\beta} = (\beta_1, \beta_2, \cdots, \beta_m)^T$$

Otherwise if the additivity is not assumable, more complex models need to be formulated, i.e. by introducing interaction terms.

Anyway, on the base of the response measure, opportune estimation methods of the parameters $\boldsymbol{\beta}$ have to be carried out: the ordinary least squares in the case of metric response, the monotonic regression in the case of ranking response. Such coefficients represent the estimated *profile* $\boldsymbol{b}=(b_0,b_1, \cdots, b_m)^T$ of the interviewed customer.

A sample of customers to be interviewed is selected from the target population. It can be thought as composed by several strata, each of them characterised by similarity of customer behaviour. It is usually difficult to a priori characterise the strata by means of social, economic, demographic variables; indeed it could be one of the aims of the study. In such case the interviewed customers can be a posteriori clustered on the base of their estimated profiles. To this aim customers need to be sampled according to specific sampling techniques, taking into account the variability between subjects.

If matrix **X** is full-rank, in order to obtain the coefficients estimates **b**, at least $m+1$ scenarios must be presented. Such matrix, called the design matrix in the design of experiment (DOE) framework, usually has not all possible rows (not all possible scenarios are presented to the interviewed customer), but a selection of them is preliminarily chosen, according to well-known criteria.

2. A new approach to questionnaire design

One of the disadvantages of the above illustrated procedure is that the number of scenarios (runs) planned in order to obtain optimal designs is usually too large.

To overcome this limitation Adaptive Conjoint Analysis (ACA) was proposed (Johnson, 1987). In the current use of ACA two techniques must be distinguished: adaptation *within* respondents and adaptation *across* respondents; SAWTOOTH software is to date the only example of implementation of ACA (Toubia et al, 2003). ACA uses a data-collection format known as metric paired-comparison questions, and relies on balancing utility between the pairs subject to orthogonality and feature balance.

Another disadvantage characterising the presentation of a number of planned scenarios is that among them there could be some indistinguishable for the interviewed customer because they differ for elements of very scarce interest.

In order to overcome the previously mentioned difficulties a new method is here proposed, which can be considered as an extension of ACA. It is applicable when the features are dichotomous, for instance "optionals" that can be present in or absent from the system, or constituting elements that can be improved or not. In such case it is possible to apply the following three-step procedure:

1) the first scenario presented to the interviewed customer is the full-optional one, i.e. that one in which all features are present at their best level (all optionals are present, or all elements are at the improved level);
2) the interviewed customer is required to one by one eliminate the features that contribute less and less to his/her satisfaction;
3) the scenarios sequentially selected are then presented again to the interviewed customer in inverse order (from the least satisfying up to the first one, i.e. the best) requiring to assign a score to each of them.

The proposed procedure has the advantage that, instead of proposing to the interviewed customer to rank several scenarios, which is a difficult and boring task, in this way the ranking of the features is automatically established, requiring a minimum effort. Moreover there is no risk that the customer is compelled to compare scenarios indistinguishable to him/her, because they differ for elements of very low interest.

The second advantage is the possibility to get a metric response, based on real or realistic scenarios, that can be analysed through the most powerful statistical techniques, i.e. regression analysis, giving the marginal contribution of each feature to the overall satisfaction.

The third advantage is the possibility to have check of coherence of the given responses, because the marginal contributes of the features must be non-decreasing going from the worst scenario to the best.

Actually, a non-coherent response profile could occur when the additive model does not hold, i.e. strong interactions between two or more features are present. In such cases it could be possible to single out some adjunctive scenarios in order to estimate the interaction effects. This problem is particularly relevant, because the usual techniques for detecting and estimating the non-linearity, as given in DOE framework, are not straightforwardly applicable. In fact "pure" replications (repetitions of the same question to the same interviewed customer about the same scenario), in order to estimate the "experimental error" variability, cannot be executed in the same occasion. On the other hand, even if it were possible to obtain new answers after time delays (capture and recapture techniques), it wouldn't be sure that it allows estimating the "experimental error" variability (an intrinsic behavioural process can lead to a different answer to the same question).

Therefore ad hoc solutions must be studied and this will be the future enhancement of the proposed methodology. Anyway in real tackled case studies, this problem is probably not involved in consideration of the particular features explored.

Another sensitive problem concerns the choice of the response metrics. This problem emerges when we want to compare different profiles or to obtain clusters of interviewed customers in order to make market segmentation. Usually a response range, say 1÷7 or 1÷10 or 1÷100, is proposed to the interviewed customer; but it is well known that the *same* range is not exploited by all subjects. In fact *zero* and *full score* are not the same for all subjects. The regression model coefficients, being of incremental kind, are independent from the zero, but they depend from the difference between the full score and the zero. In order to overcome this lack, many solutions are proposed in literature. We preferred to use a very simple normalisation procedure, consisting in dividing the distance between the observed answer y_i and the minimum response y_{min} (the score of the least satisfying scenario) by the distance between the maximum response y_{max} (most satisfying scenario) and y_{min}:

$$y'_i = \frac{y_i - y_{min}}{y_{max} - y_{min}}$$

The response so modified is strictly lying in [0, 1] and it is independent from the particular metrics adopted by each interviewed customer.

3. Application to a public transportation service

The above illustrated methodology has been applied to design the improvement of some features of the bus service of the town of Palermo. In particular the object of the survey concerned some information system devices that could realistically improve customer satisfaction. The public transportation Company (AMAT) was interested to establish, firstly, a ranking of the importance on customer satisfaction of the hypothesised devices and, secondly, a measure of their impact.

In fact the Company was interested to improve the service provided to the citizens by using highly innovative devices. In particular it was interested to better exploit all data coming from the real time traffic monitoring system (currently working only on some selected lines but progressively enlarging to cover all the network) by giving such information to the customers in the most satisfying ways: rapidly, friendlily, cheaply.

After a brainstorming with Company managers, the devices chosen for the analysis were:

- Information brochures (map of the town, tourist guide, timetable, etc.);
- Call center
- Internet web site
- Cellular phone services (sms, wap)
- Traditional information stands
- Multimedia information stands
- Traditional schedule at the bus stop
- Telematic schedule at the bus stop
- Displays and/or notices on-board
- Multimedia route map on-board

Among them there were some more traditional features, like information brochures; others more innovative, like multimedia information stands; and others of experimental type, to be installed on-board of the buses. A further selection, based on a preliminary pilot study, leaded to select the subset of the most innovative features. Finally, the format of the questionnaire proposed to interviewed customers, was that one reported in Fig.1.

The three-step procedure above illustrated was followed. The interviewers were trained to firstly list all the devices under study to the selected customers. Then, the interviewers reported on the second last column of the format the number of the eliminated feature row by row, from the top to the bottom of the table, on the base of the customer answer; the cells of the eliminated features were marked with a cross by this row to the following ones. At the end, the interviewed customers were required to assign firstly a score to the current service (without optionals) and then sequentially the scores to each scenario (row of the table) from the bottom to the top, until the full optional scenario.

In this phase the interviewer was also trained to check the coherence of the responses. In fact it is expected that the scores assigned by the interviewed customer sequentially increase, going from the bottom to the top, but with non-increasing increments, because during the elimination phase, if a feature gives a greater increment than another, it should have been eliminated afterwards.

4. Conclusions

This new procedure seems to be applicable to a wide range of problems. In the presented application to a public transportation service the results were very promising as the non-response rate was almost null: all persons who accepted the interview were able to accomplish at least the ranking phase. Furthermore all interviewed customers tried to accomplish also the second phase concerning rating assignment. Here the phenomena of incoherence were limited, thanks also to the very well trained interviewers, who were able to explain the meaning of rating.

The results of the survey, here not reported, were of high interest for the Company in order to design an improvement project for the information services.

In the next future Authors' aim is to accomplish the research by means of new experiences with other service Companies in order to deepen their knowledge of the proposed method. Particular focus will be placed on the metrics of the response and the design problem concerning the optimal tackling of possible interactions.

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Advanced information systems

1	2	3	4	5	6	7	Excluded optional	Score (0:100)
Internet web site	Cellular phone services	Call center	Multimedia information stands	Telematic schedule off-board	Displays/ notices on-board	Multimedia route map on-board		
Internet web site	Cellular phone services	Call center	Multimedia information stands	Telematic schedule off-board	Displays/ notices on-board	Multimedia route map on-board		
Internet web site	Cellular phone services	Call center	Multimedia information stands	Telematic schedule off-board	Displays/ notices on-board	Multimedia route map on-board		
Internet web site	Cellular phone services	Call center	Multimedia information stands	Telematic schedule off-board	Displays/ notices on-board	Multimedia route map on-board		
Internet web site	Cellular phone services	Call center	Multimedia information stands	Telematic schedule off-board	Displays/ notices on-board	Multimedia route map on-board		
Internet web site	Cellular phone services	Call center	Multimedia information stands	Telematic schedule off-board	Displays/ notices on-board	Multimedia route map on-board		
Internet web site	Cellular phone services	Call center	Multimedia information stands	Telematic schedule off-board	Displays/ notices on-board	Multimedia route map on-board		
Score of current service (without optionals)								

Sex	**Education**	**Age**
M € F €	primary school € middle school € high school € Laurea degree €	<18 € 18-25 € 25-40 € 40-60 € >60

Figure 1. Questionnaire format for the public transportation service survey

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