

Analysis of the potential of Russian universities due the Project 5-100 implementation

Alexander Tatochenko¹, Irina Tatochenko¹, Nikolay Chernegov^{1,}, and Larisa Poletaeva¹*

¹K.G. Razumovsky Moscow State University of Technologies and Management (the First Cossack University), 73, Zemlyanoy val, Moscow, 109004, Russian Federation

Abstract. The presented study analyzes the possibility of Project 5-100 implementing, initiated by the Decree of the President of Russia. It is aimed at increasing the competitiveness of leading Russian universities in relation to the world's leading scientific and educational centers and solving a number of other important tasks in the development of education and science in Russia. The main rankings evaluating higher educational institutions have been studied, among them the most authoritative universities in the world have been identified. A list of Russian higher education institutions that are assessed or have a chance to be included in these ratings has also been established. It was revealed that as of 2020, the only Russian university that consistently occupies a worthy place in one of the generally recognized world rankings is the Lomonosov Moscow State University. At the same time, the authors have made a quantitative assessment of the likelihood of inclusion of Russian higher educational institutions in the world university rankings. It has also been established which of the world rankings domestic universities can reach high places as quickly and successfully as possible. As a result, the objectives of Project 5-100 seem to be the most attainable within the framework of this rating. To solve such an important task, it was proposed to analyze in detail the methodology for giving marks to higher educational institutions present in it. In addition, it has been proven that it is necessary to develop measures to improve the assessment of domestic universities in a number of world research and educational centers.

1 Introduction

Since 2012, the Russian system of higher professional education (HPE) has been implementing the Project to improve the competitiveness of leading Russian universities among the world's leading research and educational centers (hereinafter – Project 5-100), initiated by the Decree of the President of the Russian Federation №599 dated 07.05.2012. The goal of the Project is to enter at least five of the best Russian universities in the top 100 leading world university rankings. In November 2019, it was decided to expand the number of Project participants to 30, starting in 2020, and for the next 6 years. This measure, apparently, is due to the fact that the declared goal of the Project was not achieved for a number of reasons. So, of the domestic universities, only the Moscow State University.

*Corresponding author: chernick@mail.ru

M.V. Lomonosov is relatively confident in the top 100 of only two rankings recognized in the world university community – Shanghai and QS (the best result is 74th position in 2020). In this regard, when determining the potential of Russian universities, identifying the world's leading university rankings, in which Russian universities have the greatest chances of entering the top 100, is a priority and urgent issue.

2 Problem Statement

Traditionally, the following ratings are considered the most authoritative in the world educational community:

- Academic Ranking of World Universities (ARWU) – so-called Shanghai Ranking, compiled since 2003 by Shanghai Jiaotong University's World-Class University Research Center [1];

- Times Higher Education World University Rankings (THE) – so-called Times Ranking published by Times Higher Education magazine since 2004 [2];

- QS World University Rankings – so-called QS-rating, formed up to 2009 by Quacquarelli Symonds (Great Britain) under the joint brand THE-QS, and since 2010 – formed independently [3];

- Leiden University Center for Science and Technology Research (CWTS) ranking – the so-called The Leiden rating, which was first compiled in 2007, and has been published in its current form since 2011. [4].

It is necessary to consider the position of the leading Russian universities in the listed ratings.

3 Materials and Methods

Consider the position of the leading Russian universities in the listed rankings – it was compiled by the authors of the article on the basis of sources [1-4] and is presented in Table 1.

Table 1. Position of Russian universities in world university rankings in 2020.

№	Rating University	QS	THE	ARWU	CWTS
1	Moscow State University named after M.V. Lomonosov	84	189	93	250
2	Saint Petersburg State University	234	601-800	301-400	496
3	Moscow Institute of Physics and Technology	302	201-250	401-500	–
4	Novosibirsk State University	231	501-600	501-600	912
5	National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)	329	401-500	701-800	–
6	Ural Federal University	364	---	701-800	1012
7	Kazan Federal University	392	601-800	901-1000	1019
8	National Research University Higher School of Economics	322	251-300	801-900	1039
9	Tomsk State University	268	501-600	801-900	–
10	Saint Petersburg National Research University of Information Technologies, Mechanics and Optics	436	401-500	901-1000	1174

11	National Research Technological University "MISiS"	451	601-800	901-1000	–
12	Saint Petersburg State Polytechnic University	439	501-600	–	–
13	National Research Tomsk Polytechnic University	387	601-800	–	–
14	Moscow State Technical University named after N.E. Bauman	284	801-1000	–	–
15	Peoples' Friendship University of Russia	392	801-1000	–	–
16	Saint Petersburg Mining University	–	801-1000	–	–
17	Moscow State Institute of International Relations	366	–	–	–
18	Saratov State University named after N.G. Chernyshevsky	521-530	–	–	–
19	Far Eastern Federal University	531-540	–	–	–
20	South Federal University	541-550	–	–	–
21	Lobachevsky University	601-650	–	–	–
22	Samara University	651-700	–	–	–
23	Russian Economic University named after G.V. Plekhanov	751-800	–	–	–
24	Novosibirsk State Pedagogical University	801-1000	–	–	–
25	Voronezh State University	801-1000	–	–	–
26	South Ural State University	801-1000	–	–	–
27	Total rating participants	1001	1001	1000	1176
28	Incl. from Russian Federation	25	15	11	7

Already at the stage of preliminary analysis of the table data, the following dependence was noted. In order of magnitude (10^3) the number of universities, included in the ratings under consideration, coincides with a slightly larger (about 17%) number of participants in the CWTS rating. At the same time, the number of Russian universities included in the QS ranking is 1.7 times more than in THE, 2.3 times more than in ARWU and 3.6 times more than in CWTS. It should also be noted that the best national university is Moscow State University. M.V. Lomonosov, occupies the highest position (84) in the QS rating, close to her (93) in the ARWU rating, and in the THE and CWTS ratings, his position is significantly lower – 189 and 250 positions, respectively. At first glance, Russian universities are best represented in the QS-rating, but it is desirable to operate with a specific quantitative assessment. To obtain it, we use the methodology proposed by the authors of the article. We will assign points to each university participating in the rating according to the place occupied. Taking into account the fact that the goal for Russian universities is to enter the top 100, the scale of the assigned points may look as follows, presented in Table 2.

Table 2. Earning points for places in the ranking positions.

№	Ranking position	Points awarded	Comment
1	1-100	10	Highest score for entering the top 100
2	101-200	8	Increased score for being close to the top 100
3	201-300	6.5	See comment on line 2
4	301-400	5	Score growing in proportion to the place in the rating
5	401-500	4	See comment on line 4
6	501-600	3	See comment on line 4
7	601-800	2	See comment on line 4
8	801+	1	Minimum score for entering the rating

For each rating, a corresponding assessment can be obtained in the form of the sum of points scored by the universities included in the rating. The value of this estimate will depend on two factors: 1) the number of universities included in the ranking; 2) the places occupied by universities in the ranking. Obviously, the most promising from the point of view of Project 5-100 implementation is the rating with the highest point score. Mathematically, the proposed score can be expressed as follows:

$$O = \sum_{i=1}^N Bi \tag{1}$$

where: O – rating score;

N – number of universities included in the ranking;

Bi – the point awarded to the i-th university in accordance with the place in the ranking (see Table 2).

To improve the accuracy of the proposed quantitative assessment, we introduce a correction factor that takes into account the proximity of the location of universities to the top 100 ranking. Let us explain the necessity of introducing a correction factor using the following example. Suppose 5 Russian universities are included in the top 100 of a certain rating. An appropriate rating score will matter: $O_1 = 5 \cdot 10 = 50$ points (Table 2). Another ranking includes 7 universities in positions 101-200, the score will be: $O_2 = 7 \cdot 8 = 56$ points. The third rating includes 10 universities in positions 201-300, respectively, the rating for the rating will be equal to: $O_3 = 10 \cdot 6.5 = 65$. You can see that the first rating, for which the task of Project 5-100 can be considered completed, has an estimate lower than the other two. At the same time, the score of the second rating is lower than that of the third, in which all universities occupy significantly worse positions. There is a contradiction between the categories of quantity and quality, which can be removed by a correction factor calculated by the formula:

$$F_{corr.} = U_{av.} / B_{max.} = (\sum_{i=1}^N Bi / N) / U_{max.} \tag{2}$$

where: F_{corr.} – dimensionless correction factor;

U_{av.} – the average score of the university in the ranking, defined as the ratio of sum of points $\sum Bi$, received by universities included in the ranking to the number of universities N in it;

U_{max.} – the maximum score for a place in the rating, in this example U_{max.} = 10 (Table 2).

The calculated values of the correction factors for the three ratings will be:

$$F_{corr.1} = (50/5) / 10 = 1,00$$

$$F_{corr.2} = (56/7) / 10 = 0,80$$

$$F_{corr.3} = (65 / 10) / 10 = 0,65$$

The above estimates for the ratings, taking into account the correction factors, will take the values:

$$A_{corr.1} = 50 * 1 = 50,00$$

$$A_{corr.2} = 56 * 0,80 = 44,80$$

$$A_{corr.3} = 65 * 0,65 = 42,25$$

It can be seen that the adjusted scores more accurately reflect the compliance of the ratings with the criteria of the Project 5-100 problem, since the score of the first rating, for which the problem is solved, is the highest.

Thus, the final calculation formula for the adjusted rating assessment will take the form:

$$A_{corr.} = O * F_{corr.} = (\sum_{i=1}^N B_i)^2 / N * U_{max}. \tag{3}$$

In accordance with the proposed methodology, based on the materials in Table 1, the authors performed calculations using formulas (1), (2), (3). The calculation results are presented in Table 3.

Table 3. Quantitative assessments of the participation of Russian universities in world rankings in 2020.

№	Rating Indicator for Russian universities	QS	THE	ARWU	CWTS
1	Number of universities participating in the ranking	25	15	11	8
2	Top position in the ranking	84	189	93	250
3	The amount of points awarded to the participants in the rating	106	49	31	15.5
4	Average score of the rating participants	4.2	3.3	2.8	2.2
5	Correction factor	0.42	0.33	0.28	0.22
6	Adjusted score. points	44.5	16.2	8.7	3.4
7	The same in relation to the QS rating indicator.%	100.0	36.4	19.5	7.6
8	Conditional average position of participants in the rating. place	381	471	521	581

Note that the average score in the ranking can serve as an estimate of the average position occupied by universities. Assuming that the scale of points is piecewise linear between its reference points, we can conclude that when moving along positions 101-1, there is an increment of 2 points (from 8 to 10 – see Table 2, lines 1,2), which corresponds to the scale division price in this area of 0.02 points. When moving through positions 201-101 and 301-201, the increments are 1.5 points (from 6.5 to 8 and from 5 to 6.5 – see Table 2, lines 2.3 and 3.4), and the price scale divisions – 0.15 points, respectively. Similarly, it can be established that the scale divisions in the areas between positions 401-301, 501-401, 601-501 have a value of 0.01 points, and between positions 801-601 – 0.005 points. Taking this into account, the conditional average position of domestic universities in the QS ranking (average score – 4.2 - Table 3, line 4) can be determined as follows:

$$401 - 0,2/0,01 = 381$$

When calculating, it was assumed that position 401 corresponds to an assessment of 4.0 points, an increase in the assessment by 0.2 points corresponds to an increase of 20 positions at a scale division price of 0.01 defined above. Similarly, conditional average positions for other ratings can be calculated – table 3, line 8.

4 Results

Analysis of the data in the table shows that in all quantitative indicators, the QS rating is significantly superior to other ratings. Accordingly, the objectives of Project 5-100 seem to be the most attainable within the framework of this rating. To confirm this assumption, we will conduct a time-based analysis, considering the results of the ratings of 2012 (start of Project 5-100) and 2016 (the middle of the time interval between the start and the current year) – tables 4, 5.

Table 4. The position of Russian universities in world university rankings in 2012 (compiled by the authors of the article based on sources [5-8]).

№	Rating University	QS	THE	ARWU	CWTS
1	Moscow State University named after M.V. Lomonosov	116	276-300	80	499
2	Saint Petersburg State University	253	351-400	401-500	500
3	Moscow State Technical University named after N.E. Bauman	352	–	–	–
4	Moscow State Institute of International Relations	367	–	–	–
5	Novosibirsk State University	371	–	–	–
6	Ural Federal University	451-500	–	–	–
7	Total rating participants	500	402	500	500
8	Incl. from Russian Federation	6	2	2	2

Table 5. The position of Russian universities in world university rankings in 2016 (compiled by the authors of the article based on sources [5-8]).

№	Rating University	QS	THE	ARWU	CWTS
1	Moscow State University named after M.V. Lomonosov	108	161	87	739
2	Saint Petersburg State University	256	401-500	301-400	775
3	Novosibirsk State University	317	401-500	401-500	–
4	Moscow State Technical University named after N.E. Bauman	338	501-600	–	–
5	Moscow State Institute of International Relations	397	–	–	–
6	Moscow Institute of Physics and Technology	431-440	601-800	–	–
7	Saint Petersburg State Polytechnic University	471-480	201-250	–	–
8	Tomsk State University	481-490	601-800	–	–
9	National Research Tomsk Polytechnic University	481-490	251-300	–	–
10	National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)	501-550	301-350	–	–
11	National Research University Higher School of Economics	501-550	–	–	–
12	Kazan Federal University	551-600	301-350	–	–

13	South Ural State University	601-650	601-800	–	–
14	National Research Technological University "MISIS"	–	601-800	–	–
15	South Federal University	601-650	601-800	–	–
16	Peoples' Friendship University of Russia	601-650	–	–	–
17	Saratov State University named after N.G. Chernyshevsky	601-650	–	–	–
18	Far Eastern Federal University	651-700	–	–	–
19	Total rating participants	701	801	500	842
20	Incl. from Russian Federation	17	13	3	2

The table shows that in terms of the number of universities included in the rankings and the places they occupy, the most advantageous position of Russian universities appears in the QS ranking. The only exception is the higher position of the Moscow State University. Lomonosov in the ARWU rating, but this is the only Russian university that occupies a worthy place in this rating. Quantitative estimates calculated by the authors using formulas (1), (2), (3) are presented in Table 6.

Table 6. Quantitative assessments of the participation of Russian universities in world rankings in 2012-2016.

№	Rating Indicator for Russian universities	QS		THE		ARWU		CWTS	
		2012	2016	2012	2016	2012	2016	2012	2016
1	Number of universities participating in the ranking	6	17	2	13	2	3	2	2
2	Top position in the ranking	116	108	276-300	161	80	87	499	739
3	The amount of points awarded to the participants in the rating	33.5	66.5	11.5	52.0	14	19.0	8	4.0
4	Average score of the rating participants	5.6	3.9	5.8	4.0	7.0	6.3	4.0	2.0
5	Correction factor	0.56	0.39	0.58	0.40	0.70	0.63	0.40	0.20
6	Adjusted score. points	18.7	26.0	6.6	20.8	9.8	12.0	3.2	0.80
7	The same in relation to the QS rating indicator.%	100.0	100.0	35.4	79.9	52.4	46.2	17.1	3.0
8	The same in relation to the QS rating indicator.%	342	409	325	400	233	213	480	601-800

The calculated data are in good agreement with the results obtained for 2020 (Table 3) – the adjusted estimate (line 6) of the QS rating is significantly higher than that of all other ratings. The fact that the average score of participants (row 4) and the conditional average position (row 8) for QS turns out to be significantly lower than for ARWU is explained by the small number of participants in the last ranking (only 2 and 3 universities in 2012 and 2016, respectively). Due to this, the high position of Moscow State University "pulls" the

indicator for the rating as a whole. It should also be noted that a stable trend over the entire considered time interval 2012-2020 is a constant increase in the number of universities included in the rankings with a parallel decrease in the average score of participants. Obviously, the expansion of the list of participants is due to not the strongest universities, for which the very fact of being included in the prestigious world rankings is the primary task. At the final stage of the analysis, to assess the dynamics of the process, we will calculate the average annual growth rates of the main quantitative indicators determined in tables 3 and 6. The calculations were performed by the authors for the time intervals 2012-2016, 2016-2020 and 2012-2020, and their results are presented in table 7.

Table 7. Dynamics of the main quantitative indicators of the participation of Russian universities in world university rankings.

№	Rating Indicator	Time interval	QS	THE	ARWU	CWTS
1	Number of universities included in the ranking – average annual growth rate, %	2012-2016	130	160	111	100
		2016-2020	110	104	138	141
		2012-2020	120	129	124	119
2	The sum of points in accordance with the places in the rating – the average annual growth rate, %	2012-2016	119	146	108	84
		2016-2020	112	99	113	140
		2012-2020	115	120	110	109
3	Average score of rating participants – average annual growth rate, %	2012-2016	091	91	89	84
		2016-2020	102	95	91	102
		2012-2020	96	93	90	93
4	Adjusted score in points – average annual growth rate, %	2012-2016	109	133	105	71
		2016-2020	114	94	92	144
		2012-2020	111	112	99	101

5 Discussion

Thus, the calculations show that the growth rates of almost all indicators in the time interval 2012-2020 are values that are not only the same in order, but also quite close in value (the difference in relative terms does not exceed 10%). Decrease in the average score (line 3) is characteristic, which is a consequence of the expansion of the list of participants at the expense of relatively weak universities. It should also be noted that the adjusted score for the ARWU and CWTS ratings in 2012-2020 does not grow, while QS and THE show an average annual growth of about 10% (row 4). This suggests that in these ratings, the positions of Russian universities tend to improve. Based on the value of this indicator achieved by 2020 (QS – 44.5 points, THE – 16.2 points – Table 3, line 6), we can conclude that domestic universities have the best prospects for achieving high places in the QS ranking. Accordingly, it seems appropriate to focus efforts on promoting Russian universities in this particular rating, for which it is necessary to analyze in detail the system of grading in it and develop measures to increase them for domestic participants in the rating.

6 Conclusion

The performed analysis and the calculations made it possible to draw certain conclusions regarding the possibility of implementing Project 5-100 and the feasibility of taking into account the rating methodology, which can contribute to solving this important task. Therefore, it seems appropriate to focus efforts on promoting Russian universities in this

particular ranking. For this purpose, it is necessary to analyze in detail the system of grading in it and develop measures to increase them for domestic participants in the rating.

References

1. *Shanghai Jiao Tong University, Academic Ranking of World Universities (ARWU)* (2019) <http://www.shanghairanking.com/ARWU2019.html>
2. *Shanghai Ranking's Academic Ranking of World Universities 2019*, <http://www.shanghairanking.com/Academic-Ranking-of-World-Universities-2019-Press-Release.html>
3. Quacquarelli Symonds, *The QS World University Rankings. QS Latin America University Rankings 2019*, <https://www.topuniversities.com/university-rankings/latin-american-university-rankings/2019>
4. M. Mussard, A.P. James, *IEEE* **6**, 6765–6776 (2018)
5. E. Ponomarenko, A. Oganessian, V. Teslenko, *International Journal of Economic Policy in Emerging Economies* **12(4)**, 391-406 (2019)
6. M. Dobrota, V. Jeremic, *IETE Technical Review* **34(1)**, 75-82 (2017)
7. D.G. Rodionov, I.A. Rudskaia, O.A. Kushneva, *Life Science Journal* **11(10s)**, 442-446 (2014)
8. D.G. Rodionov, I.A. Rudskaia, K.O. Alexandrovna, *World Applied Sciences Journal* **31(6)**, 1082-1089 (2014)
9. I.B. Stukalova, A.A. Stukalova, G.N. Selyanskaya, *International Journal of Environmental and Science Education* **11(15)**, 7961-7974 (2016)
10. D.G. Rodionov, N.G. Fersman, O.A. Kushneva, *International Journal of Environmental and Science Education* **11(8)**, 2207-2222 (2016) DOI: 10.12973/ijese.2016.591a
11. D. Rodionov, E. Yaluner, O. Kushneva, *European Journal of Science and Theology* **11(4)**, 199-212 (2015)
12. I. Stukalova, A. Shishkin, A. Stukalova, *Economics & Sociology* **8(1)**, 275-286 (2015)
13. N. Koryagina, E. Bagreeva, L. Makhova, *Journal of Entrepreneurship Education* **21(2)** (2018)