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TOWARDS QUALITY ASSURANCE OF THE STUDY PROCESS USING THE MULTI-CRITERIA DECISION-MAKING METHOD

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Abstract. The article explores in detail higher education studies that appear as one of the essential university processes. University studies are not a new phenomenon; however, they are overwhelmed by the volume of information surrounded by a wide range of diverse stakeholders. Therefore, the university inevitably needs changes in the adequate fulfillment of its mission thus meeting and harmonizing the expectations of different stakeholders of modern society and the state. Therefore, the concept and role of the study process itself in society are changing. The studies considered to be timely and qualitative are becoming a more and more relevant question to universities. Based on the previous scientific analysis of the study process at the university level and a concept of Quality Assurance for university studies formulated by the Bologna Process, the article examines the relationships and importance of the components (criteria) composing the study process at the university level. The article is aimed at revealing the diversity of the study process and at evaluating the importance and significance of the criteria composing it. To achieve this goal, the multi-criteria decision-making method the Analytical Hierarchy Process were invoked. The representatives of two major Lithuanian universities participated in the carried out research the results of which demonstrated that the criteria of the study process were fundamentally different, and some of those were difficult to measure applying quantitative parameters. Despite this circumstance, giving more attention to a combination of criteria for a particular process of university studies creates conditions for purposeful modeling the study process and the pursuit of high-quality university studies.

Keywords: study process; universities; Bologna Process; Multi-Criteria Decision-Making Method; Analytical Hierarchic Process (AHP)

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1. Introduction

Probably there is a little to argue that the performance of higher education institutions and universities in particular, are multidimensional, complex and dynamic in its origin. Surrounded by a large-scale of diverse stakeholders, universities are training and developing a new generation by providing information, teaching, the use of research methods and new knowledge based on the latest scientific achievements. Universities are one of the oldest forms of organization. Despite that fact, the implementation of higher education studies is one of the main operational processes implemented by universities. The need for the high-quality performance of universities is determined by rising competition among them, the aim to improve internal activities and demand from stakeholders to create value for money (Asif & Searcy, 2014; Dalati & Al Hamwi, 2016; Oganisjana *et al.* 2017).

That is why such questions as 'what studies at the university level can be considered as high-quality' and 'how to assess whether the studies at the university level are of high-quality' are extremely relevant in the context of contemporary global higher education.

In the ancient Greek, the term 'arête' meant perfection. Aristotle argued that the distinctive quality of a knife was its sharpness. It follows that the main purpose of the knife is to cut, and thus a good knife should be the one cutting well. Following this idea, we are trying to find out the "arête" of the studies at the university level.

The article is aimed at analysing the process of the studies at the university level from a qualitative point of view based on the principles of the internal quality assurance of higher education developed by the European Higher Education Area using multi-criteria assessment research methods.

The study process at the University consists of many entirely different elements. Study programmes, learning outcomes, a necessity of human and material resources, infrastructure, international mobility for students and career planning opportunities should be only a few points in the long list. During the process, a large number of different types of information from student admission conditions to their satisfaction with studies, alumni activities and monitoring a professional career path of graduates are available. The process involves a wide range of different stakeholders, including students, lecturers, university administration, business and employers. It should be noted that the above listed social stakeholders have different expectations and understanding of what kind of the studies at the university level are qualitative. To sum up, the complexity of the prior listed elements determines a specific model for the studies at the university level discussed in this research.

The analysis of the study process at the university level was based on the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG) (ENQA, 2015). The frame mentioned above enabled to select, structure and analyse different components of the study process, more specifically, criteria. A review of multi-criteria decision-making assessment methods revealed they could be applied for examining social phenomena or constructs. The article referred to the analytical hierarchy method (AHP) (Saaty, 1994) and the detailed analysis of the study process at the university level the matrixes of the criteria of which had been developed according to the AHP methodology. The assessment involved the participation of the representatives of two largest Lithuanian universities.

The analysed research results revealed that the criteria for the study process at the university-level were different concerning their nature and a degree of complexity. Some of them are difficult to measure employing quantitative parameters. The compatibility of expert opinions with the analyzed phenomenon was difficult to reach. Nevertheless, the results of the carried out research allow forming a model of the criteria for the study process at the university level, which can be useful for university policymakers by modelling the study process in the best possible way, satisfying the expectations of social stakeholders and striving for the highest quality of the studies at the university level.

The article is organized as follows. The first part provides the theoretical background of the quality of the studies at the university level. The second part presents the study process modeled for the university according to the standards and guidelines for ESG. The criteria for the study process have been compiled and grouped. The third

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part describes research results obtained applying the multi-criteria assessment method and suggests conclusions and insights for further research.

2. Theoretical Discussion: the Study Process and its Quality at the University Level

In the past decades, the study process at the university level has been widely discussed and studies considering various aspects by scientists worldwide analyzed. In 2010, the Agency for Quality Assurance in Higher Education in Greece conducted the study for determining the importance of the criteria for measuring the quality of higher education (Tsinidou, Gerogiannis, & Fitsilis, 2010). This research and other works (Law, 2010), (Narang, 2012), (Ardi, Hidayatno, & Zagloel, 2012) analysed the significance of the criteria for the study process at the university level from student perspective. Also, research papers exploring the ways of how to integrate students into the quality assurance procedures of the higher education institution (Elassy, 2013), (Elassy, 2015), quality improvement (Poole, 2010), the role of academic staff in internal quality assurance in higher education in Georgia (Shurgaia & Shurgaia, 2015), the national accreditation policy and quality assurance in higher education in Egypt (Schomaker, 2015), the effect of quality and quality assurance on private higher education institutions in China (Cao & Li, 2014) have been reviewed. Other works made attempts to develop and substantiate the quality management model for higher education services at the universities in Japan (Sultan & Wong, 2010), to analyse the relationship between university autonomy and control over quality management (Beerkens, 2011), external evaluation and university transformation in Finland (Haapakorpi, 2011) and process management (Kettunen, 2012). Another area covered research analysing student satisfaction, more precisely differences between student initial expectations and real experience during the studies at the university (Arif, Ilyas, & Hameed, 2013). The studies of the expectations of different social stakeholders into the quality of higher education were made by Sandmaung *et al* (2013) (Sandmaung & Khang, 2013). The empirical analysis of the relationship between quality culture and work efficiency in higher education institutions was performed by (Ali & Musah, 2012).

Quality assurance is a continuous evaluation process that involves assessing (monitoring, assurance, maintenance, improvement) a university as an institution, a university unit or a study programme. In these cases, the focus is switched on two aspects: accountability and improvement. The procedure provides data and information on decisions regarding the setup process and the assessment of the set criteria. Quality assurance can be either internal (set and developed by the institution) or external (initiated by the association or quality assurance agency), particularly in the cases where it is considered as a prerequisite for the institution to receive funding, to be accredited or to obtain or pursue its activities (Vlăsceanu, Grünberg, & Pârlea, 2007).

A review of research papers devoted to this area emphasizes the significance and relevance of the subject throughout the world. Nevertheless, there is not much scientific material that comprehensively and empirically analyses the process of higher education at the university level as a whole. This work refers to the concept assuring study quality as the central axis for measuring and evaluating the quality of higher education at the university level. The concept of quality assurance in higher education is under development by the European Bologna Process for the second decade. The European Standards and Guidelines for Quality Assurance in Higher Education (ESG) can be considered as a comprehensive instrument for assisting universities with ensuring the quality of studies they provide (ENQA, 2015). The latest ESG version released in 2015 defines the internal quality assurance of the studies at the university level in the following parts (Table 1):

Table 1. Internal quality assurance of university studies based on ESG provisions (*Source:* compiled by the authors and based on ESG provisions)

Chapter	Description	Key terms
1. Policy on quality assurance	Universities should have a publicly available quality assurance policy as a part of its strategic management.	Quality assurance Continuous improvement

	Internal stakeholders should develop and implement this policy through the established structures and processes, including external social actors	Accountability Quality culture Stakeholders Processes
2. Design and approval of study programmes	Universities should follow the process of developing and validating study programmes that should be designed in such a way that they could achieve their objectives, including the intended learning outcomes. The qualifications provided by the programme should be clear, communicated and in line with the level of the defined national qualification framework as well as with the level of qualifications of the European Higher Education Area	Study programmes Learning outcomes Study workload Approval of study programmes
3. Student-centered learning, teaching and assessment	Universities should ensure that study programmes are conducted in a way that encourages students to take an active role in the learning process while the conducted student assessment reflects this approach	Students motivation Reflection Flexible learning paths Variety of teaching methods Self-studies (individual learning) Student appeal procedures
4. Student admission, progression, recognition and certification	Universities should prepare and publish rules covering all stages of the student cycle such as admission, the regulation of the learning path during the study, recognition, certification	Student admission (enrolment conditions) Introduction to studies and a study programme Progression Mobility Recognition and certification
5. Teaching staff	Universities should take care of their teacher competencies and should have a fair and transparent process of recruiting and improving their competences	Suitable teaching environment Competent teachers Transparency
6. Learning resources and student support	Universities should have adequate funding to provide teaching and learning activities and easily accessible learning resources and facilities	Library IT infrastructure (resources) Mentors Providing information
7. Information management	Universities should ensure the collection, analysis and use of appropriate information for the effective management of their programs and other activities	Data collection Suitable indicators Student data Student satisfaction with studies Drop-out rates Career opportunities for graduates
8. Public information	Universities must make public information about their activities, including programmes, in a clear, objective, timely and easily accessible way	
9. On-going monitoring and a periodic review of programmes	Universities should periodically monitor and review their study programmes in order to ensure that they meet the set goals and student and society needs. The reviews should help with further improvement in the programmes. Any planned or performed action should be communicated publicly	Content of study programmes Changing needs of society Student workload Progression Recognition and certification Effectiveness of student evaluation Student expectations, needs and satisfaction with a study programme Learning environment
10. Cyclical external quality assurance	Universities should carry out periodical external quality assurance according to the ESG standards and guidelines	Ensuring the implementation of improvement after the external evaluation of the programme

Table 1 reveals the complexity of the quality assurance of the study process. It is composed of 10 chapters with nearly 40 key terms to describe the scope. The majority of research papers that has been analysed during this

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research evaluates or analyses one or only few components of this complex process. In order to analyse the whole process, we continued our research towards the direction proposed by the ESG.

3. Research Methodology

As mentioned by Mazurek and Perzina, (2017) pairwise comparison as a tool for decision making or measurement was considered in the works by Franciscan tertiary Ramon Llull (1275) or Marquis de Condorcet (1785). For the first time, the theory of pairwise comparison was provided by L. L. Thurstone in 1927. The methods of pairwise comparison were often criticized as too sophisticated; however, they had an excellent mathematical basis. Since early 1980s, pairwise comparison has become the central point of the analytic hierarchy process (AHP) and the analytic network process (ANP) introduced by T. L. Saaty along with his fundamental scale for pairwise comparison ranging from 1 to 9 (Saaty, 1980, 1990 and 2008). The AHP/ANP proved to be a useful tool in many areas of human action involving multiple criteria decision making such as economics, management and marketing, construction, medicine, politics, environmental protection, etc. An overview of AHP applications can be found in a number of works (for references see, e.g. (Mazurek & Perzina, 2017).

Multi-criteria assessment methods were used by the scientists for solving complex phenomena and decision-making. The choice of the AHP method was also determined by its universal characteristics compared to other multi-criteria assessment methods.
The advantages of the AHP method are as follows (Poškas, Poškas, Sirvydas, & Šimonis, 2012),:

- arithmetic mean is used for group decision-making,
- the structure of the task is hierarchical,
- assures the compatibility of the estimates,
- quantifies qualitative criteria (indicators),
- uses different dimensional criteria,
- the method is of medium complexity,
- requires the average (medium) labour cost in its application.

This work uses the AHP (Analytic Hierarchy Process) for evaluating the significance of the criteria and is based on the expert-filled dual matrix comparison. This method was described by T. Saaty in 1980 (Saaty, 1980). The choice of the method is conditioned by the fact that the significance of the indicator shows the expert opinion on the importance of the indicator for choosing the best alternative from the list of the alternatives under consideration. The components are hierarchically structured depending on their importance (Saaty, 1993). The more depth an expert puts into the analyzed system, the more accurate the forecasts and decisions will be. The theory of the method is based on human thinking. Faced with most of the controlled and uncontrolled elements that make up a difficult situation, the human mind attributes them to groups. The hierarchical system is developed to make a decision and involves several levels each of which is made of corresponding elements, i.e. criteria. Due to an uneven effect of the criteria, there was a need to determine the intensity of the impact and the importance of the criteria also known as weighting the criteria reflecting the opinion of expert evaluators on the importance of the criteria in comparison with other criteria (Lin, 2010; Nukala et al., 2005; Yang and Shia, 2002).

Succeeding the analysis of the papers devoted to the concept of quality assurance described in the theoretical part and in order to analyse the study process at the university level in a more detailed way from the qualitative approach, the following methodology has been chosen. At the first stage of the research, a questionnaire of pairwise criteria for the study process at the university level was prepared, which was done taking into account the concept of the quality assurance of internal studies according to ESG and the analysis of multi-criteria evaluation methods. The criteria for the study process at the university level I_j, $j = 1,...,30$ were divided into thematic groups D_m, $m = 1, ..., 7$ each of which comprised 3 to 5 criteria.

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Conducting a precise assessment of the quality assurance system at the university level is necessary for determining the significance of the components of the quality assurance system of the study process and criteria that make up them (Table 2). A set of the specific criteria describing the significance of the thematic group will reveal its importance, i.e. how much the criteria are higher or lower compared with other criteria.

Table 2. The specification of the content of the areas of the quality assurance system (thematic groups) and criteria (sub-factors) of the study process (*Source*: compiled by the authors)

Areas (thematic groups)		Criteria (sub-factors)	
Quality assurance policy	D_1	• continuous improvement • quality culture • accountability • stakeholders	I_1 I_2 I_3 I_4
Study programmes	D_2	• learning outcomes • student workload • institutional approval • monitoring and supervision • changes in external expertise	I_5 I_6 I_7 I_8 I_9
Students	D_3	• motivation, reflection • flexible learning paths • variety of pedagogical methods • independent learning • procedures for student complaints	I_{10} I_{11} I_{12} I_{13} I_{14}
Conditions for studies	D_4	• student admission • introduction to the programme • student progression • mobility • student certification	I_{15} I_{16} I_{17} I_{18} I_{19}
Teachers	D_5	• supportive environment • competent teachers • transparent recruitment	I_{20} I_{21} I_{22}
Study resources	D_6	• library • IT infrastructure • human support	I_{23} I_{24} I_{25}
Information	D_7	• relevant indicators • timely data • student satisfaction • drop-out rates • career paths	I_{26} I_{27} I_{28} I_{29} I_{30}

As for the second part of the research, the survey of experts E_k, k = 1, ..., 10 was conducted in February-May 2018. The experts from two largest universities in Lithuania, including Vilnius University (VU) and Vilnius Gediminas Technical University (VGTU), participated in the performed examination. The selected experts were university representatives holding a doctorate degree and having academic and administrative experience at the university. The expert group consisted of the present and former Deans and Vice-Deans of the faculties, Professors and the Heads of study programmes. The participants were professionals in their fields and developed and implemented the study process at the universities their represented. For expert selection, gender equality was taken into consideration.

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Following the research question, the experts were asked to evaluate the importance of the criteria of the study process, but not asked to evaluate the quality of the study process in the universities their represent.
The systematization and analysis of the collected data using the AHP method was performed in the third part of the research measuring the compatibility of expert opinions and calculating the weights of the criteria composing the study process at the university level.

4. The Application of the AHP Method for Assessing Criteria for the Study Process at the University Level

Let us recall that E_k, k = 1, ..., 10 denotes the kth expert. In addition, D_m, m = 1, ..., 7 and I_j, j = 1,...,30 denote the mth area and the jth criterion (see Table 2) accordingly. As it is mentioned above, to make a decision on the order of the priorities of criterion I_j in areas D_m, the AHP method (Satty, 2008) is used. The point of the method is the pairwise comparison of criterion I_j that is performed by each expert E_k separately in all areas D_m. To make a comparison, experts need a scale of the numbers indicating how many times one more important or dominant criterion is over another with respect to the property they are compared. Table 3 indicates the scale proposed by Satty (1980).

Table 3. The fundamental scale of absolute numbers (*Source:* Satty, 2008)

Intensity of importance	Definition	Explanation
1	Equal importance	Two criteria contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favour one criterion over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one criterion over another
6	Strong plus	
7	Very strong or demonstrated importance	A criterion is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one criterion over another is of the highest possible order of affirmation

Let's assume that w is the intensity of importance. Using Table 3, an expert constructs the tables of pairwise comparison. The criteria in the rows are compared with those in the columns. If a criterion in the row is more important than the one in the column, then, the corresponding cell is filled by number w. In another case, the expert uses the inverse intensity of importance, i.e., $1/w$. If criteria are of equal importance, then, the cell is filled by number 1. As an example see Table 4 representing the pairwise comparison of criteria I_1, I_2, I_3, I_4 (continuous improvement, quality culture, accountability, stakeholders) assigned by expert E_1.

Table 4. The pairwise comparison of criteria I_1, I_2, I_3, I_4 assigned by E_1 (*Source:* compiled by the authors)

D_1	I_1	I_2	I_3	I_4
I_1	1	1/5	3	5
I_2	5	1	9	9
I_3	1/3	1/9	1	3
I_4	1/5	1/9	1/3	1

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According to the opinion of E_1, criteria I_1 and I_3, I_3 and I_4 are of moderate importance, I_1 and I_4 are of moderate plus importance. In addition, E_1 strongly favour I_2 over I_1. Also, the evidence favouring I_2 over I_3 and I_4 is of the highest possible order of affirmation.

According to the same manner, all E_k made decisions on pairwise comparison tables. Every expert made the pairwise comparison of criteria in 7 areas, and therefore 70 pairwise comparison tables were constructed in total. Since all criteria are pairwise compared, the determination of the generalized weight (significance) of the criteria could be performed. Hence, the following sequence (see Table 5) should be implemented.

Table 5. The sequence of the AHP method

1. *To create pairwise comparison matrices* $P_m^{(k)} = (p_{ij}^{(k)})$, *where* p_{ij}, $i, j = 1, ..., n$, *denote the pairwise comparison of* criteria I_i *and* I_j . Recall that k and m denote, respectively, the number of expert E_k, $k = 1, ..., 10$, and area D_m , $m = 1, ..., 7$, where n – the total number of criteria in the relative area, p_{ij} is the ratio of the ith and jth ranks assigned by the kth expert.

   Clearly, the considered instant elements of pairwise comparison matrices are coincident with the elements of pairwise comparison tables.

   Let us note, that $p_{ii}^{(k)} = 1$ and $P_m^{(k)}$ is an inverse symmetrical matrix, i.e. $p_{ij}^{(k)} = 1/p_{ji}^{(k)}$. The number of the non-recurrent elements of the nth-order matrix $P_m^{(k)}$, i.e. the number of the elements compared, is $n(n-1)/2$ (the total number of the elements of the comparison matrix is equal to n^2).

   Hence, for larger n, the task of comparison becomes more tedious and time-consuming. Moreover, as provided by (Mazurek and Perzina 2017), the human brain is capable of processing only up to 7 pieces of information at the same time. This indicates that the more criteria are compared, the more inconsistent these comparisons will be. Nevertheless, the proof for this claim is missing as there are no studies known to the authors investigating the issue.

2. *To ensure the consistency of pairwise comparison matrix* $P_m^{(k)}$. The necessary condition for the consistency of the comparison matrix is the transitivity of the significance of the elements of matrix $P_m^{(k)}$. In the ideal case, the following equalities are satisfied:

   $$P_m^{(k)} q_m^{(k)} = n q_m^{(k)},$$

   where $q_m^{(k)} = (q_{m,1}^{(k)}, ..., q_{m,n}^{(k)})^T$ are an eigenvector of $P_m^{(k)}$. It is a well-known mathematical problem of eigenvalues and eigenvectors:

   $$P_m^{(k)} q_m^{(k)} = \lambda_m^{(k)} q_m^{(k)} , \quad \textbf{(1)}$$

   where $\lambda_m^{(k)} = n$ is an eigenvalue of matrix $P_m^{(k)}$, and n is the number of the criteria to be compared. As mentioned in (Saaty 1980, 1990, 2008; Ginevičius *et al.* 2004; Podvezko 2009), the AHP method is aimed at determining the weights of criteria and assessing the consistency of questionnaires elicited from the experts. For this purpose, a complicated practical eigenvalue problem should be solved as follows.

2.1. First of all, let's create normalized decision-making matrix $B_m^{(k)} = (b_{ij}^{(k)})$, where

$$b_{ij}^{(k)} = \frac{p_{ij}^{(k)}}{\sum_{i=1}^{n} p_{ij}^{(k)}}. \tag{2}$$

2.2. Find the largest eigenvalue of $P_m^{(k)}$. The problem of eigenvalues and eigenvectors is difficult to solve manually, and thus we calculate the approximate values of eigenvectors and respective largest eigenvalues. We calculate the eigenvector as the weight (significance) of criteria,

$$q_{m,i}^{(k)} = \frac{1}{n}\sum_{j=1}^{n} b_{ij}^{(k)}, \qquad i = \overline{1,n}. \tag{3}$$

Let's remark, that the higher is the value of $q_{m,i}^{(k)}$, the higher is the importance of criterion I_i.

The use of (1) and (3) gives the approximate values of $\lambda_m^{(k)} = \left(\lambda_{m,1}^{(k)},\ldots,\lambda_{m,n}^{(k)}\right)$.

2.3. It is known (see, e.g. Satty 1990) that the largest eigenvalue of the inverse symmetrical *n*th-order matrix is $\lambda_{\max}^{(k)} \geq n$. In the ideal case, when the matrix is absolutely consistent and the elements of the columns are proportional, $\lambda_{\max}^{(k)} = n$. Accordingly, in this case, the calculated values $\lambda_m^{(k)} = \left(\lambda_{m,1}^{(k)},\ldots,\lambda_{m,n}^{(k)}\right)$ must be equal to *n*. If all values $\lambda_{m,i}^{(k)}$ differ, then, approximately

$$\lambda_{\max}^{(k)} = \frac{1}{n}\sum_{i=1}^{n} \lambda_{m,i}^{(k)}. \tag{4}$$

2.4. For consistency index $S_I^{(k)}$ of $P_m^{(k)}$, we adopt values (see, e.g. Satty 1990)

$$S_I^{(k)} = \frac{\lambda_{\max}^{(k)} - n}{n-1}. \tag{5}$$

It is the negative averages of the other roots of the characteristic polynomials of $P_m^{(k)}$. The smaller is the consistency index, the higher is the consistency of the pairwise comparison matrix. In the ideal case, $S_I^{(k)} = 0$.

2.5. Now, let's calculate the degree of consistency

$$S_m^{(k)} = \frac{S_I^{(k)}}{S_A}, \tag{6}$$

where random consistency index S_A is given in Table 6. Let us note, that $P_m^{(k)}$ is consistent if $S_m^{(k)} \leq 10\%$ is acceptable. In another case, an expert is asked to revise his/her judgments. Otherwise, the created pairwise comparison matrix cannot be used for further investigations. However, this rule was criticized by some authors, see e.g. (Koczkodaj 1993). In the ideal case, $S_m^{(k)} = 0$. For information on how the inconsistency of pairwise comparison in the AHP framework changes when the number of the criterion to be compared increases, see e.g. (Mazurek and Perzina 2017).

3. *To test the consistencies of expert judgments*. Considering the results above, it is significant to determine the consistencies of expert judgments. Thus, Kendall's coefficient of concordance W_m (Kendall 1990) is used. The following calculation scheme is suggested.

3.1. Calculating the sum of the deviations from the squares of criterion ranks from the averages of criterion ranks:

$$z_m = \sum_{j=1}^{n}\left(\sum_{k=1}^{r} c_{m,j}^{(k)} - a^2\right)^2, \qquad a = \frac{1}{n}\sum_{j=1}^{n}\sum_{k=1}^{r} c_{m,j}^{(k)}, \tag{7}$$

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where $c_{m,j}^{(k)}$ is the rank of the j*th* criterion in the *m*th area for the *k*th expert. Ranking is a procedure when the highest rank equal to 1 is devoted to the most important criterion (with the highest weight), the second rank is devoted next to the most important criterion, etc.

3.2. Kendall's coefficient of concordance is calculated according to the formula

$$W_m = \frac{12Z_m}{m^2(n^3 - n)}. \tag{8}$$

If the judgments of the experts are consistent $W_m = 1$, otherwise $W_m = 0$.
In order to determine the significance of the concordance coefficient, the further hypothesis should be tested: H_0: the judgments of the experts are inconsistent ($W_m = 0$); H_1: the judgments of the experts are consistent ($W_m > 0$).

3.3. It was proved by Kendall that if the number of criteria is $n > 7$, then, the significance of the concordance coefficient could be determined with the help of criteria χ^2, as the random variable

$$\bar{\chi}_m^{\ 2} = W_m r(n-1) = \frac{12Z_m}{rn(n+1)} \tag{9}$$

is distributed according to χ^2 - distribution with $\nu = n - 1$ degrees of freedom. The significance of concordance coefficient W_m is performed by comparing $\bar{\chi}_m^{\ 2}$ with critical values $\chi^2_{\alpha,\nu}$ from chi-squared distribution with ν degrees of freedom and selected confidence level α. If $\chi^2_m > \chi^2_{0,05;\nu}$, then, H_0 is rejected, which means that the dependence between the judgments of the experts exist. Let's note, that if $3 < n \le 7$, then, the distribution of χ^2 must be applied choicely, as in the case where $\bar{\chi}_m^{\ 2} \le \bar{\chi}^2_{\alpha,\nu}$, the judgments of the experts may be consistent. In this instance, critical values $S_{\alpha,n}$ from the table of those of Kendall's coefficient of concordance (Friedman 1940) are compared with Z_m values. If $Z_m > S_{\alpha,n}$, then, H_0 is rejected.

4. *To calculate general weights.* If the judgments of the experts are consistent, then, conclusions about the significance of the criteria should be performed by calculating general weights, i.e. the average of (2):

$$\bar{q}_{m,i} = \frac{1}{n}\sum_{k=1}^{r} q_{m,i}^{(k)}, \qquad i = \overline{1,n}. \tag{10}$$

The higher is the value of (10) , the higher is the importance of criterion I_i .

Table 6. The values of random consistency index S_A (*Source:* Saaty, 2008)

n	1	2	3	4	5	6	7	8	9	10	11	12
S_A	0	0	0,52	0,89	1,11	1,25	1,35	1,40	1,45	1,49	1,52	1,54

According to the steps from Table 5, the results and conclusions, according to the significance of the criteria listed in Table 2, are derived. First, the consistency of pairwise comparison matrices $P_m^{(k)}$ was tested. The use of (4) – (6) gives the degrees of consistency $S_m^{(k)}$ (%) (see Table 7) of pairwise comparison matrices.

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Table 7. The inconsistency ratios of pairwise comparison matrices (*Source:* compiled by the authors)

E_k \ $S_m^{(k)}$	$S_1^{(k)}$	$S_2^{(k)}$	$S_3^{(k)}$	$S_4^{(k)}$	$S_5^{(k)}$	$S_6^{(k)}$	$S_7^{(k)}$
E_1	7,00	7,29	7,53	9,00	1,48	6,30	8,72
E_2	6,93	8,10	9,38	8,69	7,90	7,45	8,80
E_3	1,15	9,06	7,05	8,15	2,82	6,33	9,80
E_4	7,82	8,74	8,78	6,93	2,82	2,81	6,53
E_5	9,90	8,67	6,99	8,31	7,82	6,30	8,68
E_6	9,37	81,53	18,18	52,49	7,82	9,15	25,49
E_7	6,81	39,78	84,69	35,30	60,16	0,89	27,54
E_8	7,54	9,28	9,85	8,07	4,65	0,89	9,09
E_9	8,26	6,80	9,85	8,35	0,72	7,79	8,66
E_{10}	4,44	5,91	0,63	0,63	3,72	0,89	0,63

Here, blue areas highlight such values of $S_m^{(k)}(\%)$ because rule $S_m^{(k)}(\%) \leq 10\%$ is unsatisfied.

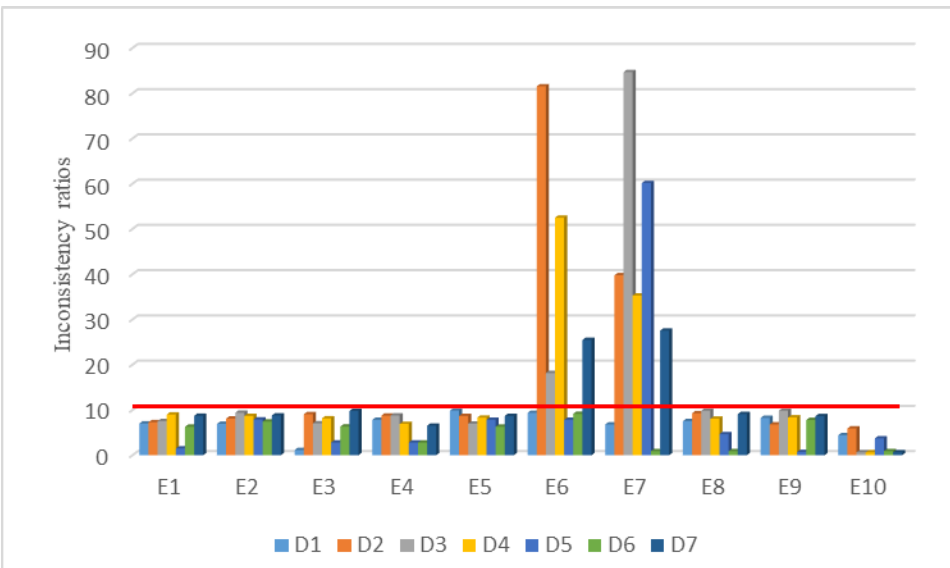

Fig.1. The inconsistency ratios of pairwise comparison matrices (*Source*: compiled by the authors)

First, since $S_m^{(6)}(\%) > 10\%$, $m = 2, 3, 4, 7,$ and $S_m^{(7)}(\%) > 10\%$, $m = 2, 3, 4, 7,$ (see Table 7 and Fig. 1), pairwise comparison matrices $P_m^{(6)}$, as m = 2, 3, 4, 7, and $P_m^{(7)}$, as m = 2, 3, 4, 5, 7, are inconsistent. Respective pairwise comparison matrices were created by experts E_6 and E_7 in areas D_2, D_3, D_4, D_7. As mentioned in Table 5, inconsistent pairwise comparison matrices cannot be used for further research, unless experts were asked to revise

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their judgments. Only pairwise comparison matrices for which $S_m^{(k)}(\%) \leq 10\%$ were selected for further decisions, i.e. the next stage of research.

Second, Table 5 shows the consistencies of expert judgments that should be performed. Thus, according to (7) - (9), the values of Z_m, W_m, χ_m^2 are calculated in every area D_m (see Table 8). Also, critical values $\chi_{\alpha,\nu}^2$ with $\nu = n-1$ degrees of freedom and $S_{\alpha,n}$ with confidence level α = 0,05 are selected (see Table 8).

Table 8. The consistency of expert judgments (*Source:* Personal elaboration, https://www.di-mgt.com.au/chisquare-table.html and Friedman, 1940)

	D_1, n = 4	D_2, n = 5	D_3, n = 5	D_4, n = 5	D_5, n = 3	D_6, n = 3	D_7, n = 5
W_m	46	61	62	40	81	39	58
χ_m^2	10,95	19,60	19,90	12,70	13,00	6,25	18,50
$\chi_{\alpha,\nu}^2$	7,82	9,49	9,49	9,49	5,99	5,99	9,49
Z_m	146,00	392,00	398,00	254,00	104,00	50,00	370,00
$S_{\alpha,n}$	101,70	183,70	183,70	183,70	48,10	48,10	183,70

Let us note, that all areas take $\chi_m^2 > \chi_{0,05;\nu}^2$, and thus, according to step 3.3 from Table 5, H_0 are rejected in all areas and there is no reason to discredit the consistencies of expert judgments. The same conclusion follows if we use critical values $S_{\alpha,n}$ from the table presenting the critical values of Kendall's coefficient of concordance as in all cases $Z_m > S_{0,05,n}$.

Since expert judgments E_k, k = 1, ..., 10 are consistent, the significance of criterion I_j, j = 1,…,30 could be tested. Table 9 shows the results of the weights (2) of the jth criterion assigned by the kth expert E_k in separate areas D_m, m = 1, ..., 7. In addition, general weights (10) and ranks are listed (also see Fig. 2).

Table 9. The weights and ranks of criteria (*Source:* compiled by the authors)

	E_k / I_j	E_1	E_2	E_3	E_4	E_5	E_8	E_9	E_{10}	$\bar{q}_{m,i}$	Rank
D_1	I_1	0,20	0,11	0,13	0,23	0,05	0,50	0,17	0,26	0,21	3
	I_2	0,66	0,62	0,46	0,63	0,57	0,26	0,44	0,06	0,46	1
	I_3	0,09	0,05	0,19	0,10	0,24	0,08	0,08	0,12	0,12	4
	I_4	0,05	0,22	0,22	0,04	0,14	0,16	0,31	0,56	0,21	2
D_2	I_5	0,59	0,29	0,53	0,43	0,50	0,24	0,43	0,42	0,43	1
	I_6	0,07	0,04	0,07	0,07	0,16	0,10	0,18	0,10	0,098	4
	I_7	0,04	0,06	0,03	0,04	0,03	0,04	0,15	0,21	0,07	5
	I_8	0,11	0,15	0,26	0,34	0,25	0,51	0,07	0,23	0,24	2
	I_9	0,19	0,46	0,10	0,12	0,06	0,12	0,17	0,05	0,16	3
D_3	I_{10}	0,48	0,44	0,45	0,45	0,51	0,48	0,45	0,15	0,43	1
	I_{11}	0,11	0,13	0,16	0,07	0,13	0,07	0,15	0,26	0,13	4
	I_{12}	0,32	0,09	0,26	0,30	0,08	0,26	0,04	0,44	0,22	2

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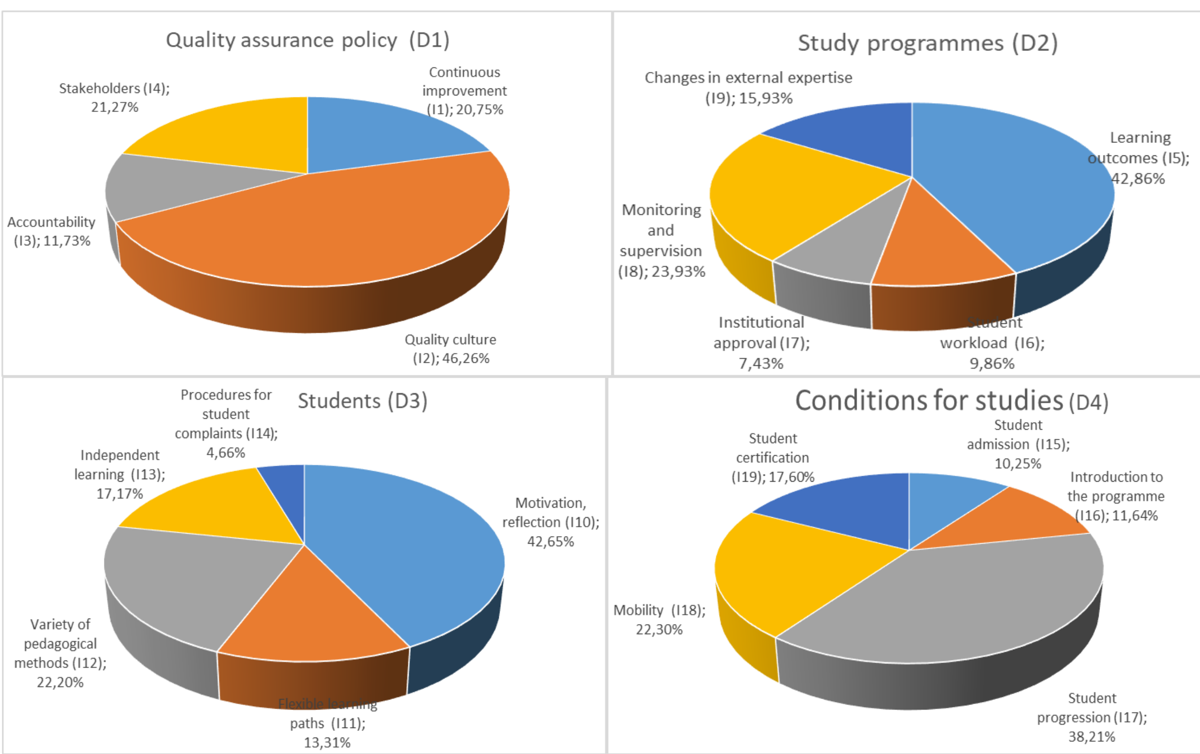
	I_{13}	0,06	0,31	0,10	0,14	0,26	0,16	0,30	0,05	0,17	3
	I_{14}	0,03	0,03	0,03	0,04	0,03	0,04	0,07	0,09	0,05	5
D_4	I_{15}	0,07	0,03	0,08	0,12	0,03	0,13	0,20	0,15	0,10	5
	I_{16}	0,47	0,16	0,04	0,04	0,08	0,04	0,04	0,05	0,12	4
	I_{17}	0,25	0,26	0,26	0,57	0,50	0,44	0,52	0,26	0,38	1
	I_{18}	0,17	0,49	0,47	0,07	0,26	0,07	0,16	0,09	0,22	2
	I_{19}	0,04	0,06	0,15	0,20	0,12	0,32	0,08	0,44	0,18	3
D_5	I_{20}	0,20	0,07	0,18	0,18	0,06	0,28	0,22	0,26	0,18	2
	I_{21}	0,74	0,78	0,75	0,75	0,65	0,63	0,69	0,63	0,70	1
	I_{22}	0,06	0,15	0,07	0,07	0,29	0,09	0,09	0,11	0,12	3
D_6	I_{23}	0,07	0,23	0,19	0,27	0,28	0,25	0,55	0,30	0,27	2
	I_{24}	0,64	0,08	0,72	0,67	0,64	0,68	0,37	0,54	0,54	1
	I_{25}	0,28	0,69	0,08	0,06	0,07	0,07	0,07	0,16	0,19	3
D_7	I_{26}	0,05	0,06	0,14	0,23	0,07	0,12	0,06	0,15	0,11	3
	I_{27}	0,22	0,03	0,04	0,11	0,04	0,03	0,03	0,09	0,08	5
	I_{28}	0,51	0,23	0,26	0,56	0,51	0,51	0,27	0,44	0,41	1
	I_{29}	0,08	0,12	0,07	0,07	0,14	0,07	0,15	0,05	0,09	4
	I_{30}	0,15	0,56	0,49	0,04	0,23	0,27	0,49	0,26	0,31	2



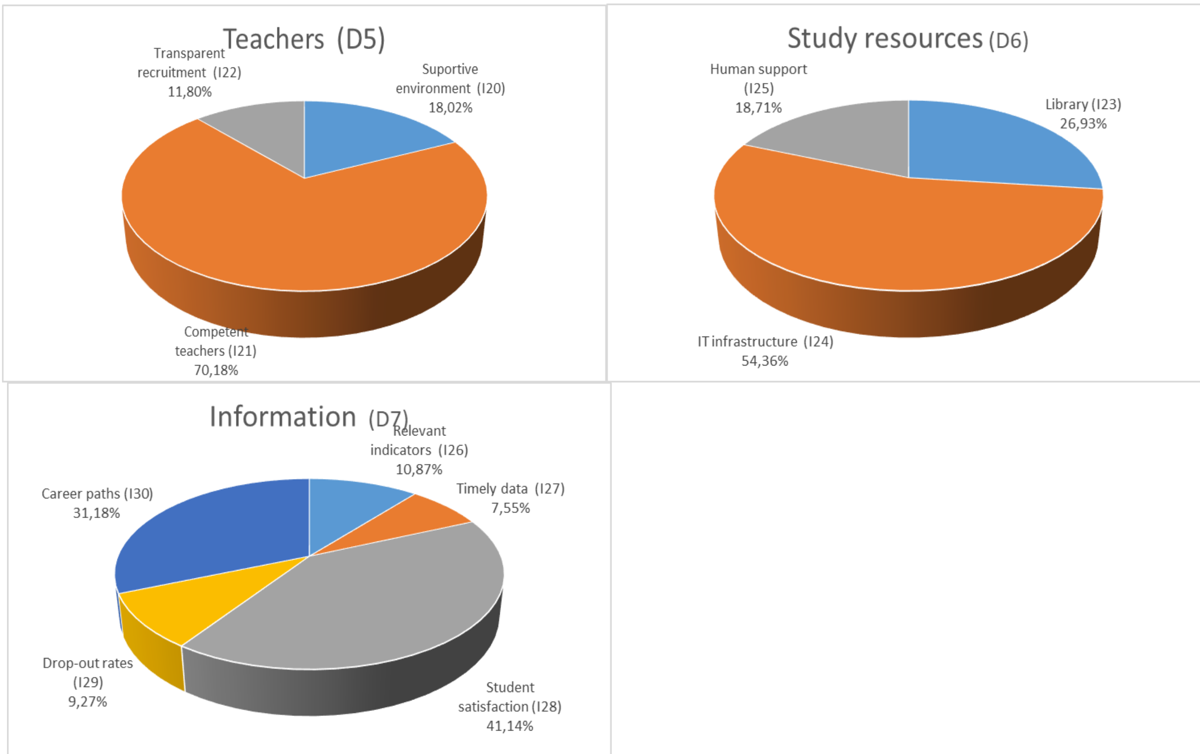


Fig.2. The general weights of criteria (*Source:* compiled by the authors)

Table 9 and Fig 2 show that, depending on expert opinions, the most significant criteria in areas D_m are I_2, I_5, I_{10}, I_{17}, I_{21}, I_{24}, I_{28} accordingly. To be more precise, the judgments of all experts considering the most important criterion I_{21} are the same in area D_5. The weight of this criterion is 70,18% of the total weights of criteria I_{20}, I_{21}, I_{22}. As for area D_3, only one expert E_{10} decided that the most important criterion was I_{12} rather than I_{10}. It is interesting to notice that experts prevail infrastructure rather than human input in area D_6. In all other areas, according to the most significant criteria, only opinions 2 or 3 are different. The weights of the most significant criteria in the above mentioned areas are not less than 38% of the total weights of the criteria in the respectful areas. Criteria I_3, I_6, I_{11}, I_{16}, I_{22}, I_{25}, I_{29} are of the lowest importance.

Recall that the group of experts is composed of decision makers from VU (E_k, k =1, 2, 3, 4) and VGTU (E_k, k =5, 6, 7, 8, 9, 10). Considering the consistent matrices of pairwise comparison (see Fig. 1), decisions on the significance of criterion I_j in areas D_m given the mentioned expert groups, are performed. Tables 10-12 and Fig. 3 and 4 exhibit the results determined following the prior steps (see Table 5).

Table 10. The consistency of the judgments of VU experts (*Source:* Personal elaboration, https://www.di-mgt.com.au/chisquare-table.html and Friedman, 1940)

	D_1, n = 4	D_2, n = 5	D_3, n = 5	D_4, n = 5	D_5, n = 3	D_6, n = 3	D_7, n = 5
W_m	63	51	84	36	81	19	39
χ^2_m	7,50	8,20	13,40	5,80	6,50	1,50	6,20
$\chi^2_{\alpha,\nu}$	7,82	9,49	9,49	9,49	5,99	5,99	9,49

Z_m	50	136	134	58	26	6	62
$S_{\alpha,n}$	49,5	88,4	88,4	88,4	-	-	88,4

Table 11. The consistency of the judgments of VGTU experts (*Source:* Personal elaboration, https://www.di-mgt.com.au/chisquare-table.html and Friedman, 1940)

	D_1, n = 4	D_2, n = 5	D_3, n = 5	D_4, n = 5	D_5, n = 3	D_6, n = 3	D_7, n = 5
W_m	45	55	45	65	81	81	85
χ^2_m	5,40	8,80	7,20	10,40	6,50	6,50	13,60
$\chi^2_{\alpha,v}$	7,82	9,49	9,49	9,49	5,99	5,99	9,49
Z_m	36,00	88,00	72,00	104,00	26,00	26,00	136,00
$S_{\alpha,n}$	49,50	88,40	88,40	88,40	-	-	88,40

Table 12. The generalized weights and ranks of the criteria assigned by VU and VGTU experts

	Criteria (I_j)	VU		VGTU	
		$\bar{q}_{m,i}$	Rank	$\bar{q}_{m,i}$	Rank
Quality assurance policy (D_1)	Continuous improvement (I_1)	0,17	2	0,14	3
	Quality culture (I_2)	0,59	1	0,20	1
	Accountability (I_3)	0,11	4	0,07	4
	Stakeholders (I_4)	0,13	3	0,19	2
Study programmes (D_2)	Learning outcomes (I_5)	0,40	1	0,40	1
	Student workload (I_6)	0,13	3	0,13	3
	Institutional approval (I_7)	0,11	4	0,11	4
	Monitoring and supervision (I_8)	0,26	2	0,26	2
	Changes in external expertise (I_9)	0,10	5	0,10	5
Students (D_3)	Motivation and reflection (I_{10})	0,46	1	0,40	1
	Flexible learning paths (I_{11})	0,12	4	0,15	4
	Variety of pedagogical methods (I_{12})	0,24	2	0,20	2
	Independent learning (I_{13})	0,15	3	0,19	3
	Procedures for student complaints (I_{14})	0,03	5	0,06	5
Study conditions (D_4)	Student admission (I_{15})	0,07	5	0,13	4
	Introduction to the programme (I_{16})	0,18	3	0,05	5
	Student progression (I_{17})	0,33	1	0,43	1
	Mobility (I_{18})	0,30	2	0,14	3
	Student certification (I_{19})	0,11	4	0,24	2
Teachers (D_5)	Supportive environment (I_{20})	0,16	2	0,20	2

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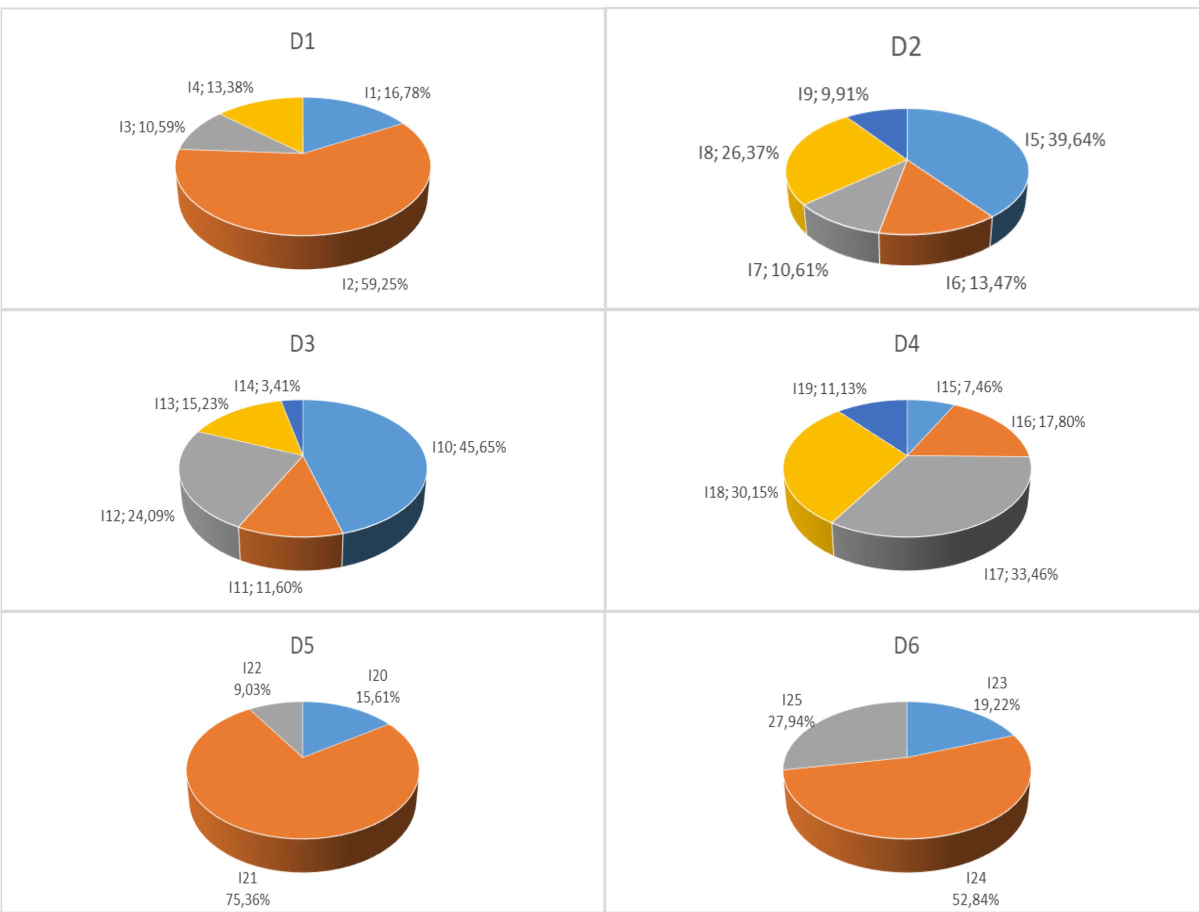
	Competent teachers (I_{21})	0,75	1	0,65	1
	Transparent recruitment (I_{22})	0,09	3	0,15	3
Study resources (D_6)	Library (I_{23})	0,19	3	0,35	2
	IT infrastructure (I_{24})	0,53	1	0,56	1
	Human support (I_{25})	0,28	2	0,09	3
Information (D_7)	Relevant indicators (I_{26})	0,12	3	0,10	4
	Timely data (I_{27})	0,10	4	0,05	5
	Student satisfaction (I_{28})	0,39	1	0,43	1
	Drop-out rates (I_{29})	0,08	5	0,10	3
	Career paths (I_{30})	0,31	2	0,31	2

The yellow areas in the above table highlight criteria for which the order of priorities assigned by a different expert group varies.



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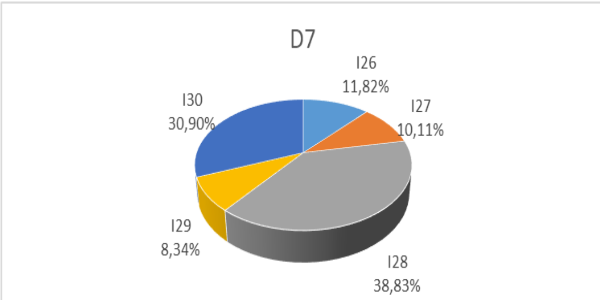
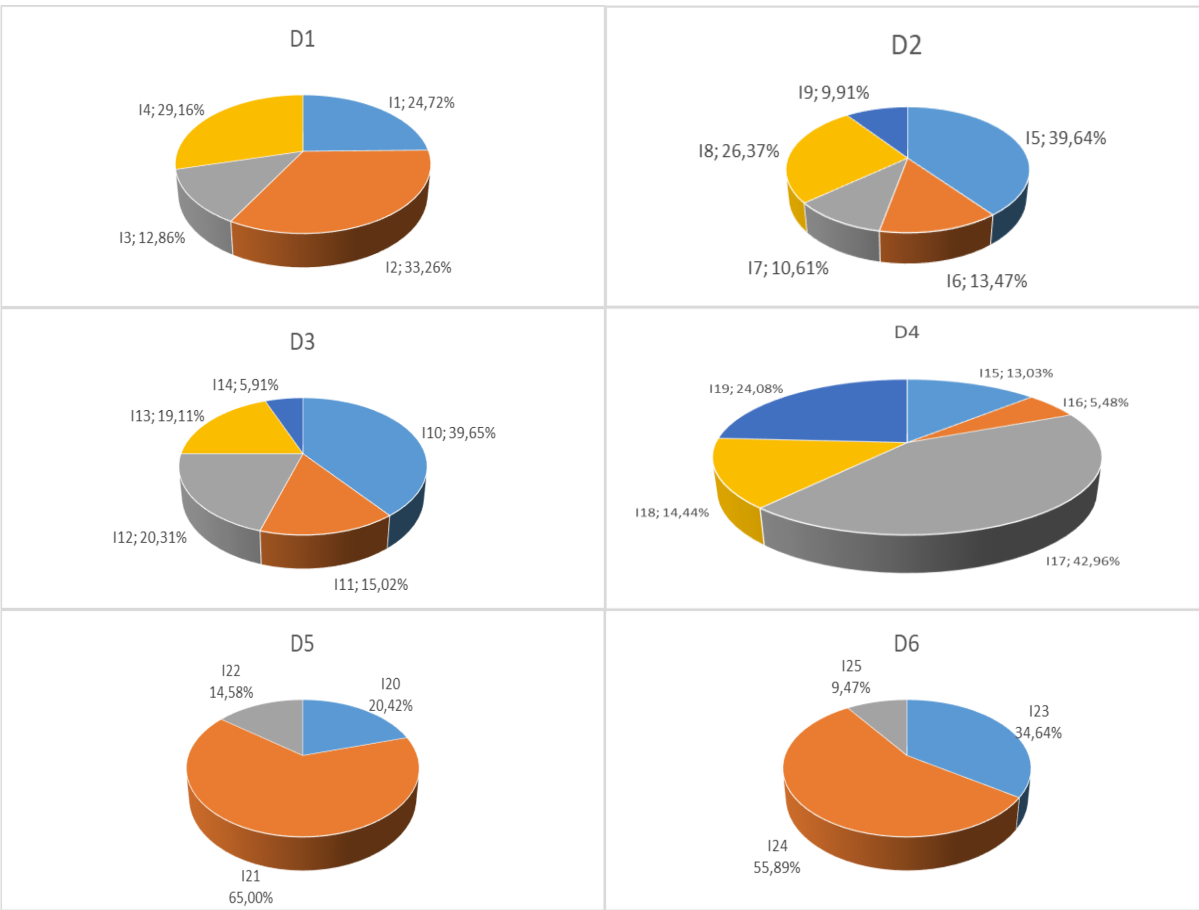


Fig.3. The general weights of the criteria assigned by VU experts *(Source*: compiled by the authors)



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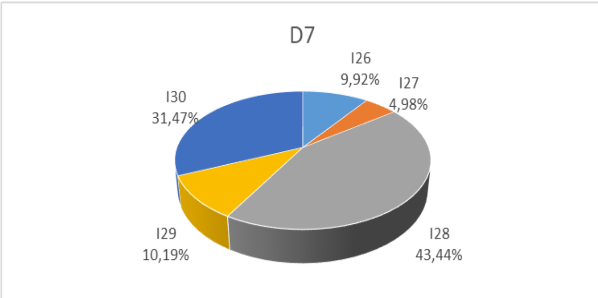

Fig. 4. The general weights of the criteria assigned by VGTU experts (*Source*: compiled by the authors)

It follows from Table 10 that there is no reason to discredit the consistencies of the judgments of VU experts in areas D_2, D_3, D_5, as $\chi_m^2 > \chi_{0,05;\nu}^2$, m = 2, 3, 5. Table 10 shows that $\chi_m^2 > \chi_{0,05;\nu}^2$, as m = 4, 5, 6, 7, and thus there is no reason to discredit the consistencies of the judgments of VGTU experts in areas D_4, D_5, D_6, D_7. It seems that the judgments of VU and VGTU experts in other areas are inconsistent. However, let‘s recall that if $3 < n \leq 7$, then, the distribution of χ^2 must be applied choicely, as in the case where $\bar{\chi}_m^2 \leq \bar{\chi}^2_{0.05,\nu}$ the judgments of the experts may be consistent. Clearly, following rule $Z_m > S_{0,05,n}$ (see step 3.3 in Table 5), in the instance of VU experts, H_0 may be also rejected in area D_1.

The use of the results in Table 12 and Fig. 3 and 4 provides us with the same main conclusions about the significance of the criterion regardless the consistencies of expert judgments. A comparison of general weights in Table 7 with those in Table 12 demonstrates that the order of priorities assigned by a different group of experts varies.

While summarizing the results of the whole research, several things have to be pointed out:
First, a selection of the experts' only from two universities in Lithuania could be named as a limitation of the research performed. Despite that, the opinions of the representatives of these two largest Lithuanian universities coincided on the most important criteria for ensuring the quality assurance of the study process at the university level.
As for the second, the involvement experts from other countries (such as Latvia, Estonia, Poland) in further research could make a significant contribution to the deeper analysis of the importance of criteria determining the quality assurance of the study process.

Conclusions

1. The analysis of theoretical and empirical research papers has confirmed the relevance of the quality of the study process at the university level in the context of higher education. For the last two decades, the importance of the quality of this process has been highlighted by a number of works worldwide. There are attempts to find keys to the quality of the study process at the university level from institutional, national and international (Bologna Process) perspectives.
2. It should be noted that the composition and development of studies at the university level is a permanent process covering a wide range of the areas composed of a large number of criteria of a different origin. However, the European Standards and Guidelines for Quality Assurance in Higher Education have provided an opportunity to compose this process in a systematic way. Also, such composition of criteria could serve as a balanced score-card for universities in the management of the study process.

3. Multi-criteria decision making methods are broadly used by scientists to assess complex phenomena. Based on the methodology for one of these methods (AHP), the questionnaire and survey of the experts were made in order to disclose this subject. The experts selected for research purposes represented two largest universities in Lithuania.
4. The obtained results of the carried out research have demonstrated the importance and weights of the criteria composing different areas of the study process at the university level. The findings have disclosed that such criteria as quality culture, learning outcomes, student motivation and reflextion, student progression, competent teachers, IT infrastructure, student satisfaction are the most important in striving to achieve the highest quality of the study process at the university level.
5. The rest of the criteria do not mean less importance of the quality of the study process at the university level. Despite that, paying attention to a certain scenario of criteria regarding the strategy and allocation of resources can lead to unique institutional performance and achievements in the quality of the study process at the university level.

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