5 PART FIVE. NHES' ANALYSIS AND CORRELATION TOOLS

The mission of the Romanian Agency for Quality Assurance in Higher Education (ARACIS) is to conduct external quality assessment of education provided by higher education institutions and other organizations providing studies programs of higher education and operating in Romania in order to:

- test the ability of the institutions providing education to meet the expectations of beneficiaries;
- contribute to the development of an institutional culture of quality in higher education;
- protect the direct beneficiaries of curricula of higher education through the production and dissemination of systematic, coherent and credible, publicly accessible information about the quality of education;
- propose to the Ministry of Education and Scientific Research (MECS) strategies and policies intended to permanently improve the quality of higher education, closely correlated to pre-university education.

ARACIS operates based on best international practices, which are taken, developed and customized in its own Methodology and their implementation is intended for both the evaluation and quality assurance in higher education in Romania as part of the European Higher Education Area (EHEA).

For the most part, the assessment activities and services currently provided by ARACIS are quality ***observation and analysis tools*** for the National Higher Education System (NHES), as it results from its mission. In order to provide a coherent overview of the NHES and to have insight into the medium and long term, ARACIS must look beyond these activities and services and develop new ***analysis and correlation tools.***



Figure 1 The basic components in the analysis and correlation of NHES

In this regard, it is necessary to identify, quantify and analyse in a logical sequence all NHES components, namely the indicators of university offer, the demand in the system, its processes and results. (*Figure 1*)

It is well known that an activity can be ***optimized*** only if it can be quantified and correlated with all the activities which it interacts with, and to this end, ***analysis and correlation tools*** are developed. As a result, within the Project QUALITAS, the following analysis and correlation tools were designed and developed:

A. The matrix of *University Offer* (education and enrollment offer) on fields/ specialties[93] at NHES level – MO^{NHES}
B. The matrix of Demand (entries/students enrolled in the first year) on fields/ specialties at NHES level – MD^{NHES}
C. The matrix of Total of Students on fields/specialties at NHES level – MTS^{NHES}
D. The matrix of Academic Staff on fields/specialties at NHES level – MAS^{NHES}
E. The matrix of Teaching Positions (according to the list of positions) on fields/ specialties at NHES level – MTP^{NHES}
F. The matrix of Alumni on fields/specialties at NHES level – MA^{NHES}

Conceptual clarifications:

- ✓ To better understand the purpose of this analysis tool we must make a clear distinction between matrices and indicators. Indicators provide statistical information on the level reached by a variable; the matrix is obtained by comparing/correlating two or more indicators over time and space.
- ✓ The indicators are generated by counting; the matrix is generated by analysis.
- ✓ The optimal matrix is SMART, i.e. Specific, Measurable, Attainable, Repeatable and Time-dependent.

Through a logical and sequential comparison of the matrices shown, we obtain other matrices having a character of relative sizes of intensity, so that:

G. *The matrix of coverage degree of the Offer by Demand* on fields/specialties at NHES level – $MCDOD^{NHES}$, obtained as ratio in percentage share between MD^{NHES} (The Matrix of Demand) and MO^{NHES} (The Matrix of Offer);

Constitutive equation: $$MCDOD^{SNIS} = \frac{MD^{NHES}}{MO^{NHES}} * 100 \qquad (1)$$

[93] *Study programs*

H. *The matrix of Ratio between the Total of students and Academic Staff* on fields/specialties at NHES level – $MTSAD^{NHES}$, obtained as ratio between MTS^{NHES} (The matrix of Total of Students) and MAS^{NHES} (The matrix of Academic Staff);

Constitutive equation: $$MTSAD^{NHES} = \frac{MTS^{NHES}}{MAS^{NHES}} \quad (2)$$

I. *The matrix of coverage degree of Teaching Positions by Academic Staff* on fields/specialties at NHES level – $MCDTPAS^{NHES}$, obtained as ratio between MTP^{NHES} (The matrix of Teaching Positions) and MAS^{NHES} (The matrix of Academic Staff);

Constitutive equation: $$MCDTPAS^{NHES} = \frac{MPD^{NHES}}{MCD^{NHES}} \quad (3)$$

J. *The matrix of Graduation Rate* on fields/specialties at NHES level – MGR^{NHES}, obtained as ratio in percentage share between MA^{NHES} (The Matrix of Alumni) and MD^{NHES} (The matrix of Demand of Students in the same year).

Constitutive equation: $$MGR^{SNIS} = \frac{MA^{NHES}}{MD^{NHES}} * 100 \quad (4)$$

These matrices are drawn separately at the level of Bachelor programs, master and doctoral fields and can be easily generated using computer tools such as Excel.

5.1 The elements and the layout of the matrices

The NHES matrices are based on correlation table method, a double-entry table representing a particular form of a combined group. Using the table of correlation, depending on the distribution of frequencies, we obtain information on the size and distribution of the indicators entered by the two variables (A, B).

The variables that form the matrix are:

Variable A. The nomenclature of fields and specialities/study programs for Bachelor's degree / master / doctorate (source: *GD published annually in the Official Gazette of Romania*).

Variable B. Size/level of the indicator recorded in each Higher Education Institution (HEI) – depending on the type of matrix, as follows:

B.1. in the matrix of MO^{NHES} *Offer* – represented by the maximum number of students that can be enrolled in higher education institutions (the schooling capacity) (source: GD Annex no.2[94])

B.2. in the matrix of MD^{NHES} *Demand* – represented by the number of students enrolled in the first academic year in each study program of higher education institutions (source: HEI, ARACIS, MECS)

B.3. in the matrix of MTS^{NHES} *Total of Students on fields/specialties* – total number of students on each specialization over the total cycle/period of study (source: HEI, ARACIS, MECS)

B.4. in the matrix of MAS^{NHES} *Academic staff on fields/specialties* – the number of teachers on each specialization over the total cycle/period of study (source: HEI, ARACIS, MECS).

B.5. in the matrix of MTP^{NHES} *Teaching positions* (from the List of positions) on fields/specialties at NHES level – the number of teaching positions from full-time and distance learning study programs (source: HEI, ARACIS, MECS).

B.6. in the matrix of MA^{NHES} *Total of Alumni on fields/specialties* – the total number of graduates in each specialty (source: HEI, ARACIS, MECS).

By combining variable A and variable B.1., it results the matrix of education and enrollment Offer on Bachelor fields/specialties at NHES level – $MO^{NHES}_{Bachelor}$ (Table 1.)

[94] *Annex no.2. OG 527/16.VII.2014 The structure of higher education institutions, the areas of Bachelor programs study and specializations/study programs accredited or authorized to function temporarily, geographical locations of deployment, the number of transferable credits for each academic program, education form and language of teaching, as well as the maximum number of students that can be enrolled in the academic year 2014-2015*

Table 1. **The matrix of education and enrollment Offer on Bachelor fields/specialties at NHES level** – $MO^{NHES}_{Bachelor}$

A. The nomenclature of fields and specialties/study programs for Bachelor's degree – *Annex no. 1 OG*					**B.1. Structure of HEI - *Annex no.2 OG***						**Total Offer 1st year on study programs/ fields**
Code DFI	**Fundamental Field (FFI)**	**Bachelor Field (BF)**	**Specialties/study programs for Bachelor's degree (S)**	**Number of credits (ECTS)**	**The maximum number of students that can be enrolled in the first year of study in state/private HEIs in year…. (O)**						
					Univ. 1	**Univ. 2**	**…**	**Univ. j**	**…**	**Univ. z**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	12
10	Mathematics and Natural Sciences	BF_1^{1D}	S_1^{1D}		O_{11}^{1D}	O_{12}^{1D}	…	O_{1j}^{1D}	…	O_{1z}^{1D}	$\sum_{i=1}^{z} O_{1.}^{1D}$
			S_2^{1D}		O_{21}^{1D}	O_{22}^{1D}	…	O_{2j}^{1D}	…	O_{2z}^{1D}	$\sum_{i=1}^{z} O_{2.}^{1D}$
		…	…	…	…	…	…	…	…	…	…
		…	S_i^{1D}		O_{i1}^{1D}	O_{i2}^{1D}	…	O_{ij}^{1D}	…	O_{iz}^{1D}	$\sum_{i=1}^{z} O_{i.}^{1D}$
		…	…	…	…	…	…	…	…	…	…
		BF_n^{1D}	S_r^{1D}		O_{r1}^{1D}	O_{r2}^{1D}	…	O_{rj}^{1D}	…	O_{rz}^{1D}	$\sum_{i=1}^{z} O_{r.}^{1D}$
Total offer 1st year FFI 10		$\sum_{y=1}^{n} BF_y^{10}$	$\sum_{r=1}^{n} S_r^{10}$	-	$\sum_{f=1}^{r} O_{.1}^{10}$	$\sum_{f=1}^{r} O_{.2}^{10}$	…	$\sum_{f=1}^{r} O_{.j}^{10}$	…	$\sum_{f=1}^{r} O_{.z}^{10}$	$\sum_{i=1}^{z}\sum_{f=1}^{r} O_{if}^{10}$
20	Engineering sciences										
30	Biological and biomedical sciences										
40	Social sciences										
50	Humanities and arts										
60	Sports and Physical Education										
Total offer 1st year NHES					$\sum_{x=1}^{FFIx} O_{x1}^{FFI}$	$\sum_{x=1}^{FFIx} O_{x2}^{FFI}$	…	$\sum_{x=1}^{FFIx} O_{xj}^{FFI}$	…	$\sum_{x=1}^{FFIx} O_{xz}^{FFI}$	$\sum_{x=1}^{FFIx}\sum_{x=1}^{z} O_{xz}^{FFI}$

Where:

O_{ij}^{FFI} – *The maximum number of students that can be enrolled in the first year of study in the fundamental field "FFI" on specialty "i" by institution "j".*

i – specialty;

j – university / higher education institutions;

x – number of fundamental fields;

y – number of Bachelor fields in FFI;

r – number of specialties;

z – numbers of HEIs.

The symbolism of colours:

Information taken from the Nomenclature of fields and specialties/ undergraduate degree programs – HG

Information taken from the structure of HEI (MECS, ARACIS or HEI)

Size of the obtained indicator

In the same matricial structure, the other indicators of variable B can be integrated, forming the other matrices, so that:

B.2. in the matrix of MD^{NHES} *Demand* on fields/specialties at NHES level – the indicator is denoted by ST_{ij}^{FFI} and represents *the maximum number of students that can be enrolled in the first year of study in the fundamental field "FFI" on specialty "i" by institution "j".*

Depending on the source of financing, they can be: students financed by the state budget[95] and students paying a tuition fee.

B.3. in the matrix of MTS^{NHES} *Total of Students* on fields/specialties – the indicator is denoted by TS_{ij}^{DFI} and represents *the total number of students at specialty levels throughout the study period (3 years-6 years) on higher education institutions in the fundamental field "FFI" on specialty "i" by institution "j".*

B.4. in the matrix of MAS^{NHES} *Academic stuff* on fields/specialties – the indicator is denoted by CD_{ij}^{DFI} and represents *the total number of teachers at specialty levels throughout the study period on higher education institutions in the fundamental field "FFI" on specialty "i" by institution "j".*

Depending on the form of employment, the teachers can be full-time professors or associates.

B.5. in the matrix of MTP^{NHES} *Teaching positions* (from the List of positions) on fields/specialties – the indicator is denoted by TP_{ij}^{FFI} – *the number of teaching position on higher education institutions in the fundamental field "FFI" on specialty "i" by institution "j".*

Depending on the form of education, we have the list of positions in full-time study (FTS), low frequency (LF) and distance learning (DL).

B.6. in the matrix of MA^{NHES} *Total of alumni* on fields/specialties – the indicator is denoted by TA_{ij}^{DFI} – *the total number of graduates at specialty level on higher education institutions in the fundamental field "FFI" on specialty "i" by institution "j".*

[95] *The tuition figure from the budget*

5.2 Types of outcome indicators

The analysis of matrices results in the following types of indicators:

- ✓ *quantitative* – when measuring certain values;
- ✓ *qualitative* – when granting a score (e.g. efficient / completely inefficient);
- ✓ *threshold* – when an indicator/index reaches the values previously established falls under the minimum and maximum limits;
- ✓ *milestone* – when it comes to a specific condition (European regulated or by specialized forums).

For example, the analysis of *indicators*[96] from the 6 basic matrices results a series of indicators obtained as relative measures of the structure, determined both in line and on column.

Table 2. Indicators obtained on column:

No.	Indicator	Significance
1	Structure of *indicator "x"* on fundamental domains (FFI) %	Structure of *indicator "x"* on fundamental domains (FFI) out of total NHES Offer
2	Structure of *indicator "x"* on Bachelor fields (BF) %	Structure of *indicator "x"* on Bachelor fields (BF) out of total FFI Offer
3	Structure of *indicator "x"* on Bachelor specialties/study programs %	Structure of *indicator "x"* on Bachelor specialties/study programs out of total Bachelor fields
4	Structure of *indicator "x"* depending on period of study / credit numbers %	Structure of *indicator "x"* depending on period of study out of total NHES Offer
5	Structure of *indicator "x"* on study programs in foreign languages % (Annex 3)	Structure of *indicator "x"* on study programs in foreign languages out of total NHES Offer

Table 3. Indicators obtained in line:

No.	Indicator	Significance
1	The share of *indicator "x"* of FFI on universities	The share of *indicator "x"* of FFI from university j out of total university offer
2	The share of *indicator "x"* on study programs on universities	The share of *indicator "x"* on study program from university j out of total offer of study programs
3	The share of *indicator "x"* by forms of ownership	The share of *indicator "x"* on study programs depending on forms of ownership
4	The share of *indicator "x"* on development areas (Annex 4)	The share of *indicator "x"* on study programs depending on development areas

[96] *Indicators "x" existing in the 6 basic matrix are:* O_{ij}^{DFI}, ST_{ij}^{DFI}, TS_{ij}^{DFI}, AS_{ij}^{DFI}, TP_{ij}^{DFI} *și* TA_{ij}^{DFI}

5.3 The usefulness of matrices

The volume of statistical information resulting from NHES matrices and the ease of processing data leads us to state that the implementation of these matrices is necessary as it would become a useful tool for MECS, ARACIS and each HEI by:

- **indicating the degree to which the objectives are achieved** (according to the National Strategy for tertiary education in Romania 2015 – 2020 MECS);
- **creating the premises to optimize the offer** at NHES level in correlation with the National Strategy for tertiary education in Romania;
- **developing specific tools for HEI/faculties/ departments** which establish educational policies for **optimizing the ratio between demand and offer**;
- **improving awareness** on the relationship between customer demand, labour market demand and university offer.

However, with the information provided by the matrices, ARACIS can answer common questions arising in regular evaluations, as for example:

- to what extent the requested schooling capacity is justified by demand of students?
- which is the discrepancy between the institutions, the ratio students/ teachers in the same study program / field?
- to what extent the customer (students) demand is correlated with the education offer?
- which is the distribution of similar fields/study programs by country regions?

The matrices of HES activities, by their complexity, provide ***a complete set of information*** to managerial/leadership structures, regardless of form of ownership of the institution, so that they can make optimal decisions in all situations.

The matrices, by data transparency throughout the system, provide ***a comprehensive overview*** of the vulnerability of HES, which leads to risk reduction and to ***the increase of system efficiency and quality***.

We hope that the management structures of HEIs will become more careful in establishing and optimizing university offer by knowing HES.

We consider that NHES matrices are ***a useful tool*** for MECS, ARACIS and HEIs, as they show the distribution and interdependence of university offer and demand in all existing fields / bachelor degree programs, master and / or doctorate studies.

In order to facilitate transparency and acceptance at all levels of these matrices of analysis and diagnosis, it is recommended that they should be developed ***annually by MECS in collaboration with ARACIS.***