



DEVELOPMENT OF RESEARCH COMPETENCIES IN QUALITY MANAGEMENT IN UNIVERSITIES

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ABSTRACT

Keywords:

Management of Universities' Information Systems, National Research Universities, Research Competencies, Development of Competencies, Universities of Russia, Quality Management In Universities.

This paper solves the problem of quality management in national research universities in Russia. The goal of this paper was to study the empirical experience and to substantiate the prospects for improving quality management in national research universities in Russia. Based on statistics on 30 national research universities of the Russian Federation in 2030, an econometric model of quality management in these universities was compiled. Based on the model, the important role of research competencies in quality management in Russian universities was substantiated. The Pareto optimum was found, which demonstrated the possibility for the maximisation of quality in Russian universities through the development of research competencies. For its achievement, a map of competencies in quality management in national research universities of Russia was offered. The main conclusion is that the quality of activities in national research universities is determined by the level of the development and the level of disclosure of research competencies of scholars working in them: citations of their publications, number of concluded licensing agreements, and science-making activity of young scientists. The theoretical significance consists in the development of a new – competence-based – approach to quality management in national research universities of Russia, the originality of which lies in the transition from norming to the development of research competencies in universities. The practical significance is that the developed competence-based approach will allow improving the practice of quality management in national research universities of Russia. Thus, the paper supports the project "Decade of Science and Technologies in Russia".



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1. INTRODUCTION

Quality is a cornerstone of state universities (Sayah and Khaleel, 2022). Unlike private universities, which are commercial organisations and thus are aimed at receiving profit, the purpose of state universities, as non-commercial organisations, is to provide high-

quality socially important benefits they specialise in (Popkova, 2020; Popkova and Sergi, 2023; Shabaltina et al., 2021, Elsayed et al. 2023).

During the research of state universities, the experience of countries with socialist origins, like Russia, is of special interest. The Russian system of science and

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higher education is notable for the fact that market transformations were not accompanied by the privatisation of universities, which, against the background of mass privatisation in other sectors of the Russian economy, were preserved until now as state property.

Due to this, the processes of reformation of the Russian system of science and higher education were aimed at and led to an effect connected not with the replacement of past organisational and managerial models of universities but their supplementing. This allowed preserving the Soviet heritage, ensuring the continuity of the development of the system of science and higher education in Russia, and modernising it carefully, assigning it with new capabilities, which disclosed under the conditions of capitalism: high flexibility, customer focus, financial and economic effectiveness, investment attractiveness, openness for foreign students, and global competitiveness.

Reforms of the Russian system of science and higher education, which were conducted in the period of the formation of capitalistic relations in Russia, turned out to be successful, for they allowed achieving the required specialisation of Russian universities. As a result, by now, spheres of specialisation of Russian universities have clearly formed, with the corresponding statuses in the system of sciences and higher education.

From the theoretical and methodological position, the complexity of determining these statuses is that they were introduced stage-by-stage, at the different waves of reforms, due to which their regulatory support is fragmentary. There is no unified normative legal act adopted at the government level that would contain a strict list of statuses in Russian universities.

Specific features of the existing statuses are reflected in the materials of Univer Expert (2023), and specific lists of Russian universities that have statuses in 2023 are given in the materials of Interfax (2023). To order the existing scientific knowledge and bring them in accordance with the modern Russian practice, a systematisation was performed and the proprietary classification of Russian universities by the criterion of the spheres of their specialisation was done based on the given materials.

First, it distinguishes government and federal universities. Their status means that they play an important role in the development of territories of federal importance due to their strategic geo-economic value for Russia, such as Moscow, St. Petersburg, the Kaliningrad Region, and historical territories, restored as parts of Russia, which receive increased support for their accelerated socio-economic development. Government and federal universities specialise in educational and scientific support for economic growth

and increase in the quality of the population's life in the territories of their location.

Second, regional flagship universities, which status means their specialisation in the development of the economy of regions of their location and support for local communities. Almost every region of Russia has a flagship university, which trains personnel and creates innovations for the key sectors of the local economy. The sense is that universities facilitate the best disclosure of the potential of regions, keeping of local youth, and their employment in regions, implementation of the strategies of regions' development, and the reduction of economic inequality among regions in Russia.

Third, sectorial universities, which status involves their specialisation in the training of personnel and technologies for specific sectors. These are mainly pedagogical and medical universities, which satisfy the economy's needs for teachers and doctors. The specifics of their activities consist in a close connection with the labour market. Targeted training is actively practised, according to which state-funded places in universities are created for specific establishments of education and healthcare (schools and hospitals), in which graduates will have to take professional practice and work for several years.

Fourth, universities that participate in the programme "Priority 2030". Universities with this status specialise in the strengthening of strategic academic leadership in Russia. Their activities are aimed at improving positions in international university rankings, such as ARWU, THE, and QS. Large attention is paid to international activities – from the attraction of foreign students to the organisation of international internships of students and teachers, as well as holding international scientific and educational events (conferences, workshops, and forums).

Fifth, national research universities. Their status was adopted by the Decree of the Government of the Russian Federation dated 13 July 2009, No. 550 (Garant, 2023). The sphere of their specialisation is R&D, with them being the driver. National research universities support the development of the innovative economy of Russia. Their activities deserve special attention against the background of the implementation of the programme "Digital Economy of the Russian Federation" (Ministry of Digital Development, Communications and Mass Media of the Russian Federation, 2023).

Also, the role of the study of the activities of national research universities is especially important in the Decade of science and technologies in Russia (2022-2031) (Kremlin, 2023). This paper focuses on the scientific and practical problem of quality management in national research universities of Russia.

Acknowledging the topicality of the problem posed, this paper seeks the goal of studying the empirical experience and substantiating the prospects for improving quality management in national research universities of Russia.

This goal was reached with the help of the following tasks. 1st task: to determine the role of research competencies in quality management in Russian universities. 2nd task: to find the Pareto optimum of an increase in the quality in Russian universities through the development of research competencies. 3rd task: to develop a competence-based approach to quality management in national research universities of Russia.

2. LITERATURE REVIEW

2.1. Quality as the priority of the management of information systems in Russia's national research universities

The fundamental basis of this research is the scientific provisions of the theory of quality management in universities (Ahmad et al., 2022; Amaimin et al., 2021; Arokiasamy and Krishnaswamy, 2021; Fauzi, 2022). The research object in this paper is the management of the quality in national research universities of Russia. Since national research universities specialise in R&D, the quality of their activities is manifested in and measured through the lens of the following:

- The total volume of R&D work performed by the university for a certain period of time, in monetary terms (Bogoviz and Mezhev, 2015; Ren et al., 2022);
- University's revenues from R&D, received for a certain period of time, per one researcher, also in monetary terms (Fernandes et al., 2023; Fernandes and O'Sullivan, 2023).

The economic sense of the use of the above evaluation criteria is that the higher the scale of the conducted R&D (as a manifestation of research activity) and the higher their profitability (as a manifestation of efficiency, demand in practice, and commercialisation), the higher the quality of the activities of national research universities (Du and Seo, 2022; Dyakov et al., 2022).

Quality management takes place in the management information systems of universities (Turginbayeva et al., 2018; Yaseen et al., 2023; Zhao et al., 2022). In the management information systems, the targeted benchmarks of quality are formed, control values of these benchmarks for raising quality are determined, and a set of managerial measures and control for their implementation during quality management in universities are formed (Guo and Qu, 2022; Malaya et al., 2022; Masele and Kagoma, 2023). Thus, quality is the priority of the management information systems in national research universities of Russia, which attention is focused on R&D.

2.2. Regulatory approach to quality management in national research universities

The issues of quality management in universities were elaborated and disclosed in the existing scientific works. Bogoviz et al. (2020) noted the important role of the globalisation of education in support for the high quality of universities' activities in the conditions of the formation of the global knowledge economy. Pasic et al. (2022) pointed to the importance of students' developing competencies that are announced in educational programmes, to ensure the high quality of universities' activities (by the example of universities in SouthEast Europe).

In their turn, Alharbi et al. (2020) draw a connection between the quality of activities of universities in the conditions of the digital economy and Industry 4.0 with the accessibility for students and lecturers of cloud storage services. Lestari et al. (2021) proved the usefulness of online learning for the improvement of the quality of education during the COVID-19 pandemic (on the example of Universitas Negeri Jakarta, Indonesia). Dewi et al. (2021) proved the existence of a close connection between the quality of education, satisfaction of students, and loyalty of students (on the example of Universitas Islam Negeri in Indonesia).

The performed literature review discovered a high level of elaboration on the issues of quality management in universities, but poor elaboration on the experience and the uncertainty of the specifics of quality management in national research universities. This uncertainty is a literature gap and causes the following research question. **RQ:** What determines the quality of the activities of national research universities?

Based on the general experience of universities, including Russian universities, the existing literature has formed a regulatory approach to quality management in universities. The sources of quality in this approach are the creation and compliance with corporate standards of quality in universities (Vanchukhina et al., 2022).

The tool of quality management in universities is human resources management (HRM) (Bogoviz et al., 2018, Eker & Akdogan Eker (2023)). The mechanism of HR quality management is connected with the norming of labour of academic staff and the creation of favourable conditions for the execution of plans (norms) by all personnel (Elayan and Sleimi, 2021). In the existing regulatory approach, the key spheres and target benchmarks of quality management in universities, i.e., indicators of management information systems are as follows:

- Growth of publication activity (Bouabid and Achachi, 2022; Kipnis and Brush, 2023);
- Expansion of opportunities for publications through an increase in the number of scientific journals, published by the university (Kumar et al., 2023);

- Increase in the share of personnel with academic degrees in the academic staff (Al-Zoubi et al., 2023);
- Norming of revenues from the use of the results of intellectual activities (Bogoviz et al., 2017; Sergi and Popkova, 2022; Veselovsky et al., 2017);
- Growth of (grant) financing of scientific research (Babina et al., 2023).

Specifics of national research universities were disclosed only in certain literature sources, which emphasise the significance of research competencies of the university’s academic staff for its R&D (Miao et al., 2021; Popkova, 2021a; Popkova, 2021b). The content analysis and systematisation of the materials of the above publications allowed distinguishing the following potential factors in the quality of the activities of national research universities:

- Citation rate of publications as a manifestation of their scientific value and significance in academic circles, which is not subject to planning or norming (publication of a certain number of papers can be planned, but it is impossible to predict or require their achieving popularity in the scientific world) (Anderson, 2021; Li and Yin, 2022);
- Number of licensing agreements as a manifestation of their demand in practice (R&D can be planned, but the results are unpredictable and cannot be normed) (Zhao and Li-Ying, 2023);
- The science-making activity of young scientists as a manifestation of the development of their human potential (a required share of personnel

with academic degrees in academic staff can be achieved, but the creativity of young scholars is unpredictable and cannot be normed) (Lambovska and Todorova, 2023).

Based on the above scientific works, the following hypothesis **H** is proposed in this paper: the quality of the activities of national research universities is determined by the level of the development and level of disclosure of research competencies of the universities’ academic staff: citation rate of their publications, the number of concluded licensing agreements, and science-making activity of young scientists.

To check the proposed hypothesis (H), we performed a factor analysis of the R&D of Russia’s national research universities. Based on the respectable official statistics, we compiled an econometric model, which mathematically reflects the regularity of measuring the quality of national research universities of Russia under the influence of the totality of the factors in the execution of the norms of labour, as well as the factors in development and disclosure of research competencies of the university’s academic staff.

3. MATERIALS AND METHODOLOGY

This research is based on the econometric methodology for obtaining the most precise and reliable results. The research objects are 30 national research universities of the Russian Federation in 2023 (as a result of 2022) (Interfax, 2023). The statistical base is given in Appendix. The system of indicators, which are studied in this paper, is shown in Table 1.

Table 1. The system of indicators for the research.

Group of indicators	Essence of indicators	Indicator	Symbol
Targeted result	University’s position in the National Ranking of Universities by Interfax (2023)		TR _{QNR}
Quality (Main Information and Computing Centre, 2023)	Volume of R&D	“Total volume of R&D works, RUB thousand”	QNR _V
	Revenues from R&D	“Revenues from R&D (except for the funds from the budgets of the budget system of the Russian Federation and government funds of support for science) per one scientific and pedagogical personnel, RUB thousand”	QNR _r
Factors of quality in the existing regulatory approach (Main Information and Computing Centre, 2023)	Publication activity	“Number of the publications of an organisation, indexed in the information and analytical system of scientific citation the Russian Science Citation Index per 100 scientific and pedagogical personnel”	Norm ₁
	Revenues from the use of the results of intellectual activities	“Share of funds received by the educational organisation from the use of the results of intellectual activities, in the aggregate revenues of the educational organisation, %”	Norm ₂
	Share of personnel with academic degrees in the academic staff	“Share of scientific and pedagogical personnel who defended PhD and doctoral theses during the reported period in the total number of scientific and pedagogical personnel, %”	Norm ₃
	Possibilities for publications	“Number of scientific journals, including online, published by the educational organisation”	Norm ₄
	Financing (grant) of scientific research	“Number of grants received during the reported year, per 100 scientific and pedagogical personnel”	Norm ₅
Potential factors from the position of research competencies (Main Information and Computing Centre, 2023)	Citation rate of publications	“Number of citations of publications, published over the last five years, indexed in the Russian Science Citation Index, per 100 scientific and pedagogical personnel”	Comp ₁
	Demand for innovations in practice	“Number of licensing agreements”	Comp ₂
	The science-making activity of young scientists	“Share of scientific and pedagogical personnel without academic degrees – under the age of 30, PhD’s – under the age of 35, doctors of science – under the age of 40, in the total number of scientific and pedagogical personnel, %”	Comp ₃

Source: Authors

To solve the first task, which is connected with determining the role of research competencies in quality management in Russian universities, we used the methods of regression and correlation analysis. The targeted result of the activities of national research universities (from the position of quality) is their positions in university rankings. As the basis, we used the National Ranking of Universities Interfax (2023), since it allows for automatized sorting by the types of universities and the selection of national research universities. The universities' position in this ranking is measured in points 0-1,000 (let us denote it by TR_{QNR}).

The method of regression analysis was used to determine the dependence of the targeted result on the quality in national research universities: the volume of R&D (QNR_v) and revenues from R&D (QNR_r). To search for an answer to RQ, first, the method of correlation analysis is used to determine the connection and, then, the method of regression analysis is used to find the dependence of quality (QNR_v and QNR_r) on the entire range of its factors from Table 1. The research model of this paper has the following form:

$$\begin{cases} TR_{QNR} = a_{TR} + b_{TR_v} * QNR_v + b_{TR_r} * QNR_r; \\ QNR = a_Q + \sum_{i=1}^5 (b_{Ni} * Norm_i) + \sum_{j=1}^3 (b_{Cj} * Comp_j). \end{cases} \quad (1)$$

The reliability of the research model (1) is checked with the help of the F-test and the t-test. Hypothesis H is considered correct at $b_{Cj} > 0$ in the research model (1). To solve the second task, which consists in finding the Pareto optimum of an increase in the quality in Russian universities through the development of research

competencies, the simplex method is used – based on the research model (1) – to find such a combination of the factors of quality from the position of research competencies ($Comp_1, Comp_2, Comp_3$) at which the targeted result is maximised ($TR_{QNR} = 1000$). The method of trend analysis is used to determine the growth rate (trend) of the values of the indicators compared to 2023.

To solve the third task, which consists in developing a competence-based approach to quality management in national research universities of Russia, the matrix method is used. This method is used to develop a map of competencies for quality management in national research universities of Russia, which reflects targeted benchmarks of the development and disclosure of competencies, set of competencies, methods of the development of competencies, and the university's departments that are responsible for the development of competencies.

4. RESULTS

4.1. The role of research competencies in quality management in Russian universities

To solve the first task, which consists in determining the role of research competencies in quality management in Russian universities, the method of regression analysis is utilised to find the dependence of the targeted results (TR_{QNR}) on the quality in national research universities: the volume of R&D (QNR_v) and revenues from R&D (QNR_r) (Table 2).

Table 2. Regression analysis of the dependence of the targeted result on the quality of research universities in Russia in 2023.

Regression statistics						
Multiple R	0.7335					
R-square	0.5381					
Adjusted R-square	0.5038					
Standard error	109.4725					
Observations	30					
ANOVA						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	2	376,901.9782	188,450.9891	15.7249	0.00003	
Residual	27	323,574.3218	11,984.2341			
Total	29	700,476.3000				
Coefficients						
	<i>Coefficients</i>	<i>Standard error</i>	<i>t-Stat</i>	<i>P-Value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Y-intercept	423.6131	36.1815	11.7080	$4.4 * 10^{-12}$	349.3749	497.8513
QNR_v	0.00009	0.00002	4.2470	0.0002	0.00005	0.0001
QNR_r	0.0302	0.0248	1.2158	0.2346	-0.0208	0.0811

Source: Calculated and compiled by the authors.

Results from Table 1 allow compiling the following equation of multiple linear regression:

$$TR_{QNR} = 423.6131 + 0.00009 * QNR_v + 0.0302 * QNR_r \quad (2)$$

According to equation (2), an increase in the volume of R&D by RUB 1,000 led to an improvement in the position of national research universities in the National Ranking by Interfax (2023) in 2023 by 0.00009 points. An increase in the revenues from R&D by RUB 1,000

led to an improvement of the position of national research universities in the National Ranking by Interfax (2023) in 2023 by 0.0302 points.

The discovered regularity is true at the level of significance of 0.01. This is explained by the fact that significance $F=0.00003$; at 2 factor variables ($m=2$) and 30 observations ($n=30$) $k_1=m=2$, $k_2=n-m-1=30-2-1=27$, F -table equals 5.4881, F -observed equals 15.7249 (exceeding F -table); therefore, the F -test was passed. In equation (2), there are 29 degrees of freedom. For the factor variable $QNRv$, the t -test was passed at the level

of significance of 0.01, where T -table equals 2.7564, and T -observed equals 4.2470 (exceeding T -table). For the factor variable $QNRr$, the t -test was passed at the level of significance of 0.25, where T -table equals 1.1739, and T -observed equals 1.2158 (exceeding T -table). The performed tests proved the reliability of equation (2). To find the answer to RQ , the method of correlation analysis is used to determine the connection between the quality ($QNRv$ and $QNRr$) and the entire range of its factors (Figure 1).

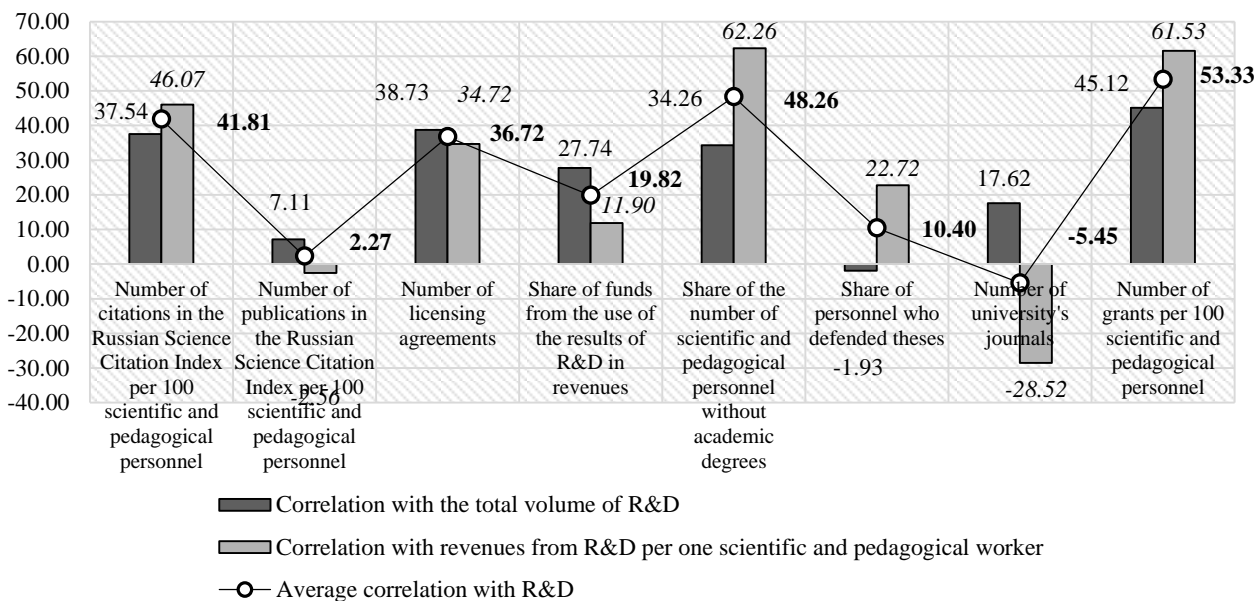


Figure 1. Correlation between quality and its factors in national research universities of Russia in 2023, %
 Source: Calculated and compiled by the authors.

Results obtained in Figure 1 demonstrated a weak connection (correlation) between the indicators of quality and its factors, distinguished in the existing regulatory approach. In quantitative terms, the correlation is as follows.

The average correlation of R&D with publication activity: 2.27% (correlation of revenues from R&D is negative: -2.56%), with revenues from the use of intellectual activities: 19.82%, with the share of personnel with academic degrees in the academic staff: 10.40%, with possibilities (journals) for publications: 5.45% (correlation with revenues from R&D is negative: -28.52%), with financing (grant) of scientific research: 53.33% (the only case of strong connection).

At the same time, we discovered a strong connection (correlation) between the indicators of quality and its potential factors from the position of research competencies. In quantitative terms, the correlation is as follows. The average correlation of R&D with the citation rate of publications: 41.81%, with the demand

for innovations in practice: 36.72%, and with the science-making activity of young scientists: 48.26%. This allowed selecting four supposedly significant factors, namely: 1) financing (grant) of scientific research; 2) citation rate of publications; 3) demand for innovations in practice and 4) science-making activity of young scientists. To specify the results obtained, the method of regression analysis was used to find the dependence of quality ($QNRv$ and $QNRr$) on the entire range of its factors (Table 3).

Results from Table 3 showed that all factors, distinguished in the existing regulatory approach, have ambiguous, contradictory impacts on the quality of national research universities of Russian 2023. Regression coefficients at the publication activity ($Norm_1$) are negative in both functions of quality (-979.0676 in the function for $QNRv$ and -0.8044 in the function for $NRvr$). The regression coefficient at revenues from the use of the results of intellectual activities is negative in the function for $QNRr$ (-767.9115).

Table 3.Regression analysis of the dependence of the quality of research institutes on the set of factors in Russian 2023.

Indicators		Resulting variable of quality	
		QNRv	QNRr
<i>Regression statistics</i>			
Multiple R		0.5799	0.8684
R-square		0.3363	0.7542
Adjusted R-square		0.0834	0.6605
Standard error		1,047,222.2246	541.6974
Observations		30	30
<i>ANOVA</i>			
Regression		8	8
Residual		21	21
Total		29	29
F		1.3299	8.0536
Significance F		0.2828	6.03837*10 ⁻⁵
<i>Coefficients</i>			
Y-intercept		108,156.6912	72.5345
Factors of quality in the existing regulatory approach	Norm ₁	-979.0676	-0.8044
	Norm ₂	24,401.7144	-767.9115
	Norm ₃	-305,849.8866	9.9611
	Norm ₄	22,631.1673	-41.0676
	Norm ₅	-4,140.0614	44.8881
Factors of quality from the position of research competencies	Comp ₁	154.1674	0.1823
	Comp ₂	13,084.5762	19.9093
	Comp ₃	79,114.9969	45.2137

Source: calculated and compiled by the authors.

The regression coefficient at the share of personnel with academic degrees in academic staff is negative in the function for QNRv (-305,849.8866). The regression coefficient at the possibility for publications is negative in the function for QNRr (-41.0676). The regression coefficient at financing (grant) of scientific research is negative in the function for QNRv (-4,140.0614).

At that, regression coefficients at the factors from the position of research competencies are positive in both functions of quality. Therefore, factors distinguished in the regulatory approach do not facilitate an increase in quality, while the factors of research competencies ensure an increase in quality. This is the basis for a clarifying regression analysis of the dependence of the quality of national research universities on the factors of research competencies in Russian 2023 (Tables 4-5).

Table 4. Regression analysis of the dependence of the volume of R&D of universities on the factors of research competencies in Russian 2023.

<i>Regression statistics</i>						
Multiple R	0.4945					
R-square	0.2446					
Adjusted R-square	0.1574					
Standard error	1,004,067.3868					
Observations	30					
<i>ANOVA</i>						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	3	8.48604*10 ¹²	2.82868*10 ¹²	2.8058	0.0595	
Residual	26	2.62119*10 ¹³	1.00815*10 ¹²			
Total	29	3.4698*10 ¹³				
<i>Coefficients</i>						
	<i>Coefficients</i>	<i>Standard error</i>	<i>t-Stat</i>	<i>P-Value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Y-intercept	239,141.5769	553,545.5431	0.4320	0.6693	-898,687.5825	1,376,970.7364
Comp ₁	158.3560	129.1746	1.2259	0.2312	-107.1663	423.8783
Comp ₂	19,358.2609	18740.8674	1.0329	0.3111	-19,164.1437	57,880.6655
Comp ₃	34,315.8624	27,790.0798	1.2348	0.2279	-22,807.4648	91,439.1896

Source: Calculated and compiled by the authors.

Results from Table 4 allow compiling the following equation of multiple linear regression:

$$QNRv=239,141.5769+158.3560*Comp_1+19,358.2609*Comp_2+34,315.8624*Comp_3 \quad (3)$$

According to equation (3), an increase in the citation rate of publications by 1 leads to an increase in the volume of R&D by RUB 158,356. An increase in the number of licensing agreements by 1 leads to an increase in the volume of R&D by RUB 193,583.2609. An increase in the share of young scholars by 1% leads to an increase in the volume of R&D by RUB 34,315.8624.

The discovered regularity is true at the level of significance of 0.1. This is due to the fact that

significance $F=0.0595$; at 3 factor variables ($m=3$) and 30 observations ($n=30$) $k_1=m=3$, $k_2=n-m-1=30-3-1=26$, F -table equals 2.3075; F -observed equals 2.8058 (exceeding F -table); therefore, the F -test was passed.

Equation (3) has 29 degrees of freedom. For factor variables $Comp_1$ (T -observed equals 1.2259) and $Comp_3$ (T -observed equals 1.2348), the t -test was passed at the level of significance of 0.25, where T -table equals 1.1739. The performed tests confirmed (on the whole) the reliability of equation (3).

Table 5. Regression analysis of the dependence of universities' revenues from R&D on the factors of research competencies in Russian 2023.

<i>Regression statistics</i>						
Multiple R	0.7080					
R-square	0.5012					
Adjusted R-square	0.4437					
Standard error	693.4722					
Observations	30					
<i>ANOVA</i>						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>	
Regression	3	12,564,452.2740	4,188,150.7580	8.7089	0.0004	
Residual	26	12,503,497.0824	480,903.7339			
Total	29	25,067,949.3564				
<i>Coefficients</i>						
	<i>Coefficients</i>	<i>Standard error</i>	<i>t-Stat</i>	<i>P-Value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>
Y-intercept	-601.2292	382.3134	-1.5726	0.1279	-1,387.0858	184.6273
Comp ₁	0.1955	0.0892	2.1914	0.0376	0.0121	0.3789
Comp ₂	0.6764	12.9436	0.0523	0.9587	-25.9296	27.2824
Comp ₃	71.3161	19.1936	3.7156	0.0010	31.8631	110.7691

Source: Calculated and compiled by the authors.

Results from Table 4 allow compiling the following equation of multiple linear regression:

$$QNRr = -601.2292 + 0.1955 * Comp_1 + 0.6764 * Comp_2 + 71.3161 * Comp_3 \quad (4)$$

According to equation (4), an increase in the citation rate of publications by 1 leads to an increase in revenues from R&D by RUB 195.5. An increase in the number of licensing agreements by 1 leads to an increase in revenues from R&D by 676.4. An increase in the share of young scholars by 1% leads to an increase in revenues from R&D by RUB 71,316.1.

The discovered regularity is true at the level of significance of 0.01. This is due to the fact that significance F equals 0.0004; at 3 factor variables ($m=3$) and 30 observations ($n=30$) $k_1=m=3$, $k_2=n-m-1=30-3-1=26$, F -table equals 4.6366; F -observed equals 8.7089 (exceeding F -table); therefore, the F -test was passed. Equation (4) has 29 degrees of freedom. For the factor variables $Comp_1$ (T -observed equals 2.1914) and $Comp_3$ (T -observed equals 3.7156), the t -test was passed at the level of significance of 0.01, where T -table equals 2.7564. The performed tests confirmed (on the whole) the reliability of equation (4).

Thus, positive values of the coefficients of regression in equation (3) and (4) proved hypothesis H. This allows for a conclusion that the quality of activities of national research universities is determined by the level of development and degree of disclosure of research competencies of scholars: citation rate of their publications, number of concluded licensing agreements, and science-making activity of young scientists.

4.2. The Pareto optimum of growth of quality in Russian universities through the development of research competencies

To solve the second task, which consists in finding the Pareto optimum of the growth of the quality in Russian universities through the development of research competencies, the simplex method was used (based on the research model (1)) to find the combination of the factors of quality from the position of research competencies ($Comp_1$, $Comp_2$, $Comp_3$), at which the targeted result is maximised ($TR_{QNR}=1,000$). The method of trend analysis is used to determine the growth rate (trend) of the values of the indicators compared to 2023 (Figure 2).

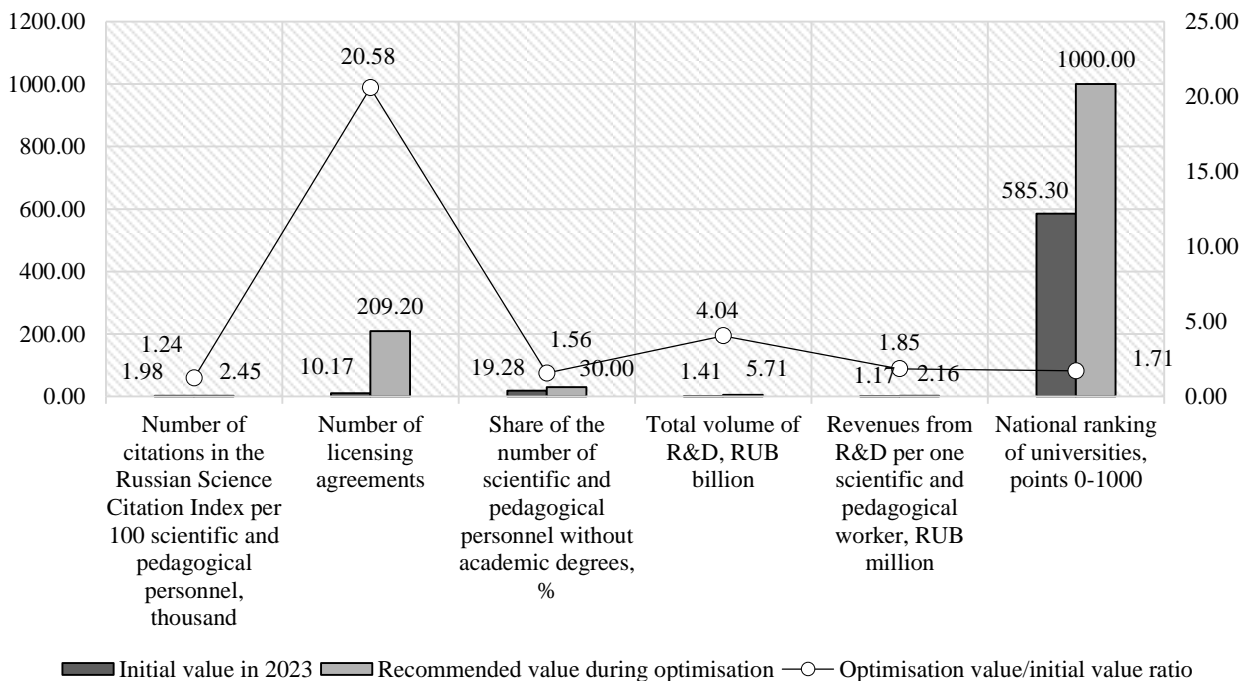


Figure 2. The Pareto optimum and the way to achieve it

Source: Calculated and compiled by the authors.

As shown in Figure 2, the calculated Pareto optimum implies an increase in the number of citations in the Russian Science Citation Index by 1.24 times (from 1,980 in 2023 to 2,450), growth of the number of licensing agreements by 20.58 times (from 10.17 in 2023 to 209.20), and an increase in the share of young scholars by 1.56 times (from 19.28% in 2023 to 30%). The implementation of the proposed measures and achievement of these control values of indicators will allow for the growth of the volume of R&D by 4.04 times (from RUB 1.41 billion in 2023 to RUB 5.71 billion) and an increase in the revenues from R&D per one scientific and pedagogical worker by 1.85 times (from RUB 1.17 million to 2.16 million). This will ensure an improvement in the positions of national research universities in the National Ranking of Universities by 1.71 times (from 585.30 points in 2023 to the maximum possible 1,000 points).

Thus, the determined Pareto optimum showed the prospect for the maximisation of quality in Russian national research universities through the development of research competencies.

4.3. Competence-based approach to quality management in national research universities of Russia

To improve quality management in national research universities of Russia, it is recommended to use a new approach – through the development of research competencies of scientific and pedagogical personnel, due to which this approach is called competence-based.

To solve the third task, which consists in the development of a competence-based approach to quality management in national research universities of Russia, the matrix method is used.

This method is utilised to develop and present (Table 5) the map of competencies for quality management in national research universities of Russia, which reflects targeted benchmarks of the development and disclosure of competencies, a set of competencies, methods of developing competencies, and university’s departments that are responsible for the development of competencies.

The first recommended targeted benchmark (Table 5) of the development and disclosure of competencies is an increase in the citation rate of publications (in the Russian Science Citation Index). To achieve this targeted benchmark, the following set of research competencies is needed:

- Ensuring search optimisation of the published scientific materials. A means of developing this competence is an organisation of scientific workshops, webinars, and advanced training courses.
- Focus on the most relevant topics in R&D and in scientific publications. A means of developing this competence is holding meetings of chairs.
- Achievement of vivid and theoretically important scientific novelty in publications. A means of developing this competence is the tutorship of experienced scientific and pedagogical workers for young scholars.

Table 5. Map of competencies for quality management in national research universities of Russia

Targeted benchmark of the development and disclosure of competencies	Competencies	Method of developing competencies	Responsible department
Increase in citation rate of publications (in the Russian Science Citation Index)	Support for search optimisation of published scientific materials	Scientific workshops, webinars, advanced training courses	Heads of chairs
	Focus on the most relevant topics in R&D and in scientific publications	Meetings of chairs	
	Achievement of the vivid and theoretically important scientific novelty in publications	Tutorship	
Increase in the number of licensing agreements	Achievement of high practical significance of R&D and their results	Practice at local companies	Heads of chairs
	Scientific communications for the popularisation of R&D and their results in business circles	Advanced training in economic literacy	Marketing department
	Legal registration of rights for the objects of intellectual property and conclusion of licensing agreements	Advanced training in legal literacy	Intellectual property department
	Engineering support for implementing the results of R&D	Practice at local companies	Heads of chairs
Increase in the science-making activity of young scholars	Creative thinking in scientific research	Stimulation of creative activity	HR department, head of chairs
	Participation in scientific teams uniting experienced and young scholars	Flexible team-building	

Source: Authors

The structural department of the university that is responsible for developing and disclosure of competencies is the head of chairs. The second targeted benchmark is an increase in the number of licensing agreements. To achieve this targeted benchmark, the following set of research competencies is needed:

- Achievement of high practical significance of R&D and their results. A means of developing this competence is practice at local companies. The responsible structural department of the university is the heads of chairs;
- Scientific communications for the popularisation of R&D and their results in business circles. A means of developing this competence is advanced training for economic literacy. The responsible structural department of the university is the marketing department;
- Legal registration of rights for the objects of intellectual property and conclusion of licensing agreements. A means of developing this competence is advanced training for legal literacy. The responsible structural department of the university is the intellectual property department;
- Engineering support for implementing the results of R&D. A means of developing this competence is practice at local companies. The responsible structural department of the university is the heads of chairs.

The third targeted benchmark is an increase in the science-making activity of young scholars. To achieve this targeted benchmark, the following set of research competencies is needed:

- Creative thinking in scientific research. A means of developing this competence is the stimulation of creative activity;

- Participation in scientific teams uniting experienced and young scholars. A means of developing this competence is flexible team-building.

Structural departments of the university that are responsible for the development and disclosure of competencies are the HR department and heads of chairs. The compiled map of competencies (Table 5) has formed a scientific and methodological basis for using the competence-based approach to quality management in national research universities of Russia.

5. DISCUSSION

This paper’s contribution to the literature consists in the development of the scientific provisions of the theory of quality management in universities through the development of a new – competence-based – approach to quality management in national research universities of Russia. Alternative approaches to this management are compared in Table 6.

As shown in Table 6, the develop competence-based approach involves a completely new organisation of management information systems in national research universities. Unlike Vanchukhina et al. (2022), the source of quality in the competence-based approach is not the creation and execution of corporate standards of quality in national research universities (as in the regulatory approach) but the research competencies of scientific personnel of the university.

Table 6. Comparison of the alternative approaches to quality management in national research universities

Spheres of the comparison of the approaches	Alternative approaches to quality management in national research universities	
	Regulatory approach	Competence-based approach
Source of quality	Creation and execution of corporate standards of quality in national research universities (Vanchukhina et al., 2022)	Research competencies of the university's academic staff
Mechanism of HR management of quality	Norming of labour of academic staff and creation of favourable conditions for the execution of plans (norms) by all personnel (Elayan and Sleimi, 2021)	Development of research competencies of the university's academic staff
Key spheres and targeted benchmarks of quality management in universities: indicators of management information systems	<ul style="list-style-type: none"> • Growth of publication activity (2.27%) (Bouabid and Achachi, 2022; Kipnis and Brush, 2023); • Expansion of opportunities for publications through an increase in the number of scientific journals that are published by the university (-5.45%) (Kumar et al., 2023); • Increase in the share of personnel with academic degrees in personnel (10.40%) (Al-Zoubi et al., 2023); • Norming of revenues from the use of the results of intellectual activities (19.82%) (Bogoviz et al., 2017; Sergi and Popkova, 2022; Veselovsky et al., 2017); • Growth of financing (grant) of scientific research (53.33%) (Babina et al., 2023). 	<ul style="list-style-type: none"> • Increase in citation rate of publications (41.81%); • Increase in the number of licensing agreements (36.72%); • Increase in the science-making activity of young scholars (48.26%).

Source: Authors

Unlike Elayan and Sleimi(2021), the mechanism of HR management of quality in the competence-based approach is not the norming of labour of academic staff and creation of favourable conditions for the execution of plans (norms) by all personnel (as in the regulatory approach) but the development of research competencies of the university's academic staff.

Contrary to the regulatory approach, quality in national research universities is not ensured by such managerial measures as growth of publication activity (correlation with R&D: 2.27%) (unlike Bouabid and Achachi, 2022; Kipnis and Brush, 2023), expansion of opportunities for publications through an increase in the number of scientific journals that are published by the university (-5.45%) (unlike Kumar et al., 2023), an increase in the share of personnel with academic degrees (10.40%) (unlike Al-Zoubi et al., 2023), norming of revenues from the use of the results of intellectual activities (19.82%) (unlike Bogoviz et al., 2017; Sergi and Popkova, 2022; Veselovsky et al., 2017) and growth of financing (grant) for scientific research (53.33%) (unlike Babina et al., 2023).

The key spheres and targeted benchmarks of quality management in universities, i.e., the indicators of management information systems in the competence-based approach are as follows: an increase in citation rate of publications (41.81%) (in support of Anderson, 2021; Li and Yin, 2022), an increase in the number of licensing agreements (36,72%) (in support of Zhao and Li-Ying, 2023), and an increase in science-making activity of young scholars (48.26%) (in support of Lambovska and Todorova, 2023).

Thus, hypothesis H was proved. Due to this, the paper supports the discussion, which continues, in particular, in the works by Alharbi et al. (2020), Bogoviz et al. (2020), Dewi et al. (2021), Lestari et al. (2021), Pasic et

al. (2022), on the issues of quality management in universities.

6. CONCLUSION

The main conclusion as a result of the performed research is that the quality of activities of national research universities is determined by the level of development and the level of disclosure of research competencies of scholars/: citation rate of their publications, the number of concluded licensing agreements, and science-making activity of young scientists.

At that, as Russia's experience in 2023 showed, standard factors – publication activity, revenues from the use of the results of intellectual activities, the share of personnel with academic degrees, opportunities for publications, and financing (grant) of scientific research – do not positively influence the quality of national research universities.

The main obtained results are brought down to the following. First, the important role of research competencies in quality management in Russian universities was proved – confirmed by the econometric model for 2023. Second, the Pareto optimum was found, which demonstrated the possibility for the maximisation of quality in Russian universities through the development of research competencies. Third, to achieve this Pareto optimum, a map of competencies for quality management in national research universities of Russia was proposed.

The theoretical significance of this paper consists in the development of a new – competence-based – approach to quality management in national research universities of Russia, which originality consists in the transition from norming to the development of research competencies in universities. The practical significance

is that the developed competence-based approach will allow improving the practice of quality management in national research universities of Russia. Thus, the paper supports the project of the “Decade of Science and Technologies in Russia”.

Summing up this research, it should be noted that though the competence-based approach to quality management in national research universities of Russia is universal, the proposed control values of the

indicators of quality management within the presented Pareto optimum are based on the experience of Russian universities and can be applied only to them. This is a limitation of the paper’s results. To overcome this limitation, future studies should find other Pareto optimums – based on the compiled econometric model – and offer control values of the indicators of quality management for other countries, to adapt the competence-based approach to their specifics.

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Appendix

The statistical base

National research university of Russia	National Ranking of Universities Interfax 2023, points 0-1000	Total volume of R&D works, RUB thousand	Revenues from R&D (except for the funds from the budgets of the budget system of the Russian Federation and government funds of support for science) per one scientific and pedagogical personnel, RUB thousand	Number of citations of publications, published over the last five years, indexed in the Russian Science Citation Index, per 100 scientific and pedagogical personnel	Number of the publications of an organisation, indexed in the information and analytical system of scientific citation the Russian Science Citation Index per 100 scientific and pedagogical personnel	Number of licensing agreements	Share of funds received by the educational organisation from the use of the results of intellectual activities, in the total revenues of the educational organisation, %	Share of scientific and pedagogical personnel without academic degrees – under the age of 30, Ph.D.'s – under the age of 35, doctors of science – under the age of 40, in the total number of scientific and pedagogical personnel	Share of scientific and pedagogical personnel who defended Ph.D. and doctoral theses during the reported period in the total number of scientific and pedagogical personnel, %	Number of scientific journals, including online, published by the educational organisation	Number of grants received during the reported year, per 100 scientific and pedagogical personnel	Link to the information and analytical materials as a result of the monitoring of the activities of educational organisations of higher education
National Research Nuclear University MEPhI	935	1612293.80	2843.10	3801.87	354.96	5	0.08	14.22	0.44	11	18.25	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=165
Moscow Institute of Physics and Technology	915	3729789.20	3694.82	3938.91	395.70	34	0.77	33.92	1.71	3	30.72	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=161
National Research University "Higher School of Economics"	854	5127712.60	969.36	864.34	210.42	9	0.03	21.02	1.17	26	10.87	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=1766
National Research Tomsk State University	805	1698022.40	515.91	1956.91	442.62	8	0.04	23.39	2.78	32	21.64	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=294
Novosibirsk State University	771	925382.70	185.11	2891.50	621.89	4	0.05	13.63	1.20	14	15.34	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=178
National University of Science and Technology (MISIS)	745	1928558.90	2527.78	7025.46	265.74	9	0.03	25.50	1.42	14	26.54	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=59
National Research Tomsk Polytechnic University	736	1655049.50	1298.23	1165.20	125.19	7	0.02	21.18	1.01	4	8.72	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=296
ITMO University	731	2439953.80	2912.52	1945.77	292.12	21	0.03	34.61	5.22	10	8.95	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=234
Peter the Great St. Petersburg Polytechnic University	693	2357703.70	887.87	5562.58	382.20	53	2.58	22.57	2.51	16	16.55	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=240
Bauman Moscow State Technical University	627	2654579.70	830.75	3735.78	299.56	11	0.06	11.29	1.39	9	3.75	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=147
National Research University "Belgorod State University"	583	1063284.50	627.81	1893.28	371.68	20	0.01	18.81	1.59	18	7.10	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=17

National Research University "Moscow Power Engineering Institute" (MPEI)	560	1552304.00	1458.10	1695.51	463.50	18	0.15	22.57	1.62	4	10.84	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=162
Moscow Aviation Institute	535	2211129.90	1242.13	1421.93	348.56	6	0.02	12.00	1.13	3	5.92	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=131
National Research State University of Nizhny Novgorod named after N.I. Lobachevsky	529	1388164.10	562.48	451.80	135.45	3	0.00	23.60	1.84	9	8.13	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=170
Pirogov Russian National Research Medical University	526	1434032.70	481.63	2213.72	193.11	2	0.00	9.32	0.53	6	0.87	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=1595
Saint Petersburg Mining University	507	1752522.00	2309.88	3303.71	263.64	4	0.32	29.55	4.97	1	12.82	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=237
Kazan National Research Technological University	499	1000428.60	1009.93	720.01	169.60	0	0.02	7.84	1.76	5	3.74	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=88
Saratov Chernyshevskiy State University	494	518731.60	420.14	973.11	416.37	13	0.00	16.35	1.80	14	11.23	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=258
South Ural State University	493	789732.10	364.90	612.90	267.10	10	0.01	13.94	1.34	23	3.47	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=336
Mordovian State University	490	154262.30	51.77	602.38	175.91	8	0.00	11.37	0.93	10	3.23	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=127
Irkutsk National Research Technical University	489	249657.90	220.08	2717.34	411.58	9	0.15	11.63	0.92	7	0.26	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=82
Moscow State University of Civil Engineering	475	929685.30	1206.84	500.47	252.73	2	0.04	21.55	2.07	4	0.81	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=144
Kazan National Research Technical University	474	689371.00	801.48	1372.06	400.98	0	0.00	15.44	2.29	2	0.00	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=87
National Research University of Electronic Technology	470	745831.70	2182.99	1086.44	196.18	28	0.02	18.80	0.91	2	17.72	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=140
Samara University	468	632027.90	512.41	657.10	158.64	5	0.00	14.76	1.35	14	8.78	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=251
Perm National Research Polytechnic University	467	1503241.50	2018.01	2901.40	290.40	12	0.04	24.20	1.41	15	17.47	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=197
Gubkin Russian State University of Oil and Gas	444	699733.60	841.53	712.11	242.60	2	0.00	16.54	0.93	10	0.67	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=219
Perm State National Research University	425	557817.10	663.82	2200.25	460.29	0	0.00	21.08	3.13	31	10.78	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=198
St. Petersburg National Research Academic University of the Russian Academy of Sciences	413	115664.50	1097.43	0.00	0.00	0	0.00	32.24	6.06	0	0.00	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=1785
Platov South-Russian State Polytechnic University	406	219296.60	293.99	511.22	255.32	2	0.13	15.40	1.16	4	6.27	https://monitoring.miccedu.ru/iam/2022/_vpo/inst.php?id=334