

MATHEMATICAL MODEL OF MEASURING THE QUALITY OF SERVICES OF THE HIGHER EDUCATION INSTITUTIONS

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Abstract. *The evaluation of educational services' quality through clearly defined criteria and methodologies is a basic requirement of the Bologna Process. The authors are proposing to debate in this study a mathematical model which could be used by the higher education managers in their approaches for determining the quality of the educational services offered, and especially for establishing the place of the higher education institution managed by them in the university hierarchy. The study uses a set of indexes proposed by various authors, adapted to the classification structure of the intellectual capital unanimously accepted world wide, namely the external and internal structure and the employees' competence. As calculation method the ROMPEDET method was used. For verifying the model's usability, this was applied in the case of the universities from Constanţa, and the results thus obtained are included in the study.*

Key – words: quality of educational services; ROMPEDET method; intangible assets indicators

Introduction

In the context of the admission of Romania into the European Space of Higher Education, the exigency of national institutions for the assessment of the educational services' quality is essential, as well as the exigency of creating by each university the internal evaluation systems, by implying all the educational stake-holders. The competent authority in Romania for the assessment of the academic activity is since 2006 the Romanian Agency of Higher Education Quality Assurance (ARACIS), which in October 2006 framed a Methodology of the quality assurance, of the provisionally authorization of functioning and the accreditation of the study programs and the higher education institutions. Consequently, the Romanian higher education system has nowadays a system of performance indexes through which the quality of the services of various higher education institutions can be evaluated and compared. ARACIS is not yet member of the European Agency for Quality Assurance (ENQA), but it hopes that until October 2007 to become associate member. Creating such an agency, not considering that is incumbent, in the new European context, can be proved very useful if the criteria and the methodology of assessment the academic quality will succeed to apply on the reality in the market which they assess.

The critical analysis of the methodology of quality assessment

With regard to this subject there are currently running many debates, both public or official and informal, between those implied in a way or another in the higher education. This situation can be explained mostly by the fact that the methodology is very recent „product”, whom practical applicability begins to be tested and, moreover, which has not had the chance to be subject of the specialists' opinions, of all that are part from the higher education system, other than the ARACIS members, because has not been yet subject of the public debate.

Therefore, among the critics raised can be counted:

- using as a performance index the percentage of the graduates who enlist themselves to the master studies – it is considered to be a formal index, because many universities can enroll preferentially their own students, for accomplishing this requirement; moreover, the enlistment to the master studies can be done very easily, in the most cases for a tax of study, without exam, so practically any graduate can became master student etc;
- using as a performance index the percentage of the graduates who in two years from graduation to be employed at the level of their academic qualification – although in principle the index is relevant, it has an operational deficiency – how can prove the graduates where they work and what they do after two years from their graduation?; how can the universities find them?; how can be checked the universities if they report accurate what they have found from their graduates? etc. ;
- the assessment of the satisfaction level of the students in connection with the professional and personal training assured by the university – again, one cannot argue against this index at

theoretical level, but is also true that, at least to these days, this index cannot assume any practical significance. First of all, it should be created a common national instrument of assessment for this satisfaction, and then it should be provided a way to collect the opinions that to assure a non-vicious assessment of the answers, through the fear not to make difficulties to the universities if the subjects do not answer „like they should”;

- the fact that, by law, in Romania cannot function in the same time more agencies of assessment for the quality of the educational services, although in other European countries this is practiced and, moreover, although in this matter it is difficult, even impossible, to find that method of quality assessment against no one can argue, and the competition could be in our benefit etc. [1]

I believe these assessments to be useful, especially because until 1st of September 2007 ARACIS tests the methodologies of evaluating and external assurance of quality, in order to elaborate a final report regarding the results of the testing. Therefore, the external evaluation of the quality of higher education in Romania is yet at an experimental stage, fact which presumes that it is open to the improvements.

Beginning with the academic year 2007–2008 the methodologies of internal and external evaluation for assuring the quality will be applied, considering the results of the experimental stage. Therefore, from October 2007 it will be incumbent the implementation of a quality system in every university, with all things thus implied, and the success of this action will depend on the measure in which the management of the higher education institutions will understand that this charge is to be done by the specialists.

The authors have been elaborated and propose a model for evaluating the quality of the higher education services. The model includes the next stages:

Stage I. The issuance of a set of indicators

It is very important that they are easily understood, operated and used. Taking into account the multiple roles of the educational services, they can be grouped in the following categories, according to the structuring model of intangible assets and to the intellectual capital used in specialized literature. [2]

External structure indicators – present the situation clearly from the clients point of view – students, parents, firms which want to buy research results from university

Table 1: External structure indicators

Indicator	Symbol	Comments
Clients' satisfaction	(E ₁)	indicator determined on the basis of questionnaires addressed both to the students and to economic operators who have worked with students and gradulators
Graduators' rate	(E ₂)	calculated by reporting the number of graduates to the number of those admitted
Students' selection	(E ₃)	calculated by report between the number of those admitted in the higher education establishment and the total number of candidates
The number of students per teacher	(E ₄)	calculated by report between the number of students and the number of teachers
The existence of didactic areas related to the specifics of the area	(E ₅)	calculated by report between the space surface for didactic activities expressed in m ² and the number of student at ordinary education.
Owned market share	(E ₆)	it can be calculated at local and/or national levels
The number of research contracts signed with representatives of the business area	(E ₇)	graded depending on the period of time

Internal structure indicators – are necessary for the management of the company in order to notice the registered progress and to initiate corrective actions when needed. Such indicators may be:

Table 2. Internal structure indicators

Indicator	Symbol	Comments
Investments in the data processing systems	(I ₁)	The informational system plays an important role in obtaining the necessary information, helping in identifying the origin of any further problem.
The percentage of the number of jobs filled in with right-holder.	(I ₂)	Calculated by report between the number of right-holders and the number of available didactic jobs.
The structure of didactic jobs of professors	(I ₃)	
The proportion of the auxiliary personnel	(I ₄)	The inverse of this indicator is the specialists' proportion.
Employees attitude towards the workplace	(I ₅)	The employees' attitude towards the institution can be measured in the same way as customers' attitude.
Personnel fluctuation	(I ₆)	The smaller the fluctuation is, the more efficient.
"Beginners'" rate	(I ₇)	Beginners will be considered the persons having seniority in office of less than 3 years.
A balanced allocation on income sources	(I ₈)	The way of allocating will be determined on three sources: study, research and other activities fees.

Development perspective – answers the question “Can the institution create, on long term, value and improve it?”

Table 3. Development indicators

Indicator	Symbol	Comments
The percentage of professors-leaders in ScD./PhD. Thesis of the total of professors	(D ₁)	It will be appreciated by grades
Investments made for personnel basic and advanced vocational training	(D ₂)	The money invested for participation at conferences, seminars, libraries' supply, etc
International collaborations intensity	(D ₃)	Takes into account both the visits to/from abroad and research contracts
Necessary instruments for the implementation of the requests provided by the Bologna process	(D ₄)	It is about a basic implementation and not one of form, which has already been realized

The indicators presented above are not restrictive but they can be further completed and improved, the authors mainly trying to emphasize their structure. [3]

The second stage of the proposed methodology obviously becomes the choice of the institutions with which the comparison will made. In the present paper the authors have chosen in order to verify the model the next universities: „Spiru Haret” University, „Dimitrie Cantemir” University, Maritime University, „Ovidius” University, „Gaudeamus” University.

The third stage. ROMPEDET method application – ROMPEDET = Romanian Model of Performance Determination.

This is a Romanian model for determining the performance; the model has been invented by Prof. Univ. Dr. Ion Stancioiu in order to appreciate the quality level of a variant in comparison with the others and applied by the authors for higher education, in order to evaluate the quality levels of Romanian universities.

The ROMPEDET method, compared with ELECTRE, Combinex and KT methods that present serious inconveniences regarding the credibility of the conclusions they reach, does not allow the subjectivity of the appreciation of quality and technical levels. Therefore, performance H_i of a variant V_i ($i = 1, 2, \dots, m$) can be obtained by adopting variant V_{k_i} as a basis and reporting it to its characteristics of variant V_i , taking into account the importance of each and every characteristic, according to the formula:

$$H_i = a \prod_{j \in S_1} \left(\frac{x_{ij}}{x_{kj}} \right)^{y_j} \cdot \prod_{j \in S_2} \left(\frac{x_{kj}}{x_{ij}} \right)^{y_j} \quad (1)$$

in which:

- a – scale factor (it has been proposed $a=100$ for a more evident differentiation between variants);
- x_{ij} – characteristic values of j of variant V_i ;

- x_{kj} - characteristic values of j of variant V_k ;
- γ_j – the percentage of characteristic j in defining the performance level of H_i ; γ_j is rated as such: $0 \leq \gamma_j \leq 1$; $\sum \gamma_j = 1$.
- S_1 – the subdivision of characteristics which is desirable to have high values for the performance to be higher;
- S_2 – the complementary subdivision of the characteristics which is desirable to have smaller values for the performance to be higher;

If the information about the exploiting costs are missing or the function writing of these costs reported to the characteristics of the products is difficult, the percentage γ_j can be established on the basis of the formula:

$$\gamma_j = \gamma_{j1} = \frac{\sum_{j_2} a_{j_1 j_2}}{\sum_{j_2} \sum_{j_2} a_{j_2 j_2}}; 0 \leq \gamma_j \leq 1; \sum_j \gamma_j = 1; j_1/j_2 = \overline{1, n} \quad (2)$$

in which j_1/j_2 represent the elements of the matrix square $A_{n \times n} = \|a_{j_1 j_2}\|$, having the values:

$$a_{j_1 j_2} = \left\{ \begin{array}{l} 1, C_{j_1} I C_{j_2} \text{ (caracteristica } C_{j_1} \text{ este de egală importanță cu } C_{j_2}) \\ 2, C_{j_1} P C_{j_2} \text{ (caracteristica } C_{j_1} \text{ este mai importantă decât } C_{j_2}) \\ 4, C_{j_1} P P C_{j_2} \text{ (caracteristica } C_{j_1} \text{ este mult mai importantă decât } C_{j_2}) \\ 0, \text{ în rest} \end{array} \right\} \quad (3)$$

where: I represents logic operator of indifference, and P logic operator of preference. [3]

For establishing the preference matrix A which represents the basis of applying the (2) formula, it is recommended the hierarchy of indicators presented above and grouped in three categories, as follows:

		External Structure Indicators							Internal Structure Indicators								Development Indicators				Grades	γ_j
		E ₁	E ₂	E ₃	E ₄	E ₅	E ₆	E ₇	I ₁	I ₂	I ₃	I ₄	I ₅	I ₆	I ₇	I ₈	D ₁	D ₂	D ₃	D ₄		
External Structure Indicators	E ₁	1	2	1	4	2	0	2	1	2	4	2	0	1	0	2	2	0	4	0	30	0,063
	E ₂	0	1	1	2	4	0	1	2	4	0	1	2	4	0	1	2	4	0	1	30	0,063
	E ₃	1	0	1	0	1	2	4	0	1	2	4	0	1	2	4	0	1	2	4	30	0,063
	E ₄	0	0	2	1	0	1	2	4	0	1	2	4	0	1	2	4	0	1	2	27	0,057
	E ₅	0	0	0	2	1	2	4	0	1	2	4	0	2	4	0	1	2	1	4	30	0,063
	E ₆	4	2	0	0	0	1	2	4	0	1	2	4	0	1	2	4	0	1	2	30	0,063
	E ₇	0	0	0	0	0		1	2	4	0	1	2	4	0	1	2	4	0	1	22	0,046
Internal Structure Indicators	I ₁	1	0	4	0	2	0		1	0	1	2	4	0	1	2	4	0	1	2	25	0,053
	I ₂	0	2	1	4	1	4	0	2	1	2	4	0	1	2	4	0	1	2	4	35	0,074
	I ₃	0	4	0	1	0	1	2	1	0	1	4	2	0	1	2	4	0	1	2	26	0,055
	I ₄	0	1	0	0	0	0	1	0	0	0	1	1	2	4	0	1	2	4	0	17	0,036
	I ₅	2	0	2	0	4	0	0	0	2	0	1	1	4	0	1	2	4	0	1	24	0,051
	I ₆	1	0	1	2	0	2	0	4	1	2	0	0	1	1	2	4	0	1	2	24	0,051
	I ₇	2	2	0	1	0	1	4	1	1	1	0	2	1	1	4	1	0	2	4	28	0,059
	I ₈	0	1	0	0	2	0	1	0	0	0	4	1	0	0	1	1	2	4	0	17	0,036
Development Indicators	D ₁	0	0	4	0	1	0	0	0	2	0	1	0	0	1		1	0	1	2	13	0,027
	D ₂	2	0	1	4	0	2	0	4	1	2	0	0	2	2	0	4	1	2	4	31	0,065
	D ₃	0	4	0	1	1	1	2	1	0	4	1	0	0	1	0	1	0	1	2	20	0,042
	D ₄	4	1	0	0	0	0	1	0	0	0	4	1	0	0	4	0	0	0	1	16	0,034
																					475	1,000

Table 4. Results of model application

Nr. crt.	X	Indicatorii structurii externe							Indicatorii structurii interne								Indicatori de dezvoltare				H
		E1	E2	E3	E4	E5	E6	E7	I1	I2	I3	I4	I5	I6	I7	I8	D1	D2	D3	D4	
		note	%	%	nr.	mp/student zi	% local	nr./cadru	um/cadru	%	%	%	%	note	%	%	note	%	um. / cadru did.	vizite/ cadru did.	
1.	Univ. "Spiru Haret" Constanța	0,750	0,000	0,000	0,000	1,000	1,000	0,500	1,000	1,000	1,000	1,000	0,833	0,956	0,250	0,667	0,000	0,900	0,000	1,000	635
2	Univ. "D. Cantemir" Constanța	0,250	0,545	0,000	0,300	0,667	0,321	0,250	0,200	0,250	0,714	0,714	0,500	0,217	0,750	0,500	0,000	0,400	0,111	0,200	371
3	Univ. de Marină Constanța	0,500	0,091	0,500	1,000	0,867	0,464	0,250	0,500	0,583	0,714	0,714	0,833	0,867	1,000	0,833	0,000	0,600	0,111	0,400	587
4	Univ. "Ovidius" Constanța	1,000	1,000	1,000	0,677	1,800	0,893	1,000	0,500	0,917	0,000	0,000	1,000	1,000	0,000	1,000	1,000	1,000	1,000	1,000	844
5	Univ. "Gaudeamus" Constanța	0,000	0,318	0,000	0,333	0,000	0,000	0,000	0,000	0,000	0,714	0,714	0,000	0,000	1,000	0,000	0,000	0,000	0,000	0,000	163
Criterii		Max	Max	min	min	Max	Max	Max	Max	Max	Max	min	Max	min	min	Max	Max	Max	Max	Max	

Global indicator of quality H_i , for each analyzed university, can be determined following the application of this percentage on the previously determined indicators.

Conclusions:

The present methodology is part of an attempt to create an important methodology-managerial instrument for any higher education establishment manager. Using this managerial tool, they can periodically evaluate the institution they are managing and to interfere in those indicators with high percentage in order to raise the general quality level of the institution.

The proposal of the authors has the advantage of being easily applied for any university and periodical and comparative assessment is a criterion for appreciation of managerial capacities. The flexibility of the method allows the replacement and modification of the indicators in order to be permanently up-to-date to the requests of the national regulatory institutions (ARACIS in Romania).

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