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

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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.
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 rankings.

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  |
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-ranking, 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 ranking  |
| 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 ranking                   |

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:

\[ O = \sum_{i=1}^{N} B_i \]  

(1)

where:

- \( O \) – rating score;
- \( N \) – number of universities included in the ranking;
- \( B_i \) – 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: \( O_1 = 5 \times 10 = 50 \) points (Table 2). Another ranking includes 7 universities in positions 101-200, the score will be: \( O_2 = 7 \times 8 = 56 \) points. The third rating includes 10 universities in positions 201-300, respectively, the rating for the rating will be equal to: \( O_3 = 10 \times 6.5 = 65 \). 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:

\[ F_{corr} = \frac{U_{av}}{B_{max}} = \left( \frac{\sum_{i=1}^{N} B_i}{N} \right) / U_{max}. \]  

(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 \( \sum B_i \), 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:

\[ \text{Acorr.1} = 50 \times 1 = 50.00 \]
\[ \text{Acorr.2} = 56 \times 0.80 = 44.80 \]
\[ \text{Acorr.3} = 65 \times 0.65 = 42.25 \]

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:

\[ \text{Acorr.} = \mathbf{O} \times \text{Fcorr.} = \left( \sum_{i=1}^{N} B_i \right)^{2} / N \times \text{Umax}. \quad (3) \]

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  | 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               | 501-550 | 301-350   | –    | –    |
| 11 | National Research University Higher School of Economics   | 501-550 | –         | –    | –    |
| 12 | Kazan Federal University                                 | 551-600 | 301-350   | –    | –    |
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 2012 | QS 2016 | THE 2012 | THE 2016 | ARWU 2012 | ARWU 2016 | CWTS 2012 | CWTS 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 ranking | 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.

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