Journal of Engineering Education Transformations ,
Volume 36 , No. 1 , July 2022 , ISSN 2349-2473, eISSN 2394-1707

The Influence of Multidisciplinary Factor on the Technical Universities' Positions in International Rankings

Leonid Sobolev
Moscow Aviation Institute (National Research University), Moscow, Russia
sobolevlb@yandex.ru

Abstract : The article is devoted to a comparative analysis of world-class technical universities (TUs) ranks in the International Quacquarelli Symonds (QS) ranking 2021. The top-100 of QS-2021 includes only one Russian TUs, and there are no TUs of large industrial countries such as India and Brazil. Many Russian TUs were founded in the 30s of the last century, were related to certain industry ministries and have retained their narrow orientation up to the present time. However, the manufacturing of modern high-tech products (aircraft, robotics, electronics, medical equipment etc.) requires engineers to have knowledge from various fields of science (multidisciplinarity), supported by profound interdisciplinary researches. In addition, multidisciplinary TUs provide the opportunity for students to change their specialty or adjust it during their undergraduate and graduate studies. The analysis showed that leading positions in international rankings are occupied by multidisciplinary research TUs that conduct training and interdisciplinary research at the intersection of various scientific activities. This study can be useful not only for Russia, but also for the transformation of TUs in other countries.

Keywords: multidisciplinary, technical university (TU), engineering specialties, training, transformation

1. Introduction

Universities were created historically as educational and research institutions and included the wide spectrum of disciplines available at that time. The development of interdisciplinary research in universities and the organization of regional multidisciplinary universities are global trends. In addition, the employers and the enrollees pay more attention to the position of a university in international rankings. In fact, there is competition between universities for talented students by providing them with the freedom of choosing specialization and the possibility of obtaining practical skills in research activity within the university. The quality of higher education is one of the important factors for the successful development of the country economy. The transition to the knowledge economy is possible only if the country has world-class universities with modern learning and research laboratories, highly qualified staff, and stable relations with companies in industry [1].

Leonid Sobolev
Moscow Aviation Institute
(National Research University), Moscow, Russia
sobolevlb@yandex.ru

Most modern technical (polytechnic) universities, in addition to technical faculties, have faculties of natural sciences, bioengineering and medicine, social sciences and arts. Such structures of the TU corresponds to the desire of many young people to get higher education at the intersection of technical and humanitarian sciences, to change specialization during the learning process and to have more job opportunities after graduation. Among the alumni of world-class TUs, there are famous entrepreneurs, Nobel and other prestigious prizes laureates, scientists, public and statesmen, and even actors. The employers prefer to hire graduates who have acquired skills of a practical and scientific nature at the university. Successful alumni and innovations create the reputation of the university, which is the one of the main factors influencing the university rank in international rankings. Russia is represented by a small number of universities in the global rankings, and the top-100 includes only Lomonosov Moscow State University [2].

The greatest influence on the transformation of Russian TUs towards international standards has been Russia joining the Bologna Convention in 2003 and the creation of national research universities (NRU) and federal universities (FU) in the districts of the Russian Federation. The Government «5-100» project played an important role in increasing the competitiveness of Russian TUs. According to this project, the Russian Government provided financial support to more than twenty Russian universities with the aim to enter into the top-100 of authoritative international rankings: Quacquarelli Symonds (QS), Times Higher Education (THE) and Academic Ranking of World Universities (ARWU). This project was not implemented for a number of reasons, but it undoubtedly increased interest in international rankings [3].

In the last decades, Russia has seen profound transformation from a command economy to a free market economy. These economies differ profoundly in their attitude to ownership on production means, pricing of goods and services, competition in manufacturing and sales, forming a labor market and the role of the Government in the economy. The transition to a market economy requires an adequate reform of higher education, in particular, modernizing learning programs, improving the research base of TUs, introducing competition among students and professors, increasing the role of English for communication with foreign colleagues and much more. Obviously, the low position of Russian technical universities in international rankings leads to the low competitiveness of domestic products in international markets.

The Federal budget remains a main source of financing Russian universities, while world-class TUs, in addition to the Government subsidies, usually have several sources of financing such as regional budgets, tuition fees, preferential contracts from Government and private organizations, private donations and research funds. The big budgets and endowments of the Western universities permit the creation new research laboratories and inviting famous professors and scientists from all over the world. In these conditions, the countries with limited financial resources are looking for ways to improve the ratings of universities without fundamentally breaking the existing higher education system. One of the ways to improve the ranks of TUs is multidisciplinarity (similar to the creation of conglomerate companies in industry) through increasing the number of academic programs and schools or mergers with other universities.

The purpose of the article is to analyze the influence of a multidisciplinary factor on the TUs rank in the Subject and Global QS rankings 2021 and the possibility of raising this rank through the merger process.

2. Methodology

The universities in QS rankings are assessed on the basis of several indicators with different weightings: reputation (the opinion of the academic community and employers about the university), quality of learning (feedback from graduates, the number of Nobel and other well-known prizes among university professors and researchers), innovation and practical value of research works, publication activity and citations, and the proportion of foreign students and professors. In QS ranking 2021 an assessment of a university is given not only by global indicators, but also by a subject principle, including 48 specialties (disciplines) [4].

These specialties are collected into five subject groups:

- Engineering & Technology (E&T),
- Natural Sciences (NS),

- Social Sciences (SS),
- Life Sciences & Medicine (LS&M),
- Arts & Humanities (A&H).

The methodology of this article is based on the interdependence and complementary nature of all five subject groups in the multidisciplinary TUs, the E&T being the core of this scientific and educational system (Fig. 1). Thus, innovations in NS allow conducting applied researches and creating the innovative products in E&T. The feedback also works: the demand for new scientific equipment for NS is met by E&T. Innovations in SS (especially in the economics) drive the successful commercialization of innovative products created by E&T, and consequently successful startups are case studies for economics programs.

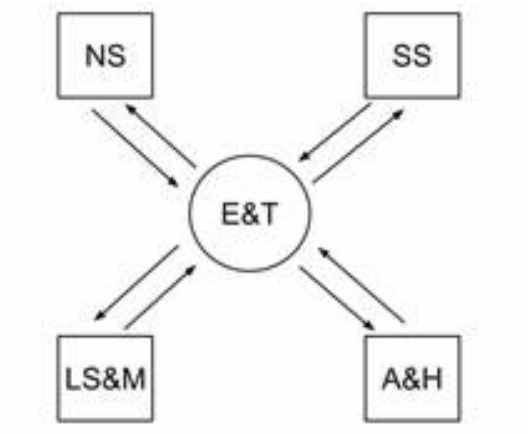

Fig.1 : Interdependence of the subject groups in the multidisciplinary TUs

Modern civilization considers human health and the environment as the priorities for scientific and industrial activity. Therefore, each TU should have strong LS&M, set tasks for creating new instruments and equipment for medicine and environmental protection. And vice versa, the knowledge of medical practice leads to developing unique devices (for example, Da Vinci Surgical System). In addition, the important requirement for modern technical devices and machines is the ergonomics and aesthetics (design) created in A&H. The innovative engineering solutions and technologies open up new opportunities for leisure and sports. Thus, multidisciplinary TUs have competitive advantages over industry TUs due to both better student selection and a greater variety of scientific research.

3. Results

3.1. General information

The top 100 of the Global QS-2021 are represented by the following regions:

- North America (USA and Canada) - 30
- Europe (excluding Russia and the CIS) - 33
- Asia - 26
- Oceania - 8
- South America - 2
- Russia and the CIS - 1
- Africa – 0.

In general, the number of high-quality universities corresponds to the contribution of the respective regions in the Global GDP and reflects the interaction of their industrial potential with the quality of engineering education. Tables 1-3 show the ranks of the 15 best TUs of three regions (North America, Europe and Asia) in the Subject and Global QS-2021. These TUs have not only good engineering schools, but also provide good training in disciplines, at first glance, little connected with engineering. Today the most demanded engineering specialties (computer and robotics engineering, aerospace engineering, military engineering, etc.) require the knowledge from various scientific fields. In addition, students can adjust their specialization during learning process at the multidisciplinary TUs [5].

3.2 Multidisciplinary TUs of North America

Table 1 shows the ranks of the five best US' and Canadian TUs in the subject and global QS-2021. We see that all of these universities have high ranks not only in technical disciplines, but also in other subject rankings, which provides them with a high global rank. These universities are “old” (founded in the 19th century or earlier) and then have been developed as multidisciplinary institutions. All these universities have a research status and high quality learning process. Three of them (MIT, Stanford and Harvard) are private, and two others (University of Berkeley and University of Toronto) are public. The main

difference between private and public universities is state subsidies. The private research universities have a low enrollment rate (5-8%) and considerably higher tuition. They tend to have much larger endowments to cover the difference between tuition and the cost per student. For example Harvard's endowment is more than $40 billion. The impressive endowment of Harvard is a consequence of the fact that many successful entrepreneurs and statesmen who graduated from this university continue to sponsor the university and its research activities. The private universities also apply to federal and private agencies for research grants. The public universities accept more students and have a higher enrollment rate (25% at UB and 43% at UT). They are funded almost entirely by state and local governments and can also apply to federal and private agencies for research grants. Their endowments are smaller than private universities. The tuition fees that students pay cover much less than the cost per student [6].

Table 1: Top 5 North American TUs in Subject and Global QS-2021

University	Country	**E&T**	NS	LS&M	SS	A&H	Global
Massachusetts Institute of Technology (MIT)	USA	**1**	1	6	5	5	1
Stanford University	USA	**2**	2	4	3	16	2
University of California, Berkeley	USA	**5**	6	15	7	-	30
Harvard University	USA	**12**	3	1	1	2	3
University of Toronto	Canada	**18**	18	13	18	17	25

Source: created by author, QS-2021

All North American TUs have many research laboratories in various fields of sciences and conduct a wide range of interdisciplinary research. For example, MIT has the Lincoln Laboratory, known for its achievements in aerospace and computer technologies. Stanford University has the Stanford Artificial Intelligence Laboratory (SAIL), known for its achievements in bioinformatics, computer vision, decision theory, image processing, machine learning, artificial intelligence, sensors and robotics. Stanford alumni have founded many successful companies such as Google, Yahoo, Hewlett-Packard, Sun Microsystems, and Instagram. This university has graduated 59 Nobel laureates and 30 billionaires. The University of Berkeley is known primarily for research in the natural sciences. At the Lawrence National Laboratory new chemical elements, such as neptunium, plutonium, berkelium, californium and others were discovered and 11 scientists were awarded Nobel prizes. The engineering departments of these TUs closely cooperate with industrial companies, which together with federal and local governments fund applied research, intellectual property protection and technical transfer, organize internships for students and offer jobs to alumni [7].

The engineering specialties at the American TUs, as a rule, are chosen by less than 50% of students, the rest prefer to study economics, physics or history. As result, the 2019 Nobel Prize in Economics was awarded to two visiting professors from MIT and one professor from Harvard for their practical methods of fighting poverty. If you trace the history of these universities, the emergence of new faculties was dictated by technical progress and demand for new specialties. The wide range of academic programs allows for interdisciplinary research, and the students form their own specialty in the learning process. They usually determine their specialty only in the third year and choose the main area of professional interest for writing their bachelor's diploma. This diploma can be performed at the junction of various disciplines, taking into account the interest of a potential employer. The alumni showed success in research work and can look forward to continuing their masters and doctoral studies at the university, in order to pursue a career as at the university and industry, or try to start their own business [8].

3.3 Multidisciplinary TUs of Europe

Europe (excluding Russia) is represented in the top 100 E&T ranking by 27 universities, five of which are included in Table 2. All European TUs joined the Bologna Declaration and develop their educational and research policies in accordance with the accepted pan-European standards and national interests.

Table 2: Top-5 European TUs in Subject and Global QS-2021

University	Country	**E&T**	NS	LS&M	SS	A&H	Global
University of Cambridge	UK	**3**	4	3	5	3	7
ETN-Zurich Swiss Federal Institute of Technology	Switzerland	**4**	6	53	56	134	6
Politecnico di Milano	Italy	**20**	150	-	117	124	137
Technical University of Munich	Germany	**29**	31	68	216	-	50
Ecole Polytechnique	France	**52**	26	-	238	-	61

Source: created by author, QS-2021

Table 2 shows that European TUs (especially from UK and Switzerland) occupy high ranks in both Subject and Global QS rankings and continue to maintain their reputation for innovation, advancements in research and enterprise. It is no wonder that many European TUs constantly rank high

amongst their global peers as some of the top places to study engineering.

Most TUs participate in the Erasmus exchange program, giving students a chance to experience other parts of Europe and indeed, the world.

The University of Cambridge is closest to American TUs in terms of both structure and tuition fee. Cambridge is the wealthiest university in Europe by both endowment size (£7.12 b) and budget size (£2.3 b). The alumni, faculty and research staff awarded 121 Nobel and 11 Fields Prizes that confirms the thesis about the importance of multidisciplinarity for occupying a high position in international rankings. Cambridge also has a research partnership with MIT (USA). The ETN-Zurich is close to Cambridge in structure and funding. In the rest of European TUs the tuition fee is lower and, state budgets and funds are the main source of funding. The technical disciplines (multidisciplinary) correspond to the industries' demand in these countries. The university budgets show that European investment in education and research, especially from private sources, is insufficient to compete with universities of North America and shows an ever-widening gap [9]. The European Union is Russia's largest industrial and trading partner, therefore the Russian TUs should be close in structure and quality to European ones. Russia is interested in the experience of creating science parks and business incubators at the European TUs, increasing funds from private sources, building multidisciplinary TUs through mergers and weaker forms of cooperation [10].

3.4 Multidisciplinary TUs of Asia

Asia has the largest number of first-class universities in the most developed countries: Japan, China (including Hong Kong), South Korea and Singapore. Although higher education in these countries has a long history, in the post-war years Japan adopted the American model of the university, while Singapore and Hong Kong are based on the British model of higher education. The best TUs in these Asian countries are summarized in Table 3, which shows that these top Asian universities are multidisciplinary.

Table 3: Top-5 Asian TUs in Subject and Global QS-2021

University	Country	**E&T**	NS	LS&M	SS	A&H	Global
Tsinghua University	China (Mainland)	**9**	16	129	32	19	15
National University of Singapore	Singapore	**10**	14	144	-	30	11
Korea Advanced Institute of Science and Technology	South Korea	**16**	44	217	89	-	39
The Hong Cong University of Science and Technology	Hong Kong (SAR)	**18**	40	355	33	15	27
University of Tokyo	Japan	**20**	13	33	34	22	24

Source: created by author, QS-2021

The experience of reforming Chinese universities is very interesting for Russia, because up until the 1980s China copied the system of the Soviet Union higher education and the organization of science. However, at the same time with market reforms in the economy, the Chinese Government began deep reforms in higher education and science in accordance with Western (market) models. China has implemented two projects ("211" and "985") aimed to improve the quality of education at universities and getting Chinese universities in the top-100 world-class universities. The Chinese Government provided great finance support to universities for academic and research activities. Many postgraduates get opportunities to have internships at the best world universities. The “Backflow” program implemented the return of Chinese scientists to China. As a result six Chinese universities enter in the top-100 of the QS ranking 2021. The abovementioned reforms have allowed the creation of research infrastructure, strengthened cooperation with business and the attraction of eminent professors and researchers from all over the world [11]. India has three multidisciplinary TUs (IITB, IITD and IITM), ranking high in E&T but significantly lower in other subject rankings, especially in LS&M. The Government of India, supported by the academic community, has also announced its desire to create world-class multidisciplinary universities [12].

3.5 Multidisciplinary Russian TUs

There are 724 universities in Russia [13], 200

Table 4: Top-5 Russian TUs in Subject and Global QS-2021

University	**E&T**	NS	LS&M	SS	A&H	Global
Lomonosov Moscow State University	**67**	21	278	55	53	74
ITMO University	**160**	256	-	-	-	360
Bauman Moscow State Technical University	**174**	401-450	-	451-500	-	282
Peter the Great St. Petersburg Polytechnic University	**180**	265	-	-	-	401
Moscow Institute of Physics and Technology	**186**	66	-	-	-	281

Source: created by author, QS-2021

situated in Moscow and St. Petersburg. At 28% of Russian universities' students learn engineering specialties and they have 50% of budget-funded places. It is possible to study at the TUs for free if entrants pass the Unified State Examination and score the required number of points. Table 4 shows the top 5 best Russian TUs in the E&T ranking, as well as their ranks in Global QS-2021.

Table 4 shows that the Lomonosov Moscow State University holds the highest rank in E&T and global rankings. The low ranks of other four TUs included in Table 4, are due to a lack of multidisciplinary and consequently interdisciplinary research. The most fundamental research is carried out in the scientific institutes of the Russian Academy of Sciences, while the universities have low level research laboratories and most students do not have an opportunity to participate in research. The lack of LS&M specialties in the Russian TUs is alarming, creating problems with medical equipment and medicine in Russia. The low positions in the SS rankings can be explained by the weakness of economic and sociological research in most TUs, which leads to incorrect marketing estimates and low level management at the State companies. The lack of Russian TUs in the A&H ranking is the result of neglecting industrial design. So, the scarcity of academic and scientific fields is one of the reasons of the low Russian TUs' ranks in world rankings and, at the same time, a reserve for improving a situation.

In Russia there are no private TUs with their large budgets and endowments, strong research laboratories and close cooperation with companies included in the Forbes 500 list. Nevertheless, it is possible to adopt an experience of creating multidisciplinary public TUs with engineering schools in specific areas, such as at the University of Berkeley (physics), Purdue University (aeronautics) or the University of Michigan (robotics).

Five more Russian TUs occupy 200+ positions in E&T and Global QS-2021 and have good chances to improve their positions in international rankings. Two of them (St. Petersburg State University and Tomsk State University) belong to the "old" (imperial) universities, have been multidisciplinary since their inception, but have relatively weak results in research. Novosibirsk State University has close scientific cooperation with the Siberian Branch of the Russian Academy of Sciences. The Higher School of Economics solves the problem of multidisciplinary through mergers and, finally, MEPhI, can improves its rank, following the example of the University of Berkeley (USA). The first-year undergraduates of Russian TUs are sometimes disappointed in their chosen specialty and want to change it. The limited choice of disciplines for students leads to a high attrition in the first years [14].

4. Mergers of the universities as one of the methods to achieve multidisciplinarity

Mergers are an effective method to create multidisciplinary universities. They can be divided into horizontal mergers (the merging universities have a similar specialization) and conglomerate mergers, leading to creation of multidisciplinary universities. The strategic motivations for university merger activities may have different particular features. The large universities tend to be more competitive nationally and globally (to achieve better positions in international rankings). But only conglomerate mergers can achieve these goals, enhancing a reputation and funding from different sources [15].

University mergers have occurred throughout the history of all countries. The list of university mergers in USA includes about 130 cases, more than 30 having occurred after 2000. These mergers mainly concern small universities in states [16]. The US' multidisciplinary universities have an advantage over highly specialized ones not only in terms of opportunity for interdisciplinary research and expanding the horizons for students, but also from the practical side to fill university budgets and create scientific and industrial clusters.

In Europe there are more than 4 000 universities, but most of them are small and only one in ten teaches more than 20 000 students. University mergers are widespread in Europe. It is estimated that since 2000 there have been nearly 130 mergers and acquisitions of universities belonging to the European Association of Universities. The mergers have taken many forms over the past 20 years. They receive increased attention in the context of unifying European higher education, as well as exploring new ways of interuniversity cooperation. It is believed that by increasing the size and multidisciplinarity, these universities will be able to increase competitiveness and attract additional resources. Much attention in many EU countries is paid not only to mergers, but also to the creation of network structures in the form of cooperative agreements and alliances. Cooperation

refers to specific arrangements at the institutional level, focused on a specific area and covering agreements for partnerships and the creation of new organizations such as joint institutes, schools or faculties [17].

Asian universities are also involved in merger processes to improve their positions in international rankings. For example, the Tsinghua University left a polytechnic model and incorporated a multidisciplinary model emphasizing collaboration between distinct schools within the broader university environment. The merger process has been particularly successful in China, being a part of government program to improve the quality of higher education [18].

The Russian system of engineering education is undergoing serious transformations initiated by the Government in order to improve the quality of higher education. TUs introduce new educational programs in the most popular specialties and innovative teaching methods into the educational process, develop international academic mobility and strive for improving positions in international rankings. The TUs try to achieve leadership in Russian higher education and propose competitive educational programs for the international educational market. The multidisciplinary TUs sometimes have a geographically distributed structure, uniting regional educational and research institutions.

Most Russian universities (not only TUs), created in the 30s of last century (MAI, MADI etc.), mainly concentrated in Moscow and St-Petersburg continue to train students for the definite industries, despite that most large enterprises were removed from both cities. According to the author, the Russian TUs having a status of "national research universities" (especially in megacities) should gradually move away from narrow disciplines to multi disciplines. Tables 4 shows a successful example of creating a multidisciplinary university due to merger processing. ITMO University achieves the greatest success in moving up in the QS-2021 and absorbed three universities: Academy of Management Methods and Techniques, Institute of International Business and Law and the St. Petersburg State University of Low-Temperature and Food technologies. Higher School of Economics (HSE) absorbed Moscow State Institute of Electronics and Mathematics (MIEM). HSE is one of the elite universities and enjoys great prestige among Russian leadership. In the SS rating-2021, HSE ranks highest among Russian universities (48th), ahead of Moscow State University (55th) and St. Petersburg State University (123th). The merger is beneficial to both united universities. HSE gained a strong position in engineering due to merger of MIEM and took a step towards creating a multidisciplinary university. MIEM received a new building equipped with modern scientific equipment and raised the passing score of enrolled applicants. The teaching staff increased the number of publications in international journals and grants for applied research. The new HSE has taken a step towards models of world-class universities such as MIT (USA) or Cambridge (UK) [19]. An example of a horizontal merger is the merger of two aerospace universities in Moscow: the Moscow Aviation Institute (MAI) and the Moscow Aviation Technological Institute (MATI). However, this horizontal merger did not lead to a significant improvement in the position of the united university in international rankings.

5. Discussion

Through this study, the influence of the multidisciplinarity of world-class TUs on their rank in the international QS ranking is traced. Many TUs have been multidisciplinary since their inception, and the challenge is to develop all disciplines evenly. The industry TUs can be transformed into multidisciplinary ones through the process of mergers or acquisitions, creating new laboratories and inviting foreign professors and scientists.

The problem of the leading national universities' rank is discussed not only in Russia, but also in India [12]. The author of the article analyzed the ranks of Indian TUs in the QS rankings. Seven of them are in the top-200 of the E&T ranking, but only two are at the end of the Global QS ranking top-200. Perhaps, as in Russia, this fact is a consequence of low ranks in other Subject rankings. The problem of multidisciplinarity in Indian universities is discussed by Marisha at al. [20].

The ideas of multidisciplinarity, interdisciplinarity and transdisciplinarity have been widely applied to the relationship between sciences. The problems of terminology are taken into consideration to clarify the meaning of the word 'discipline' and its cognates. Also the relationship between sciences and technologies are a common practice among strict sciences and technologies [21].

Many researchers consider a multidisciplinary environment as an important factor for research collaborations, especially interdisciplinary researches that involve researchers from different disciplines. The higher level of multidisciplinarity within a university is associated with internal collaborations that are more prevalent and more interdisciplinary. The analysis suggests that multidisciplinary universities are more collaborative and more interdisciplinary [22].

Economics and engineering played a vital role in addressing the challenges posed by economic and technological progress. Looking at the history of the relationships between the two disciplines, there are three paradigms for the economics–engineering alliance: economics "for/and/as" engineering. This alliance is seen as an interaction of the two disciplines and transdisciplinarity. The mission of the alliance is to restore a unified perspective of knowledge and to estimate the complexity in the future [23].

Bibliographic studies show a large number of references to multidisciplinary and interdisciplinary research works. Many citations refer to papers that are published in journals covering adjacent scientific disciplines. This suggests that modern sciences are closely interconnected and based on interdisciplinary cooperation [24].

6. Conclusions

The analysis of world-class TUs shows that they are multidisciplinary and have high academic and research reputation in all groups of disciplines. They continue the traditions of the earlier centuries, adding new disciplines and programs in accordance with scientific and technological progress. The students receive practical skills under the guidance of researchers and university professors, starting from their first years of study in the research university laboratories. In addition, the universities have big budgets, allowing not only to meet contracts from government agencies and large international corporations of civil and military profiles, but also to invite qualified professors and researchers.

The «old» Russian universities (Moscow State University, St. Petersburg State University, Kazan state university and Tomsk state university) are partly multidisciplinary. However, after the exhaustion of short-term factors, such as publication activity, attraction of additional public funds and foreign students increasing, the entering into the "top-100" requires the use of long-term factors, such as increasing the efficiency of research work, attracting significant financial resources from business, competitive selection of teaching staff and researchers, publications in peer-reviewed international journals, participation in international conferences etc. The alumni of Russian TUs sometimes do not find interesting jobs and change their field of activity or leave to work abroad.

Russian TUs have not had significant results in such important areas as social sciences (primarily industry economics), life sciences and medicine, design and leisure activities. The problem of expanding the scientific and practical base of TUs can be fundamentally solved only through the inclusion of industrial and research institutes in the structure of universities. However, such a reform faces the resistance from leaders of state research institutes and the Russian Academy of Sciences. The problem is partially solved by creating branches of university departments in research institutions. Only the strong research university laboratories are able to rejuvenate and modernize the teaching staff of universities, to prepare the candidate and doctor dissertations of practical value, to stop the emigration of young scientists and engineers from Russia.

The multidisciplinary can be reached through university mergers. The article demonstrates the examples of successful mergers of Russian universities that have lead to improve position of the merged universities in the international rankings.

Multidisciplinarity is one of the general trends in the development of the TUs and increasing their ranks. However multidisciplinarity is a necessary but not sufficient condition for the success of TUs in the international rankings. In addition, the TUs should have good links with industrial companies, strong research laboratories, strict competitive selection of professors and students, various sources of funding, autonomy and other success factors.

Disclosure statement

No potential conflict of interest was reported by the author.

ORCID

Leonid Sobolev https://orcid.org/0000-0001-6955-1271

References :

[1] J. Salmi, The Challenge of Establishing the World Class Universities // The World Bank. DOI:10.1596/978-0-8213-7865-6

[2] L. Sobolev, Russian Engineering Universities in International Ratings // Universal Journal of Educational Research, Vol. 8, No. 12A, pp. 7487 - 7493. DOI: 10.13189/ujer.2020.082532

[3] G. Kliucharev and A. Neverov, Project «5-100»: some interim results // RUDN Journal of Sociology 18(1): 100-116. DOI: 10/22363/2313-2272-2018-18-1-100-116

[4] QS World University Rankings – Methodology (2021) // Available at: https://www.topuniversities.com/qs-world-university-rankings/methodology

[5] T. Mednikova T. and V. Senashenko, Engineering Education in the USA // Higher Education in Russia- No.11- pp. 140-148 Available at: https://vovr.elpub.ru/jour/article/viewFile/71/21.pdf

[6] M. V. Dobrynina M.V, US policy on engineering education after World War II: the 1958 reform and its strategic importance. // Theories and Problems of Political Studies, 8 (4A), pp. 63-70. DOI: 10. 34670/AR.2019.45.4.059

[7] A. Y. Derevnina, Research universities in the USA: cooperation with industry and business. University Management: Practice and Analysis.2010-4-60-66. (In Russ.)

[8] N. Mowlaee, How Multidisciplinary Engineering Studies Can Accelerate Your Career // Available at: https://interestingengineering.com/multidisciplinary-engineering-studies-accelerate-career

[9] J. Enders, H. De Boer and D. Westerheijden, Reform of Higher Education in Europe // University of Twente, The Netherlands, 28 p. DOI:10.1007/978-94-6091-555-0

[10] M. Zieliński, A. Rogala, and M. Takemura, Business Model of Science and Technology Parks: Comparison of European Best Practice, The Bulletin of the Faculty of Commerce Meiji University, 2014 nr 1 - Meiji: Meiji University Press. pp. 15-28. Available at: https://www.researchgate.net/publication/280053029

[11] M. Li and R.Yang, Governance reforms in higher education: A study of China // UNESCO, International Institute for Educational Planning (IIEP). // Available at: https://unesdoc.unesco.org/ark:/48223/pf0000231858

[12] The point of multidisciplinary research universities in India. Available at: https://www.hindustantimes.com/education/the-point-of-multidisciplinary-research-universities-in-india/

[13] Gokhberg L. at al. (2020) Education in Figures: A Brief Statistical Book / M: NRU HSE, 2020. - 120 p. DOI: 10.17323/978-5-7598-2306-3

[14] E. Shmeleva and I. Froumin, Factors of Attrition among Computer Science and Engineering Undergraduates in Russia // Educational Studies, Moscow. 2020-3-110-132. DOI:10.17323/1814-9545-2020-3-110-136

[15] Y. Cai, R. Pinheiro, L. Geschwind and T. Aarrevaara, Towards a novel conceptual framework for understanding mergers in higher education // European Journal of Higher Education. 2015, 6(1):1-18 DOI: 10.1080/21568235.2015.1099457

[16] List of university and college mergers in the United States (2021) Available at: https://en.wikipedia.org/wiki/

[17] E. Pruvot, T. Estermann and P. Mason, Thematic Report 2: University Mergers in Europe // European University Association. Available at: https://eua.eu/resources/publications/363:define-thematic-report-university-mergers-in-europe.html

[18] Y. Wan and M. Peterson, A case study of a merger in Chinese higher education: the motives, processes, and outcomes // International Journal of Educational Development 27(6):683-696 DOI: 10.1016/j.ijedudev.2006.07.007

[19] T. Agasisti, A. Egorov and M. Maximova, Do Merger Policies Increase University Efficiency? Higher School of Economics, Research Paper No. WP BRP, 226/EC/2020

[20] Marisha, S. K. Banshal & V. K. Singh, Research Performance of Central Universities in India 2017, Current Science, 112(11):2198-2207 DOI: 10.18520/cs/v112/i11/2198-2207

[21] D. Alvargonzalez, Multidisciplinarity, Interdisciplinarity, Transdisciplinarity, and the Sciences. International Studies in the Philosophy of Science, 2018, Vol. 25, No. 4, pp. 387–403 DOI: 10.1080/02698595.2011.623366

[22] Z. Zuo & K. Zhao, The more multidisciplinary the better? – The prevalence and interdisciplinarity of research collaborations in multidisciplinary institutions. Journal of Informetrics, 2018, 12, 736–756. https://doi.org/10.1016/j.joi.2018.06.006

[23] S. Mariotti, Forging a new alliance between economics and engineering. Economia e Politica Industriale, 2021, 48(1):1-22 DOI:10.1007/s40812-021-00187-w

[24] Leeuwen T.V. & Tijssen R. Interdisciplinary dynamics of modern science: Analysis of cross-disciplinary citation flows. Research Evaluation, 2000, 9(3):183-187 DOI: 10.3152/147154400781777241

[25] obolev Leonid B. – Dr. Sci. (Tech.), Prof. of Department Economics, Moscow Aviation Institute, Russia, sobolevlb@yandex.ru