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Article

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METHODOLOGY TO EVALUATE THE QUALITY OF PUBLIC SERVICES

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Abstract

The preferences of citizens and their satisfaction level for the actions carried out in the public sectors are usually established by questionnaires, taking into account the specificities and priorities of each city. No global methodology exists to collect and to treat information because of various variables to be tested, upgradeable character of the human behaviour and his subjective perception.

We propose a global methodology that will join two methods. With the method of fractional array to obtain a very low number of questions, we can pattern the relationship between the tested variables (price, security, etc.) and the characteristic of the wanted performance (such as the quality of the service). Interviewed people can be classified into socio-demographic categories by the tool user. Afterwards, the Analysis of Variance gives significant variables. A reduced model illustrating a “mean” behaviour is designed for all hypothetical situations.

The proposed methodology is tested for the category “student” in two case studies: to evaluate the teaching quality at Faculty of Economic Sciences (FSE) within Oil and Gas University from Ploiesti (Romania) and to estimate the quality of using car parks in La Rochelle (France).

Keywords: fractional array, students' evaluation, behavioural model, road users

JEL Classification: L80, N7, C60, I21, I23, C12, R41

Introduction

The necessity to generate only qualitative public services is imposed on the one hand, by the need to respond appropriately to activities of general interest which are required by the demands, increasingly diverse and complex, of the citizens, and on the other hand, in order to improve the quality of life in a country, the standard of living of the population for that country.

Influenced by the specific historical period, the European Community identified the decisive factor of integration, namely integration through education, or better said through an educational system, the most organized form of shaping human personality.

In this context building, a unique European vital space means to raise it on a unitary European educational space that has the purpose of shaping the European citizen, capable of a successful socio – professional integration in the most competitive economy in the world. The beneficiaries of this unique educational space are the students, the teachers and the educational institution as well as the entire community.

In order to cooperate in the European research and teachers or students mobility projects and for the international recognition of study certificates, universities need to adjust their offer, standards, criteria and evaluation procedures. Ensuring the quality of the Academic Education implies that:

- There exist organisms, standards (models) and institutional procedures for internal and external evaluation;
- The educational institution is capable of presenting evidence regarding the conformity of the internal Quality Management System with standards or models agreed.

The fundamental purpose of any university is excellence in research and academic education. Universities challenge themselves to obtain excellence via an internal intellectual and simulative environment for the students as well as for the teachers, environment that is sensitive both to national and international needs. Universities admit the need for an efficient management for all resources available.

Consequently, each university tries to achieve its didactic and research planned objectives through the promotion of certain targets, standards and procedures, which are introduced in the Quality Manual and are according to the principles included in Bologna Process documents. Quality insurance in academic education consists in the sum of all organizational mechanisms and procedures through which maintenance and permanent improvement of academic standards are confirmed at the institution level. In the academic educational space, quality issues involve specified quality requests: competent teachers, students prepared according to the followed specialization, a segmented and flexible study programs offer, according to the European universities study programs, the opportunity to cover, through academic education, a part of the working force market, etc.

The hereby paper is organised as follows: firstly, we describe the methodology to design the questionnaire and the statistical treatment of the database, in order to analyse the quality of different kind of public services. Secondly, two studies are performed to validate this approach: the first one refers to the quality of teaching in Faculty of Economic Sciences within Oil – Gas University (Ploiesti-Romania) and the second one analyses the quality of the infrastructure at Ecole d'Ingénieurs en Génie des Systèmes Industriels (La Rochelle-France). Finally, discussions are performed on the efficiency of this methodology as well as on potential extensions.

1. Methodology

The quality of a service perceived by people is always difficult to be quantified; the classical questionnaire, based on observed preferences, shows a lot of inconveniences. The most delicate aspect of this kind of questionnaire is the subjectivity of the given answers,

because the respondents are frequently influenced by different parameters that have no connections with the tested factors. A classical example is the evaluation of the teaching quality; even if the test parameters are carefully chosen in agreement with the tested values (quality of documents, communication degree,...), it is well known that the preferences of students are influenced by other intangible parameters which are the consequence of the individual interactions teacher-student.

On the other hand, this kind of questionnaire is always carried out at the end of the teacher exhibition and it is not possible to correct some dysfunctional aspects. Out of these reasons, we suggest the use of the technique of declared preferences: the respondents are placed in hypothetical scenarios and must indicate their evaluation for each one. In order to build such a questionnaire, we will use the Design of experiments method (DOE) coupled with a Vigier's model [4].

Our approach is based on the belief that people with similar socio-demographic characteristics have similar preferences. Consequently, for the various categories of students (age, gender) we propose to design for each one a model describing the "mean" behaviour based on a similar perception of effects of factors changes. The main steps of the approach are schematically presented in figure 1.

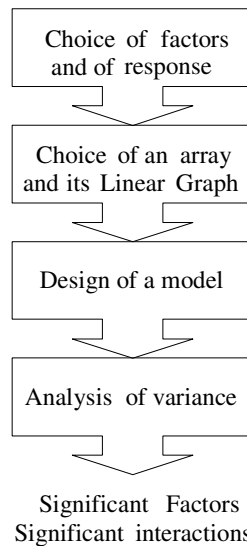


Figure 1. Steps of our approach

Step 1: The choice of factors and of response to analyse

The *factors* are the parameters under study which can be controlled and which are independent. The *levels (modalities)* of a factor refer to the number of values of the variable. The quality characteristic to be optimised is the *response* to be observed. The response to optimise is the quality of a service and for it we can use a crisp value (a score)

as well as a semantic evaluation (very well, bad,...). Several responses can be jointly studied with the same questionnaire.

Step 2: The choice of an array and its Linear Graph

In order to obtain the maximum information with such a questionnaire, a full matrix with all possible combinations of factors and levels is necessary. Let us suppose a questionnaire in order to test the effects of the variation of 11 factors, each one having 2 levels. A full factorial array using 2 048 questions will be strongly inadequate for this kind of analysis.

The Taguchi's method [3] uses an orthogonal factorial array which is a subset of a complete array. Figure 2 shows an example where A, B,...are the tested factors, the values 1 and 2 are the levels of the factors and a horizontal line of the array is a hypothetical scenario to be evaluated. In a scenario (or question), one or more variables are deliberately changed at the same time. Varying several factors simultaneously may have interactive effects on the studied response (when the effect of a factor depends on the level of another, an interaction exists). Taguchi provides many standard orthogonal arrays and corresponding linear graphs for this purpose (in order to affect columns for factors and interactions). The fractional arrays reduce the number of necessary combinations and are obtained by using orthogonality theories after the "sacrifice" of several interaction effects. The columns of the array presented in figure 2 could be used as follow: A, B, D, G for factors and C, F, E for interactions.

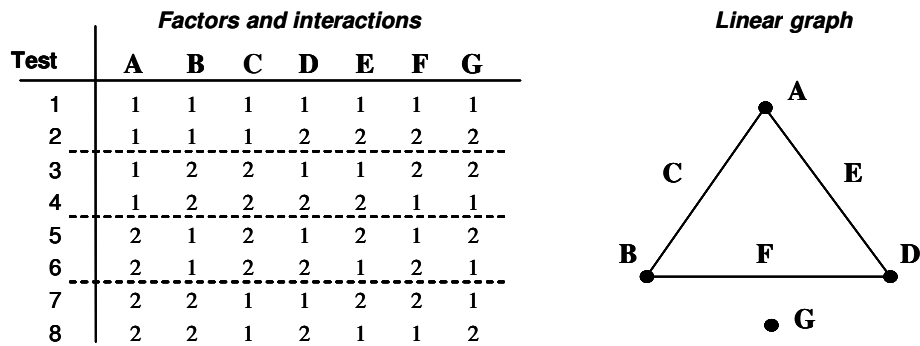


Figure 2. $L_8(2)^7$ array and one of its linear graph

Step 3: Design of model

We have adopted a model based on the Analysis of Means (ANOM) proposed by Vigier [4]. When the evaluation is done with crisp values, the determinist part of the model can be schematically represented as follows:

$$S = S_{mean} + (a_1 \ a_2)A + (b_1 \ b_2)B + \dots \begin{pmatrix} a_1b_1 & a_1b_2 \\ a_2b_1 & a_2b_2 \end{pmatrix} \dots \quad (1)$$

where a_i - matrix elements representing the mean effect of factor A at level i ;
 $a_i b_j$ - matrix elements for the mean effect of the AB interaction when A is at level i and B at level j .

$$\begin{aligned}
 a_i &= S_{mean}(A_i) - S_{mean} \\
 a_i b_j &= S_{mean}(A_i, B_j) - S_{mean} - a_i - b_j
 \end{aligned}
 \tag{2}$$

with S_{mean} - mean value of all scores;

$S_{mean}(A_i)$ - mean value of the scores for the combinations where A is at level i ;

$S_{mean}(A_i, B_j)$ - mean value of the scores when A is at level i and B at level j .

Step 3: Analysis of Variance (ANOVA)

The aspects of interest of our work are to establish the main factors which affect the quality of a service. We have used the approach proposed by Vigier (Vigier, 1988), consisting in comparing the variance of the mean effects of the actions (factors and interactions) with the residual variance. Ignoring higher-order interactions, there are three levels of significance which are established with the Fischer and Snedecor test: not significant (NS) for $F_{resp} < F_{0.05}$; significant (S) for $F_{0.05} < F_{resp} < F_{0.01}$; very significant (VS) associated to $F_{resp} > F_{0.01}$.

Analysis of Variance table

Table 1

Action	Variance	F_{resp}
Factor A	$V_A = \frac{N}{n_A(n_A - 1)} \sum_i a_i^2$	$\frac{V_A}{V_r}$
Interaction AB	$V_{AB} = \frac{N}{n_A n_B (n_A - 1)(n_B - 1)} \sum_i \sum_j a_i b_j^2$	$\frac{V_{AB}}{V_r}$
Residual	$V_r = \frac{1}{\gamma_r} \sum_i \sum_j (Y_{ij}^{exp} - Y_{ij}^{th})^2$	

The significations of the variables inscribed in this table are:

N - number of tests; n_A, n_B - number of levels for the factors; γ_r - residual degree of liberty; $Y_{ij}^{exp}, Y_{ij}^{th}$ - the calculated and theoretical value of the response (scores); F_{resp} - Fischer coefficients).

The analysis of variance (ANOVA) allows reducing the model, taking into account only the very significant factors and interactions. The designed model can be used to evaluate the score for questions without response (all combinations not included in the factorial array).

2. Applications of the questionnaire with declared preferences

a) quality of teaching – Oil-Gas University - UPG, Ploiesti, Romania

In order to observe the quality issues, our University organized a research study called “Student satisfaction investigation” which tries to establish the most significant factors for a quality academic education in Economic Sciences. After various discussions and analyses, five characteristics were taken into consideration, characteristics that represented the questionnaire base for students. Those characteristics concern: the teacher’s patience in explaining to students, his ability to communicate, his authority during the teaching process, his experience and the knowledge of using soft, innovative teaching methods. Combining this characteristics, a questionnaire was designed using the $L_8(2)^7$ array. In the table 2 is presented this questionnaire.

The affectation of the columns was changed by adding a new factor at the place of the interaction E (because we estimated that the interaction between the patience to explain and the authority of the teacher does not exist). The interactions which are evaluated are: patience to explain-ability to communicate and capacity to communicate-authority during the teaching process).

Questionnaire to evaluate the quality of academic

Table 2

question	patience to explain (A)	ability to communicate (B)	authority (D)	innovante means to teach E	experience (G)
1	no	no	no	no	no
2	no	no	yes	yes	yes
3	no	yes	no	no	yes
4	no	yes	yes	yes	no
5	yes	no	no	yes	yes
6	yes	no	yes	no	no
7	yes	yes	no	yes	no
8	yes	yes	yes	no	yes

The potential responses are presented in table 3.

Responses and associated scores

Table 3	
Response	Value
Extremely bad	0
Very bad	20
Bad	40
Good	60
Very Good	80
Excellent	100

The number of responses treated is 1208 (151*8) and after the elimination of aberrant answers (out of a Gaussian distribution) and the ANOVA application, the reduced model obtained was:

$$Y = 49.21 + (-11.11 \ 11.1)A + (-9.45 \ 9.45)B + (-7.58 \ 7.58)G \quad (3)$$

We can remark that for all students, an average "perception" of the quality of academic education, in order of the weight, is done by: a great the patience to explain, a great the ability to communicate and a great experience. The other factors, as well as the interactions, are non-significant.

A study by gender and age range was done: the preferences are the same, but the males consider that the ability to communicate is the most important factor to ensure a high-quality teaching process. Only young persons (<25 years) granted an important weight to the innovative methods; for the same category, a strong interaction between the patience to explain and the capacity to communicate was pointed out.

b) the quality of infrastructure-EIGSI, La Rochelle, France

It is well known that the quality of an academic education is strongly linked with the quality of the infrastructure. For the small cities (such as La Rochelle) with academic institutions, a problem occurs concerning the possibility of timekeeping for the university courses in the peak periods of the urban traffic. One of these causes is the difficulty to find a vacant place to park the car. In order to estimate the potential measures to improve this problem, we were firstly interested in the preferences of students and teachers who must park their cars and the behaviour of students if no place is available.

According to the tangible factors such as walking time, distance, duration, price ... frequently chosen as input variables (Shoup, 1999), we added intangible factors such as the activity to carry out (urgently or not), the facility to get access into the University (easy or not).

The response to be studied is the "quality" of the car park; the potential evaluations and the modalities of the factors are presented in Table 4.

Potential Responses and Factors to be tested

Table 4

Response	Value	Input variables	Mark	Level 1	Level 2
Very rarely	0	Price of the parking	A	Cheap	Expansive
Rarely	20	Distance to University	B	Near	Far
Occasionally	40	Walking speed	C	Fast	Slow
Sometimes	60	Parking duration	D	Short	Long
Frequently	80	Number of persons	E	1	> 1
Very frequently	100	Type of activity	F	Urgent	Not urgent
		Accessibility of area	G	Easy	Difficult

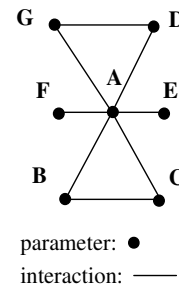
A questionnaire based on $L_{16}(2)^{15}$ array was sent to students and teachers (table 5).

Questionnaire Used and Interactions to be Estimated

Table 5

Scenario	A	B	C	D	E	F	G
1	Cheap	Near	Fast	Short	1	Urgent	Easy
2	Cheap	Near	Fast	Long	>1	Not urgent	Difficult
...
15	Expensive	Far	Slow	Short	>1	Not urgent	Difficult
16	Expensive	Far	Slow	Long	1	Urgent	Easy

Linear graph



For a rigorous statistical analysis, the same questionnaire was sent to a significant number of people belonging to the same category. The preliminary feedback of respondents showed that the number of choices of responses must be low (4 or 6).

We treated 1728 responses (108*16) of students and 608 (39*16) responses of teachers. In agreement with the linear graph, eight interactions could be evaluated. A model was designed for each category and the Analysis of Variance was performed.

a. For students, the determinist part of the reduced model is:

$$Y = 39.98 + (12.7 \quad -12.7)A + (7.64 \quad -7.64)B + (4.5 \quad -4.5)C + (6.77 \quad -6.77)G + \begin{pmatrix} 4.36 & -4.36 \\ -4.36 & 4.36 \end{pmatrix}AG \quad (4)$$

b. For teachers, the determinist part of the reduced model is:

$$Y = 39.85 + (12.6 - 12.6)A + (11.75 - 11.75)B + (3.47 - 3.47)F + (6.5 - 6.5)G + \begin{pmatrix} 4.04 & -4.04 \\ -4.04 & 4.04 \end{pmatrix} AG \quad (5)$$

It is interesting to find a very similar behaviour for the two categories about the price and accessibility. In contrast with the model for students, the walking speed is non-significant for teachers, but the activity type affects their choice. For both models, the number of people and the parking duration are non-significant parameters. The only important interaction is between the price and the distance car park-university (AG).

Now, suppose that a student selected a car park but cannot find a vacant place to park; the potential scenarios are schematically presented in figure 3.

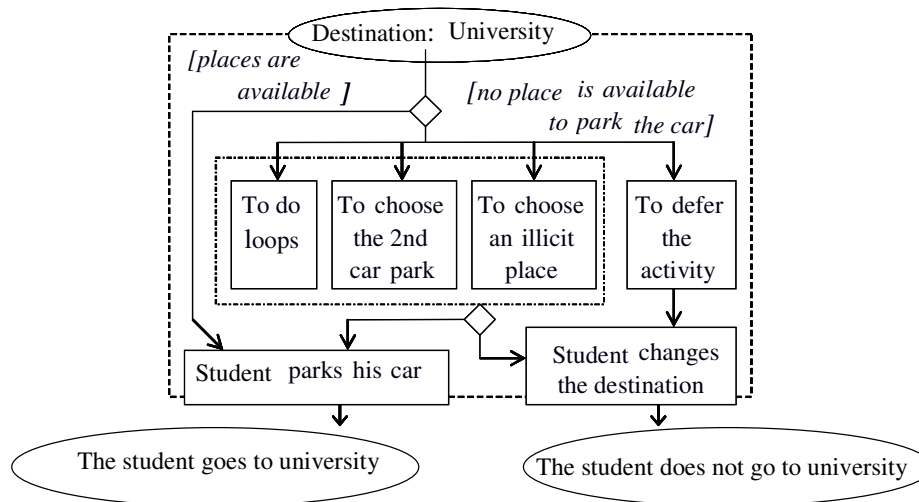


Figure 3. Choice between potential alternatives

Four potential alternatives are proposed for each scenario: to do loops to search a place, to go to the second car park (with the second score), to park on an illicit place or to defer the activity in University.

Only very significant factors preliminarily established (Price of the parking, Distance to University, Walking speed, Accessibility of area) are tested in $L_8(2)^7$ array and the response to the analysis is the frequency of choice. The scores are computed after the fusion of information of the students. The discernment framework contains the four alternatives:

$$\Theta = \{ \text{to do loops, to choose the second park, to choose illicit place, to defer the activity} \}$$

For each alternative, the respondents have four possibilities: "very rarely" (VR), "rarely" (R), "frequently" (F) and "very frequently" (VF). These evaluations are converted into scores.

The scores are also computed for all alternatives and for eight scenarios of the L_8 array. For example, in the case of scenario 1, the choice is "to do loops" and in the case of scenario 5, the choice is "to choose an illicit place". The reduced model is elaborated for each alternative. For example, in the case of the alternative "to do loops", only the weather, the activity duration and the importance of activity are significant. For the case "to choose an illicit place", the distance and the duration are significant.

Conclusions

Quality control implies the use of management procedures that verify and guarantee the standards of the academic activity (teaching, learning and research). On the other hand, the infrastructure quality significantly contributes to the insurance of the best conditions in this field.

We proposed a methodology which is able, using a low number of questions, to distinguish among the factors and the interactions which are perceived to be significant for the quality of a service (in our case, the teaching process and the car park quality). It is the first interest of this method but, using the Vigier's model, we are able to quantify and classify the impact factors per social categories, gender and age range. Another point of interest is that this kind of questionnaire can be done before the implementation of a service, in order to estimate the potential consequences and to correct actions in agreement with the preferences of students. We will use this method to evaluate the quality of different services, such as the equipment of laboratories or the evaluation systems of teaching activities in universities. These works will be done simultaneously in both schools (Ploiesti and La Rochelle) in order to compare the preferences of our students. In order to cooperate in the European research, to ensure high performance during the academic exchanges or for the international recognition of study certificates, Universities need to adjust and to find common points in their offer, standards, criteria and evaluation procedures.

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