



The Effect of Covid-19 Pandemic on the Regional Universities Research Culture and the Quality of the Engineering Education

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Abstract. In this paper we define *university research culture* and suggest a metric to evaluate the level of its maturity by comparing five universities in Russia, including the regional ones. We argue that strong research culture is pivotal for talent attraction and quality education, especially in engineering. By comparing the research productivity of universities with established and with immature research cultures during COVID-19 pandemic, we demonstrate that the mature research culture has helped universities to survive such global stressful situations with comparatively fewer losses, whereas the universities with currently undeveloped or emerging research culture have experienced a dramatic impact on their publication output. We suggest a set of activities to enhance research capacity of HE organizations by engaging local full-time faculty and report the results of implementation of a related faculty development program at one of the regional universities under study in late 2019 – early 2020. The implementation results show that such an intervention has contributed to enhancing research capacity and has advanced research culture at the University even at the time of pandemic as the result of increased research productivity of experienced and moderately experienced researchers and of forming new research groups.

Keywords: University research culture · Research capacity enhancement · Faculty engagement in engineering research · Faculty development · Research productivity

1 Introduction

Research capacity enhancement, a term initially used mostly in healthcare, is currently understood broadly and in relation to the task of increasing the levels of research skills, the ability to do quality research, and, in general, the task of enhancing research productivity of states and, hence, universities. The latter have to respond to the requirements of university rankings, which despite criticism are thought of as the globally accepted manifestation of education quality [1]. For previously teaching-focused universities, this response is essentially a shift towards more intensive engagement in research, which can become obligatory. Such an organizational change requires reconsidering of funding, hiring and promotion, workload distribution, faculty professional development policies. Besides, the validity of the assumption of the value research brings to the education quality is still a debatable topic, though a considerable number of studies have provided evidence that research and teaching can mutually enhance each other when research is integrated in teaching process in the forms of research-led, research-based or research-oriented teaching [2–9].

Policies, attitudes and behaviors change in the said type of educational institutions is indeed a challenging task, and the latter more so than the former as it can imply establishing an additional component of already existing organizational culture - *research culture*, which, in turn, means the need to alter the whole existing culture to internalize and intergrade this new component. In this paper we adopt the following definition of *research culture*: “Research culture is a set of values, beliefs, assumptions and behaviors related to the implementation of research that is owned by the organization collectively” [10]. Baporicar [11] insists that «... for a university ... to claim a strong research culture, research should be valued by a majority of its members».

A number of studies describe efforts aimed to enhance research capacity and advance research culture, as well as the results and limitations of such efforts. Among them, Nguyen in [12] and Kuzhabekova et al. in [13] argue that, while one evident way of increasing research output – attracting foreign-born or diaspora faculty who have been exposed to research-intensive culture - plays its positive role and can increase the number and quality of publications, the effect of this practice on the attitudes and behaviors of local faculty remains unclear. Besides, Griffioen in [14] discusses “hiring research expertise” as a strategy of research capacity enhancement and points out several drawbacks of existing faculty hiring practices, e.g., when staff involved in the selection process do not have sufficient competence to assess the research experience of the candidates, where, apparently, it is unreasonable to rely only on their formal degrees as the evidence of such expertise. She also expresses her doubts that such a strategy, even if well-implemented, contributes to the task of better connection of research and teaching. Griffioen [14] and Nguyen [12] also state that mere redistribution of faculty time from teaching only to teaching and research does not necessarily change their behaviors, and lecturers can still

feel the lack of protected time for research. Hence the need to allocate more deliberate effort to professional development of local full-time faculty and to establish practices that would cumulatively result in both higher level research skills and attitudes and behaviors characteristic to a mature research culture. Griffioen et al. [15] list the Developmental Policy as one of the tools university administrations could apply to increase faculty research self-efficacy. Apart from the skills related to performing and writing up research and grant writing [16], it is advisable that faculty development interventions focus also on the development of interpersonal skills and collaboration and establishing research groups [17–19], which are likely to advance local research cultures and can become even more crucial in the time of unexpected and unwanted change like pandemic.

In this paper we investigate the state of the university research culture in five universities in Russia, including those in regional areas. Currently, there are over 950 universities in Russia [20] and over 29,000 globally [21]; the competition among them is strong [22]. As global University rankings are mainly focused on research output and university academic reputation, this competition compels HE organizations in Russia previously primarily focused on teaching to advance their research activities [23]. In the past decades, a number of Russian universities drastically improved their publication records. However, the extent to which the internal research culture has been affected remains little studied.

We imply that strong research culture is essential for the quality modern education and talent attraction [24], in particular in such rapidly evolving area as engineering. Further, we propose a metric of the maturity of the research culture and particular activities to advance it, including faculty development activities, students' engagement in research, and organizational changes to boost research synergy effects at the universities. At one of the regional universities under study, we implemented faculty development activities in late 2019 – early 2020. Here we report the results of this intervention and compare the achievements of the said University with other universities' research output in 2020. We show that covid-19 pandemic in 2020 had a noticeable effect on the universities' research output, especially the regional ones, due to the predominantly immature research cultures of the said universities, whereas those with mature research cultures maintained strength during the covid-19 pandemic.

This research effort aims to address three tasks:

- to suggest a metric that can be used by Higher Education institutions to evaluate the level of the maturity of their organization's *research culture*
- to evaluate the impact of covid-19 pandemic on the research output of the universities that we qualify as having mature and those having immature research culture
- to propose activities that are likely to facilitate internal research culture advancement, based on the results obtained from the implementation of a set of research advancement activities at one of the regional universities under study

The results of this study can be used by the universities in transition from a pure educational to an educational-research model. The rest of this paper takes the form of three chapters: chapter Approach and Data Collection explains the approach towards the formulation of *university research culture* metric and describes how the data were

collected for the evaluation of research culture; chapter Results and Discussion presents research culture metric, evaluates the data analysis results, lists the suggested measures for research capacity enhancement and evaluates the implementation results of such a faculty development program at one of the universities under study; chapter Conclusion summarizes the study and suggests the focus of further related research.

2 Approach and Data Collection

As stated in the Introduction, the concept of *research culture* can be explained in terms of attitudes and behaviors related to conducting research, shared by the majority of members of an organization; therefore, we investigate not only the cumulative research output of universities in terms of quality publications, but also the share of the full-time faculty members engaged in active research, based on their publication output. We assume that once the share of such faculty members is significant enough, universities are more likely to naturally develop a set of collective behaviors supporting and promoting scientific curiosity, e.g., spontaneous research discussions during coffee-breaks and lunches, official and informal research seminars, incorporating recent scientific discoveries in the courses content. We also assume that part-time faculty members have little or no effect on the research culture of the university. This is due to a relatively common practice in Russia (also consistent with an experience in China as cited in [12]) where part-time faculty members tend to be only nominal, which means that they will just mention the affiliation of a university in their papers, while almost never be actually involved in the life of a particular university to the extent that would enable them to affect collective behaviors and beliefs as they will not communicate with the peers at the university, will not inspire the younger scientists, will not share their experience, and will not engage in joint research efforts. Thus, *research culture index* was calculated based on the data indicative of publication activity of full-time faculty only.

The data for this study were collected between November 2019 and July 2020 from five Russian universities, labelled as A, B, C, D, and E in this paper. University A is a medium-size polytechnical school, 13,000 students and around 420 faculty members, based in a large metropolitan city in the North of Russia; university B is a medium-size polytechnical school, 9,500 students and 650 faculty, based in a metropolitan city in the East; University C is a classic university with over 10,000 students and 700 faculty, based in the North; D is a department of the major classical university, with over 29,000 students and 1,500 faculty, based in the capital city; university E is a small private research-based university, with 110 students and 36 faculty, based in the metro area in the North.

The first dataset represents the data of the full-time faculty members including their age group and the number of the scientific publications indexed by Scopus in the last four years. We chose Scopus database as being the main metric affecting university rank in QS university ranking and thus the universities state funding in Russia. Clearly, this metric leaves aside a number of publications related to engineering education, which constitutes the limitation of the suggested approach for the evaluation of research culture. Another significant limitation of this data collection method is not being able to track individual papers, but rather the number of the publications by every author, i.e., a joint

paper by two researchers of the university is counted as two papers. This gives us a max estimation of the papers produced in the university. We tracked publications only by the faculty members with primary affiliation at a particular university. We did so because it is common in Russia for faculty never or rarely to be physically present at their secondary affiliate institutions and not affect their research culture, while often contribute substantially to the overall publication metrics of those secondary affiliation institutions.

Further, three of the five universities under study, namely universities A, C, and D, conducted an in-house designed survey [28] among the faculty members aiming to identify the challenges that prevent the faculty from more active research. The surveys requested the respondents to elaborate on how their research activities could be supported. Finally, we implemented faculty development activities from November 2019 till July 2020 at University A and later collected the overall research output of 2020 from all the five universities under study, as well as that of the end-tail top-110 world university list by QS and compared the research output dynamics of year 2020 at these universities.

3 Results and Discussion

3.1 Resent Publication Activity

To simplify the comparison of publication activity between the universities under study, we categorized the faculty into four groups:

- a. faculty regularly publishing in the past two years, 2018 and 2019, two or more papers per year
- b. faculty moderately publishing in the past two years, 2018 and 2019, one or two papers per year
- c. rarely publishing faculty - having published at least one paper in the last four years, 2016 and 2017
- d. faculty having published no papers since 2016. This type we categorized by age group

It is important to note that the retirement age set by the government in Russia since 2020 is 65 years old for men and 60 years old for women. After reaching the said age, the nationals will be receiving monthly pension. However, the faculty rarely stop working full time at the university after reaching the retirement age.

Table 1 presents publication activity of universities A, B, C, D, E in the period from 2016 to 2019. The results showed that the share of rarely publishing and non-publishing faculty remains relatively high. We believe that the most promising target groups for the implementation of the measures to advance research culture and boost publication activity are already publishing faculty and non-publishing faculty aged 20–50 years old.

Table 1. Recent publication activity of full-time faculty in five universities

University label	Faculty with publications in last four years				Faculty without publications				
	2+ papers 2018/19	1–2 papers 2018/19	1+ papers 2016/2017	Total	20–50 y/o	50–65 y/o	65–75 y/o	75+ y/o	Total
A	6%	5%	19%	30%	28%	20%	18%	4%	70%
B	9%	13%	34%	56%	20%	10%	11%	3%	44%
C	2%	2%	31%	35%	39%	20%	5%	1%	65%
D	26%	25%	25%	76%	13%	7%	3%	1%	24%
E	7%	16%	59%	82%	10%	4%	2%	2%	18%

3.2 University Research Culture Index

From the data on the publication activity by full-time faculty members presented in Table 1, we define a *research culture index* (RCI) calculated as the ratio of the faculty who publish regularly in the past two years (2+ papers and 1 + papers per year) and the faculty without publications. The index indicates how visible the faculty performing active research are among the peers at the university (Table 2).

Table 2. Research culture index (RCI) vs Scopus-indexed publications per faculty

University label	A	B	C	D	E
RCI	0.16	0.5	0.06	2.13	1.28
Papers/faculty	0.28	0.64	0.34	0.86	0.46

We suggest that in those universities whose $RCI \geq 1$, the research culture is mature. In those with $RCI < 1$ the research culture is immature and requires special attention and nourishing. The data analysis revealed universities where faculty population is dominated by staff with few or no research output at all - this is a warning sign. Even when the overall number of publications per faculty member is rather high, e.g., University B with the average number of Scopus-indexed papers per faculty 0.64, the second highest in this study, the internal university research culture index is low, $0.5 < 1$. It illustrates the case when the main contribution to research output is coming from the part-time faculty members. An example of the average number of publications being non-predictive of RCI is the cases of Universities C and E – their averages of the number of publications differ by 1.35 times, whereas their RCIs show over 20 times difference.

Based on the RCI and on research activity dynamics as presented in Table 1 it is possible to identify if any actions are necessary to advance research capacity, and in case such a necessity reveals – to tailor actions depending on the current situation of a university. However, yet another component is pivotal for such tailored planning – faculty

needs assessment from the faculty perspective, which in this study was performed in the form of a survey. The results are presented in the following section.

3.3 Faculty Survey Results

To facilitate organizational change, which in our case means to advance research culture by promoting and supporting more intensive faculty involvement in research, it was essential to perform needs assessment, which could engage the target audience in decision making process. Universities A, C, and D have conducted surveys of their faculty members aiming to identify the key factors preventing faculty members from producing Scopus-indexed publications and, for those publishing already - the factors preventing them from more active research. Over 32% of the faculty members participated in the survey at University A, 49% at University C, and 21% of the faculty of the department under consideration at University D. The results were predictably unique for each university; they are detailed in Appendix II.

Overall, in University A, about half of the respondents indicated the lack of time as a key reason for low research productivity. This result might be explained by the student to faculty ratio at the University A - over 30, which does indicate a problem with teaching load for faculty. One inspiring observation in the survey results is that the faculty are more interested in professional support from the University rather than in the increase in monetary stimulus. For this university a professional development program was designed and implemented.

For University C, however, the financial aspects look to be the most critical. Even though the average compensation for the faculty is 55% higher than the median for the region, it is still low compared to other universities included in this study. A noticeable share of the faculty members asked to reduce their teaching load, however at this university the student per faculty ratio is 14, so the teaching load can be assumed to be normal. Therefore, this perceived “the lack of time” might probably be related to the likewise perceived low level of compensation.

University D is the “healthiest” in terms of the research culture. The financial issues are less important for the faculty, too. The average faculty compensation is over double the average in the region. However, there is a lack of understanding of why research is important and how it can contribute the faculty members’ career.

3.4 Recommendations to Improve Research Culture

Based on the survey results previously reported [28], the publication productivity (Table 1), and RCI scores (Table 2), we have developed a set of recommendations, which included:

- engaging less active faculty in research by organizing special activities, e.g., open research seminars
- yearly awards for the best first paper
- review teaching load for actively publishing faculty
- establish university fund for supporting travel to the conferences
- set up multidisciplinary seminars to enhance ideas exchange

- engage faculty in engineering education research
- establish Writing Centers that would educate and consult the authors and offer training on academic writing in English and on paper submission
- engage students in research

Recommendations for the Universities with $RCI \geq 1$

- Keep nurturing the research culture and emphasize the importance of research for the faculty members. The latter can be done, for example, by including research productivity indicators in promotion policies or assigning more weights to them; by introducing yearly awards to recognize research achievements.
- Further clarify the reasons hindering the inactive faculty engagement in research. If the reasons can be addressed, act upon them.
- Engage the inactive faculty in research by organizing open research seminars, yearly awards for the best first publication, improve international and national collaborations (part of this group might be inactive due to the lack of collaborators that share their research interest or from whom they could learn).
- For the faculty focused on teaching, try to encourage them to explore possibilities of doing active research in the area of higher education. Consider introducing research and inquiry teaching and learning in regular courses.
- Engage students in research early, open for them options to join research groups. Support students' initiatives building upon their natural curiosity.
- Offer support in academic writing in English
- Expand the multidisciplinary research collaborations with other national and international universities, for example via Grand Challenges Scholars Program [25].

Recommendations for the Universities with $RCI < 1$

The universities with $RCI < 1$ lack shared values, beliefs, assumptions and behaviors related to the implementation of research. The primary goal for such universities is to build an internal research culture and to embed that culture in the university practices. For such universities we recommend developing an action plan for the next 3–5 years focused on improving research culture. The activities can target different faculty groups:

- 1) For those who publish at least one paper per year:
 - Review the teaching load for those who publish actively
 - Establish a university fund supporting travelling for the most important conferences to support publications. The funding could come from reallocation of the existing university funds and attracting grants.
 - Introduce a regular seminar helping the authors to generate new ideas
 - Engage faculty in engineering education research as an additional research area
 - Support national and international research collaborations
 - Offer support in academic writing in English and grant-writing

2) For those who publish occasionally or do not publish:

- Offer writing support and training on publication strategy, publication process and academic writing in English
- Offer a workshop on how to submit their first research paper
- Organize activities assisting in establishing research groups and finding co-authors within the university and beyond
- Organize regular social activities helping to promote research culture

In University A, a faculty development program has been designed based on the suggested recommendations; it was implemented in winter and spring 2020. The process and the results are detailed in the next section.

3.5 Impact of Covid-19 and the Maturity of University Research Culture on Research Output

For University A, in early 2020 we implemented faculty development activities for several faculty groups. Namely, for active researchers, we launched a weekly multi-disciplinary research seminar, introduced the idea for extending research interests to education, assisted with setting up international research collaborations. For not publishing and seldom publishing faculty, we provided a 6-day training on academic writing in English and on finding a suitable venue for publications, organized a dedicated funding for conference travel for presenting research, established an award for the best first publication. Further in 2021 we collected research productivity data for 2020 to evaluate the impact of the said interventions.

Global pandemic made 2020 a special year and affected many if not all spheres of life and work, including research collaborations. This, hypothetically, could have affected research and publication activity. Table 3 presents the comparison of the RCI with the growth/decline of the Scopus-indexed publications in 2020 y/y in the universities under study.

Table 3. Research Culture Index (RCI) vs Scopus-index publications dynamics

University label	A	B	C	D	E
RCI	0.16	0.5	0.06	2.13	1.28
Change in overall Scopus-indexed publications	-2%	-24%	-23%	+11%	-9%

The results showed that that the majority of the universities under study experienced a decline of the number of publications in 2020. However, one of the universities with mature research culture, i.e., D with RCI = 2.13, managed to increase the number of papers anyway – this effect we attribute to the established research strategy. Another university with an RCI score indicative of established research culture, University E, has published 9% less papers in 2020. This decrease is not as substantial as in universities B and C, whose RCIs are below 1, but it is still noticeable and hardly desirable. This fall might be due to a smaller share of actively publishing faculty in the recent two years (Table 1) at this University.

As for University A, with a low RCI value, which has undergone a faculty development intervention - it demonstrated a moderate decline in overall publications number even compared to University E. This result can be attributed to as much as 20% of new authors, as well as to outstanding 30% increase in publications per faculty for full-time publishing authors. The slight fall of the number of publications may be explained by the loss of part-time external collaborators, who did not participate in the development activities. Thus, the implemented measures proved effective in terms of advancement of research culture and enhancement of research capacity of University A, which manifested in the publication results.

To evaluate this effect of the level of maturity of research culture on a broader scale, we added to the comparison the publication productivity of several distinguished universities in 2019 and 2020. Table 4 illustrates the change in overall numbers of Scopus publications in 2020 for the end-tail top-100 world university list by QS, top Russian universities – these two categories we assume to have strong research cultures - and the universities under study. Clearly, the majority of the top-110 universities have not experienced a decline in publications in 2020. This could be due to the mature research culture and a solid research strategy applied by the faculty members. For the major Russian universities, 2020 was challenging in terms of publications. Some universities have experienced fall of the number of publications, others have a moderate growth.

Table 4. Research Culture Index (RCI) vs Scopus-index publications dynamics

University	#QS World	2019	2020	Change, %
Moscow State University	74	8814	8800	0
University of North Carolina, Chapel Hill	95	8574	8993	5
University of St Andrews	96	2008	1839	-8
Lund University	97	6131	6441	5
KTH Royal Institute of Technology	98	4604	4265	-7
University of Nottingham	99	6558	7272	11
Universidad Nacional Autónoma de México	100	6903	7382	7
Pennsylvania State University	101	9622	10019	4
Trinity College Dublin, The University of Dublin	102	3282	3785	15
Technical University of Denmark	103	4861	4923	1
University of Helsinki	104	6449	6675	4
Washington University in St. Louis	105	6800	7473	10
Saint-Petersburg State University	225	4486	4709	5
Tomsk State University	250	2422	2223	-8
Moscow Institute of Physics and Technology	281	2598	2588	0
University D	298	3034	3363	11
ITMO University	360	2388	2500	5
Kazan Federal University	370	3164	2713	-14
Tomsk Polytechnical University	401	1986	1759	-11
University A	-	387	379	-2
University C	-	347	268	-23
University B	-	534	407	-24
University E	-	89	81	-9
Innopolis University	-	314	347	11
Skolkovo Institute of Science and Technology	-	1091	1193	9

Notably, the research productivity of Russian universities known for hiring international faculty and diaspora for full-time positions who previously have been exposed to research-intensive culture, i.e., Innopolis University [26], Skolkovo Institute of science and Technology [27], and University D from our study, seems to have not been negatively affected by the covid-19 pandemic. We believe this is due to established research cultures and strategies at these institutions.

4 Conclusion

Educational organization have recently been paying increased attention to research capacity enhancement for various reasons. One manifestation of such capacity enhancement is the publication activity of the faculty. In this study we analyzed the number of Scopus-indexed publications of full-time faculty members at five universities in Russia, including two technical universities and two universities with large engineering departments. Based on the data, we proposed a *research culture index* (RCI) as a ratio between the number of actively publishing and non-publishing faculty members at the university. Here we argue that when RCI is equal or greater than 1, the university enjoys a strong research culture. Universities with $RCI < 1$ have immature research culture even when the total number of publications per faculty is high. We believe that strong university research culture is beneficial for the quality of education and talent attraction, thus research cultures at the universities should be developed and maintained.

To suggest a set of possible action for advancing research culture, we conducted faculty surveys at three of the universities under study to clarify which factors prevent the faculty from publishing (or publishing more actively) and which support university can offer to encourage research activity. Based on the survey results and the RCI scores, we proposed recommendations for the universities on how to improve their internal research culture. We assert that a vivid inspirational environment, supporting natural curiosity of the students at the university is essential for quality education.

While providing consultancy services for the universities in Russia the authors faced a strong resistance in engaging faculty in research. The vast majority of the faculty are focused on teaching only and find it impossible to conduct research. Most of the faculty teaching engineering have never considered engineering education as a possible research focus. Among other action items we suggest introducing faculty to research in engineering education, using the data from their primary activity.

In addition, we clearly observed that the universities with mature culture had more built-in resistance to the stress caused by Covid-19 pandemic. We encourage colleagues to apply the described methodology to analyse their universities or organizations. The proposed *research culture index* is easily applicable and could provide informative insights into the nature of the organization operations. The proposed method could be especially interesting for the universities in transition from a teaching-focused model to the one focused both on research and teaching to the benefit of students, faculty members, and the university international outlook.

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