Nuances
Estudos sobre Educação

INDICATORS FOR ASSESSMENT OF THE DEVELOPMENT OF A UNIVERSITY'S INNOVATIVE ACTIVITY AS A FACTOR IN ITS COMPETITIVENESS IN THE NATIONAL AND INTERNATIONAL MARKETS

INDICADORES PARA AVALIAÇÃO DO DESENVOLVIMENTO DA ATIVIDADE INOVADORA DE UMA UNIVERSIDADE COMO FATOR DE COMPETITIVIDADE NO MERCADO NACIONAL E INTERNACIONAL

INDICADORES PARA EVALUAR EL DESARROLLO DE LA ACTIVIDAD INNOVADORA DE UNA UNIVERSIDAD COMO FACTOR DE SU COMPETITIVIDAD EN LOS MERCADOS NACIONALES E INTERNACIONALES

Polina EFREMOVA[1]
Irina ROMANOVA[2]
Viktor BELKIN[3]
Lyudmila VASILYEVA[4]

ABSTRACT: The main aim of the paper is to reveal the nature and degree of influence of various indicators defining the level of development of a university's innovative activity. The paper presents an approach under which a university's innovative activity is defined by the key directions of development: scientific research, educational, and administrative. The authors also argue for the need to evaluate not only the results of a university's innovative activity but also the process of creation of innovative products and services and innovation potential. As a result of the conducted research, the authors conclude that some elements of a university's innovative activity affect it to a greater extent than anticipated, particularly the elements of administrative innovations, the "process" stage of innovative activity, and interaction with partners.

KEYWORDS: Assessment of educational innovations. Management innovation. Non-technological innovations.

RESUMO: *O principal objetivo do artigo é revelar a natureza e o grau de influência de vários indicadores que definem o nível de desenvolvimento da atividade inovadora de uma universidade. O artigo apresenta uma abordagem sob a qual a atividade inovadora de uma universidade é definida pelas principais direções de desenvolvimento: pesquisa científica, educacional e administrativa. Os autores também defendem a necessidade de avaliar não apenas os resultados da atividade inovativa de uma universidade, mas também o processo de*

[1] Far Eastern Federal University, Vladivostok – Russia. PhD, Associate Professor. ORCID: https://orcid.org/0000-0002-4446-0282. E-mail: efremova.pv@dvfu.ru
[2] Far Eastern Federal University, Vladivostok – Russia. Dr of Sciences, Professor. ORCID: https://orcid.org/0000-0002-8258-9220. E-mail: romanova.im@dvfu.ru
[3] Far Eastern Federal University, Vladivostok – Russia. Dr of Sciences, Professor. ORCID: https://orcid.org/0000-0003-4919-1840. E-mail: belkin.vg@dvfu.ru
[4] Far Eastern Federal University, Vladivostok – Russia. Dr of Sciences, Professor. ORCID: https://orcid.org/0000-0003-0735-6707. E-mail: milav12@mail.ru

criação de produtos e serviços inovadores e o potencial de inovação. Como resultado da pesquisa realizada, os autores concluem que alguns elementos da atividade inovativa de uma universidade a afetam mais do que o previsto, principalmente os elementos das inovações administrativas, o estágio "processo" da atividade inovativa e a interação com os parceiros.

PALAVRAS-CHAVE: *Avaliação de inovações educacionais. Inovação em gestão. Inovações não tecnológicas.*

RESUMEN: *El objetivo principal del trabajo es revelar la naturaleza y el grado de influencia de varios indicadores que definen el nivel de desarrollo de la actividad innovadora de una universidad. El artículo presenta un enfoque bajo el cual la actividad innovadora de una universidad se define por las direcciones clave del desarrollo: investigación científica, educativa y administrativa. Los autores también defienden la necesidad de evaluar no solo los resultados de la actividad innovadora de una universidad, sino también el proceso de creación de productos y servicios innovadores y el potencial de innovación. Como resultado de la investigación realizada, los autores concluyen que algunos elementos de la actividad innovadora de una universidad la afectan en mayor medida de lo previsto, en particular los elementos de las innovaciones administrativas, la etapa de "proceso" de la actividad innovadora y la interacción con los socios.*

PALABRAS CLAVE: *Evaluación de las innovaciones educativas. Gestión de la innovación. Innovaciones no tecnológicas.*

Introduction

The high pace of transformation of today's universities, which shape a new landscape of education and science, necessitates a more adequate assessment of the level of their innovative activity as the primary factor in universities' competitiveness in the markets for educational services, labor, and innovative products and services. The so-called delayed effect is observed, in which the results of the transformation of research or educational process in the university cannot be evaluated immediately, which entails the need to assess not only the final results of innovation but also the innovation process and innovation potential (EFREMOVA, 2018; EFREMOVA; ROMANOVA, 2016).

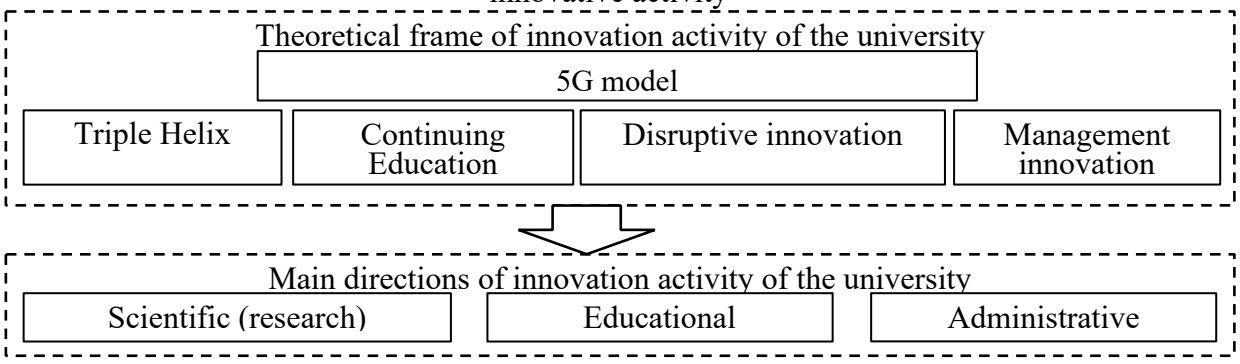
The theoretical framework of the study is formed by the following theories and concepts, which are typically considered separately in the study of innovative activity of universities:

- the theory of "disruptive innovation", which suggests that the principal condition of the "survival" of universities is their adaptation through new formats of providing educational and other services, the use of new business models, and the enhancement of partnerships, which is the only way for universities to achieve maximum benefit for society (CHRISTENSEN 2011)

- the "triple helix" theory, under which the a university's innovative activity boils down to scientific research and mediation between business and the state (commercialization of technology) (ETZKOWITZ; LEYDESDORFF 1995);
- ● the concept of "lifelong learning", or "continuing education" (CE), the spirit of which has been in the air for the entire duration of the existence and development of human society (Final Report of Delphi Study, n.d.);
- the concept of "management innovations", the proponents of which point to the underestimated value of this kind of innovations, and the most radical followers suggest the potential soon replacement of the paradigm based on technological innovation by the one with administrative innovation at its core, creating the conditions for technological, product, and other innovations (KRASNICKA; GLOD; WRONKA-POSPIECH, 2016; MOTHE; THI, 2010; VOLBERDA; VAN DEN BOSCH; HEIJ, 2013);
- the theory of evolution of the innovation process proposed by R. Rothwell (1994) and further developed by other researchers (BARBIERI; ALVARES, 2016) emphasizes the importance of assessing not only the resources spent (**income**) and the results obtained in innovative activity (**outcome**), but the very process (**process**) of the 5-6G model. Applied to universities, the 5G and 6G models presuppose broader interaction with external partners, as well as the establishment of multidisciplinary teams within subsystems and the intensification of links between subsystems and the key directions of the university's activities, the parallel nature of innovative processes, and the development of an information ecosystem.

From this, it follows that a university's innovative activity should be considered in the context of the main directions of the institution's activity: scientific research, educational, and administrative (Fig. 1).

Figure 1 – Theoretical justification of the choice of the main directions of a university's innovative activity



Source: Prepared by the authors

Methods

The goal of the study is to determine the strength and nature of the influence of particular elements of a university's innovative activity on the level of development of this activity as the key factor in the competitiveness of the university at the national and international level.

Problem statement:

The problem in need of exploration is the need to determine the indicators that affect the level of development of a university's innovative activity.

The problem that requires a solution is increasing the level of development of a university's innovative activity (the key factor in its competitiveness at the national and international levels) by balancing the key directions of innovative activity: scientific research, educational, and administrative.

In accordance with the outlined research goal, the objectives of the study include:

- to determine the indicators that affect the level of development of the university's innovative activity in the scientific research, educational, and administrative directions;
- to aggregate indicators by aggregated groups, taking into account the "income-process-outcome" model;
- to assess the degree and nature of the mutual influence of the particular elements of the university's innovative activity (indicators and aggregated groups of indicators (AGIs)) on each other and on scientific research, educational, and administrative activities overall.

Proceeding from the outlined theoretical framework and the preceding empirical study (EFREMOVA, 2019; EFREMOVA; ROMANOVA, 2020a; 2020b), the key research hypotheses are formulated as follows:

H1: the level of development of the university's innovative activity is contingent on the level of development of innovative activity by its key directions: scientific research, educational, and administrative, but not to the same degree.

H2: administrative innovation activity exerts considerable influence on scientific research and educational innovative activities, as well as on the overall level of development of innovative activity.

H3: the level of partnership development exerts considerable influence on the level of organization of the process of creating innovative products in the university and on the results of innovative activity.

Research methods: desk and field research using qualitative (content analysis, expert survey) and quantitative (survey) data collection methods.

The study was conducted in four stages:

- desk study: content analysis, formulation of requirements for the model system of indicators, criteria, and a list of indicators;
- field study: expert evaluation of the degree of significance of the proposed indicators, formation of the final list, aggregation of indicators into aggregated groups;
- field study: a survey of innovation-active employees and students of the university in order to assess the level of development of innovation activity.
- processing and interpretation of the data obtained.

The study was conducted at the Far Eastern Federal University in 2019.The study was conducted at the Far Eastern Federal University in 2019.

The research instruments employed include:

- Expert assessment questionnaire. The experts were asked to determine the degree of importance of each indicator on a ten-point scale (where 1 – absolutely not important, 10 – very important) in order to assess the level of innovation activity of the university (the threshold value is 5.5). The expert group (10 experts) consisted of Russian and foreign specialists in the field of university innovation management (EFREMOVA, 2019);
- Quantitative survey questionnaire. The sample size was 384 people, with a confidence interval of 5%, which is acceptable for a study in the field of social sciences, and a 95% confidence probability. To ensure the representativeness of the sample, we used the quota method (non-random quota sampling) in accordance with the existing organizational and numerical structure of the selected university (EFREMOVA; ROMANOVA, 2020a;2020b). The survey was conducted among innovation-active individuals from the overall group of the university's staff and students who passed the procedure of self-assessment of the level of involvement in innovative activities. The evaluation model of correspondence of development of a university's innovative activity to the "ideal point" – expectations of the main interested parties – was used. Respondents were asked to rate each indicator based on their idea of its perfect state, as well as in terms of its correspondence to the chosen ideal point. The assessment was performed on a seven-point scale, where 7 is the highest assessment of the indicator and 1 is the lowest (the threshold value is 4). In addition, of interest was the respondents' assessment of the current state of innovative activity in the considered university on the whole.

Data analysis was performed using the Microsoft Excel spreadsheet processor. Pearson pair correlation matrices were constructed based on data obtained from the quantitative survey.

Results

To create the system model for the assessment of university innovative activity development, the following requirements for this activity are introduced: the coverage of the main activities of the university by the university's innovative activities in the three planes (research, educational, administrative) accounting for dynamics in the development of innovative activity based on the indicators of innovation potential (income), innovative activity (process), and the results of innovative activity (outcome).

Based on content-analysis of scientific literature, the leading Russian and global university rankings, and national and global innovation activity rankings, the list of indicators of a university's innovative activity was formed (Table 1). A total of 59 indicators are proposed to characterize the innovation potential (income; the code begins with 1), innovative activity (process; the code begins with 2), and the results of innovative activity (outcome; the code begins with 3) of the university. Of these, by each direction: 27 indicators of scientific research activities (Code S); 23 indicators of educational innovative activities (Code E); 9 indicators of the university's administrative innovation activity (Code A). The importance of each indicator was assessed in the expert survey on a ten-point scale.

Table 1 – Assessment indicators of the university innovative activity development level

AGI	№	Indicator	Code
F1	1	Development of innovative and entrepreneurial activities is enshrined in the mission and strategy of the university	S1.1
	2	Development of innovative educational activities, including the implementation of the principles of CE are enshrined in the mission and strategy of the university	E1.1
	3	Existence of a quality assurance process for the CE process	***E1.8***
	4	Usage of the university organizational - economic form - an autonomous institution	***A1.1***
	5	Presence of procedures for analyzing and optimizing administrative processes in the university	***A2.3***
	6	University policy allows combining the work of the staff and students at the university with innovative and entrepreneurial activities, work in business	S1.8
F2.	7	Specific weight of the number of (SPP) without a degree – up to 30 years, candidates of sciences – up to 35 years, doctors of sciences – up to 40 years, in the total number of NDPs in the reporting year, %	S1.2
	8	Percentage of academic staff who are employed in a non-academic environment (main job or part-time job), %	E1.2
	9	Motivation system in the university promotes innovative behavior of employees and increases productivity	***S1.3***

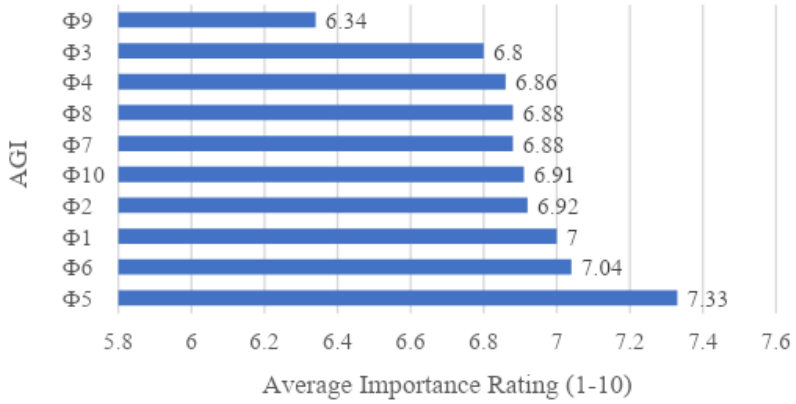
	10	Share of the university administrative staff involved in the development of innovation and business activities in the total number of administrative staff	A1.2
F3.	11	Volume of income from R&D per one scientific and pedagogical worker, thousand rubles	S1.4
	12	Share of funds in the budget for the development of innovations in educational activities, %	E1.3
F4.	13	Share of R&D performed on their own (without the involvement of co-executors) in the total income of the educational organization from R&D	S1.5
	14	Availability and quality of the electronic library at the university	E1.4
	15	Number of computers with Internet access per student/Number of classrooms equipped with ITT per 1 study group	E1.5
	16	Number of University centers in the field of engineering	S1.6
	17	Introduction of IT systems that support management decision-making processes in the last 5 years	***A2.2***
	18	Implementation of IT systems and other communication tools or methods for gathering information and knowledge and sharing it with employees (for example, Intranet, knowledge bases) over the past 5 years	***A2.3***
F5.	19	Number of companies with which the university has an agreement on the establishment of basic departments	E1.6
	20	Number of enterprises with which an agreement on cooperation in the field of educational activity has been signed (for targeted training of specialists)	E1.7
	21	Number of established joint laboratories/innovation infrastructure facilities	S1.7
	22	Number of joint publications with co-authors from the non-academic environment in publications indexed in the priority for the organization of information and analytical systems of scientific citation (RISC, Scopus, Web of Science)	S2.5
	23	Number of R&D sponsorship agreements, contracts, and joint projects with non-academic partners	S2.7
	24	Number of contracts for consulting services	S2.8
F6.	25	Share of R&D funding from extrabudgetary sources	S2.1
	26	Number of R&D contracts under which the university attracted funding from extrabudgetary sources	S2.2
	27	Number of APPE, trainings that received external funding in the total number of programs implemented in APPE, trainings	E2.1
	28	Number of grants received for the reporting year per 100 faculty	S2.10
	29	Number of university infrastructure development projects that have received external funding per 100 employees	A2.3
F7.	30	Average annual number of intellectual property items on the balance of the university	S2.3
	31	Average annual number of participants in university programs aimed at developing entrepreneurship	S2.9
	32	Share of research and teaching staff, graduate students, and undergraduate students involved in creative associations and innovative projects in the reporting year in the total number of researcher students, graduate students, and undergraduate students	***S2.4***
	33	Average annual number of operating small innovative enterprises (business societies) established at the university since 2009	S2.6
	34	Average annual number of resident teams of business incubators and technology parks of the university per 100 faculty members	S2.11
F8.	35	Number of educational programs implemented in the reporting year, innovation-entrepreneurial orientation	E2.2
	36	Number of publications of the organization indexed in the priority information and analytical systems of scientific citation (Scopus, Web of Science, RISC)	E2.9
	37	Number of citation publications of the organization indexed in the priority information and analytical systems of scientific citation (Scopus, Web of Science, RISC)	E2.10
	38	Number of programs of APPE, trainings implemented in the reporting year, including specially ordered, consistent with the principles of CE and using new information technologies in the total number of such programs	E2.3
	39	Number of international CE programs implemented in the reporting year	E2.4
	40	Number of MOOCs developed by university staff implemented in the reporting year	E2.5
	41	Share of courses (disciplines) innovative for a particular university implemented in the reporting year in the total number of disciplines implemented	***E2.6***

	42	Number of international CE programs implemented in the reporting year	***E2.7***
	43	Number of programs created in cooperation with public or private companies, including professional development programs implemented in the reporting year per 1000 students	E2.8
F9.	44	Share of funds received by the university from the use of the results of intellectual activity in the total income of an educational organization, %	S3.1
	45	Amount of funds received through the use of the results of intellectual activity in the reporting year per 100 staff	S3.2
	46	Amount of funds received by the university from the SIE in the reporting year (on average)	S3.3
	47	Average annual number of operating small innovative enterprises (business societies) established at the university since 2009	S3.4
	48	Income from programs of APPE, trainings implemented in the reporting year, including special orders (active this year), corresponding to the principles ofCE and using new information technologies in the total income from the implementation of all educational programs	E3.1
	49	Number of awards in the field of innovation awarded by business or the public sector, agencies, funds	S3.5
F10.	50	Percentage of students completing additional professional education programs	E3.2
	51	Number of award-winning programs of APPE, trainings, and MOOCs in the reporting year	E3.4
	52	Number of jobs in the created innovative infrastructure and business entities	S3.6
	53	Student satisfaction with the use of innovative learning technologies in the educational process	E3.3
	54	Satisfaction level of SPP, administrative staff with the implemented administrative innovations in the field of document circulation, communication, etc.	**A3.1**
	55	Degree of satisfaction of the users of infrastructure services supporting research and entrepreneurial innovation	***S3.7***
	56	Percentage of patents received/submitted applications	S3.8
	57	Index of compliance with the quality of management decisions at the university	***A3.2***
	58	Percentage of university staff who have upgraded their qualifications in the university's programs for training innovative personnel for the university's internal needs and for supporting innovation processes in the total number of employees	A3.3
	59	Share of innovation-oriented personnel trained and advanced for small and medium-sized innovative businesses based on the university's programs to the total number of graduates	E3.5

Source: Prepared by the authors

Based on survey results, the consistency of expert opinions on the significance of the indicators was tested with the coefficient of variation. As a result, the opinions of experts are deemed consistent and the proposed indicators are assessed as important. In addition, for the sake of convenience of further calculations, the indicators were combined into aggregated groups characterizing the level of development of the university's innovative activities at the stages of "income" – innovation culture and policy (Φ1), the readiness of staff for innovative activity (Φ2), financial resource capacity (Φ3), material and technical equipment (Φ4); "process" – connections with the non-academic environment/partnerships (Φ5), ability to raise funds independently (F6), process of creating an innovative product (Φ7), the process of creating an innovative educational product (Φ8); "outcome" – economic effects (Φ9), non-economic effects (Φ10) (Fig. 2).

Figure 1 – Average values of expert assessment of the importance of AGIs of the university's innovative activity development level



Source: Prepared by the authors

The results of expert assessment support the importance of the proposed indicators and allow to formulate the H3 hypothesis. The summed average scores of indicators on the factors affecting the development of innovation activity in the university suggest that the most important factor, according to experts, is "Connections with the non-academic environment, partnerships". Among factors of the greatest importance (significance) are also "Ability to raise funds independently" and "Innovation culture and policy".

The data obtained in the quantitative survey can be divided into three groups: assessment values of the ideal (optimal) level of the proposed indicators, assessment values of the actual level of the indicators, and innovative activity development coefficients (K, which are the ratio of the assessed actual state of the level of innovation development to the ideal one), which give an opportunity to examine the gap between the desired and the current state of development of innovative activity (Table 2).

Table 2 – Calculated values of development coefficients for each innovation development indicator on the example of the FEFU, 2019

Code	A1.1	A1.2	A1.3	A2.1	A2.2	A2.3	A3.1	A3.2	A3.3	E1.1	E1.2	E.3	E1.4	E1.5	E1.6	E1.7	E1.8	E2.1	E2.2	E2.3
Arithmetic mean of the ideal point score (from 1 to 7)	6.1	4.9	5.2	6.2	6.2	6.0	6.2	6.3	5.6	6.4	5.9	5.9	6.7	6.6	6.0	6.0	6.1	5.9	5.4	5.6
Arithmetic mean of the actual state score	2.6	2.7	2.9	3.9	3.8	2.6	3.3	2.7	2.9	3.3	3.2	3.0	4.2	4.3	3.5	3.3	3.2	2.7	2.7	2.8

(from 1 to 7)																				
Development coefficient K by indicator	**0.43**	**0.56**	**0.56**	**0.63**	**0.62**	**0.44**	**0.53**	**0.42**	**0.51**	**0.52**	**0.54**	**0.5**	**0.63**	**0.65**	**0.57**	**0.55**	**0.52**	**0.45**	**0.5**	**0.49**
Code	E2.4	E2.5	E2.6	E2.7	E2.8	E2.9	E2.10	E3.1	E3.2	E3.3	E3.4	E3.5	S1.1	S1.2	S1.3	S1.4	S1.5	S1.6	S1.7	S1.8
Arithmetic mean of the ideal point score (from 1 to 7)	5.7	5.7	5.7	5.2	5.6	6.0	6.2	5.6	6.0	6.4	6.2	5.8	6.2	5.9	5.1	6.0	5.7	6.5	6.5	6.4
Arithmetic mean of the actual state score (from 1 to 7)	2.5	2.4	2.8	2.7	2.8	3.2	2.8	2.5	3.2	3.1	2.6	2.4	3.1	2.9	3.0	3.3	4.1	3.1	3.3	2.7
Development coefficient K by indicator	**0.44**	**0.42**	**0.5**	**0.53**	**0.5**	**0.54**	**0.46**	**0.45**	**0.53**	**0.49**	**0.42**	**0.42**	**0.5**	**0.5**	**0.58**	**0.54**	**0.72**	**0.48**	**0.5**	**0.42**
Code	S2.1	S2.2	S2.3	S2.4	S2.5	S2.6	S2.7	S2.8	S2.9	S2.10	S2.11	S3.1	S3.2	S3.3	S3.4	S3.5	S3.6	S3.7	S3.8	
Arithmetic mean of the ideal point score (from 1 to 7)	5.8	5.7	5.9	5.9	5.9	6.1	5.9	5.6	5.6	5.7	5.7	5.6	6.3	6.0	5.8	5.8	5.9	5.8	6.1	
Arithmetic mean of the actual state score (from 1 to 7)	2.5	3.3	2.7	2.7	3.0	2.9	3.0	3.3	2.7	2.6	3.4	2.1	2.3	2.4	2.6	2.9	3.9	2.3	2.6	
Development coefficient K by indicator	**0.43**	**0.57**	**0.45**	**0.45**	**0.5**	**0.48**	**0.5**	**0.58**	**0.49**	**0.47**	**0.6**	**0.37**	**0.36**	**0.4**	**0.45**	**0.5**	**0.67**	**0.39**	**0.43**	

Source: Respondents' evaluation of innovation activity (from 1 to 7) in general – 3.62; in scientific research – 3.5; educational – 3.57; administrative – 3.43.

The collected data were processed using standard Excel instruments and with an additional analytical instrument package. The calculated coefficient of variation falls within the norm (up to 33%). Overall, the average assessment of the factual level of the considered indicators is below the threshold value (4). Yet the average assessments of the "ideal" indicator

values do not reach the highest score either (7). It should be pointed out that in each and every case, the value of ***K*** is below 1, most often even lower than 0.5, which suggests a rather low estimation of innovative activity indicators in the examined university.

Correlation analysis of all three groups of data reveals considerable connections between indicators within the considered directions of activity, which is repeated most of the time with only the strength of the connection varying. It should be noted that connections are mostly observed *within subgroups*, which confirms the accuracy of the choice of indicators to characterize each of the considered directions. Meanwhile, correlations between indicators of various directions cannot be completely ruled out either (Table 3). For instance, the greater the gap between the ideal and actual value of the A1.1 indicator (the use of the legal advantages of an "entrepreneurial" university), the larger the gap between the ideal and actual value of the S1.2 indicator (development of entrepreneurial culture at the university) (r = 0.43). The same connection is found between the coefficients of innovative development A1.2 (the share of administrative staff involved in innovative processes in the university) and E1.3 (the share of funds in the budget for the development of innovations in educational activities), r = 0.30. Deviation of the A3.3 indicator (advanced training of innovative personnel for the internal needs of the university) from the ideal affects the deviation of the E2.3 and E3.5 indicators – the number of innovative programs/modules and the graduation of "innovative personnel" (r = 0.41 and 0.33, respectively).

Departure from the ideal value of the A3.2 indicator (index of correspondence of the quality of managerial decisions made) affects the gap with the ideal value of the E3.4 indicator (external recognition of the university's educational products), r = 0.32. A noticeable link is detected between the saturation of educational programs with "innovative" courses/modules (E2.3), as well as the number of innovation-oriented staff trained (E3.5) (correlation coefficient 0.50), and the ability for independent funding of scientific research (S2.1) (r = 0.35). The above-described findings substantiate the influence of administrative innovations on other directions in the university's innovative activity.

Table 3 – Correlation between the *development coefficients* of some indicators of administrative, educational, and scientific research a university's innovative activity

Code	A1.1	A1.2	A3.2	A3.3	E2.3	E3.5
E1.3		***0,30***				
E2.3				***0,41***		
E3.4			***0,32***			
E3.5				***0,33***		
S1.2	***0,43***					
S2.1					***0,35***	***0,33***

Source: Prepared by the authors

The same applies to the relationship between the innovative development coefficients A1.2 (the share of administrative staff involved in innovative processes in the university) and E1.3 (the size of the budget for the development of innovations in educational activities), r = 0.30. The difference of the A3.3 indicator (advanced training of innovative personnel for the internal needs of the university) from the ideal value affects the deviation of the E2.3 and E3.5 indicators – the number of innovative programs/modules and the production of "innovative personnel" (r = 0.41 and 0.33, respectively). Deviation from the ideal value of the A3.2 indicator (index of correspondence of the quality of managerial decisions made) influences the deviation of the E3.4 indicator (external recognition of the university's educational products), r = 0.32 (Table 3). A considerable relationship is found between the saturation of educational programs with "innovative" courses/modules (E2.3), as well as the number of innovation-oriented personnel trained (E3.5) (correlation coefficient 0.50) and the ability for independent funding of scientific research (S2.1) (r = 0.35). The above-described results confirm the influence of administrative innovations on other directions in a university's innovative activity (H2).

A number of considerable links between indicators are also detected within each direction (scientific research, educational, and administrative), however, they are more evident in the AGIs (Table 4).

Table 4 – Calculation of the coefficients of correlation between ***the coefficients of development*** of innovative activities of the university in the AGIs

DIRECTION		ADMINISTRATIVE					EDUCATIONAL									SCIENTIFIC (RESEARCH)								
	STAGE	INCOME	PROCESS		OUTCOME		INCOME				PROCESS			OUTCOME		INCOME				PROCESS			OUTCOME	
	CODE	Φ_{A1}	Φ_{A2}	Φ_{A4}	Φ_{A6}	Φ_{A9}	Φ_{E1}	Φ_{E2}	Φ_{E4}	Φ_{E3}	Φ_{E5}	Φ_{E6}	Φ_{E8}	Φ_{E9}	Φ_{E10}	Φ_{S1}	Φ_{S2}	Φ_{S4}	Φ_{S3}	Φ_{S5}	Φ_{S6}	Φ_{S7}	Φ_{S9}	Φ_{S10}
ADMINISTRATIVE DIRECTION	INCOME Φ_{A1}	1,00																						
	Φ_{A2}	***0,41***	1,00																					
	PROCESS Φ_{A4}	***0,62***	0,24	1,00																				
	Φ_{A6}	***0,47***	0,21	***0,67***	1,00																			
	OUTCOME Φ_{A9}	***0,62***	***0,50***	***0,67***	***0,48***	1,00																		
EDUCATIONAL	Φ_{E1}	-0,02	0,07	0,06	-0,01	0,23	1,00																	
	Φ_{E2}	0,06	0,02	0,05	0,08	0,12	***0,47***	1,00																
	Φ_{E4}	-0,08	0,08	0,03	-0,11	0,20	***0,54***	***0,35***	1,00															
	INCOME Φ_{E3}	0,07	***0,30***	0,03	0,05	0,25	***0,60***	***0,40***	***0,48***	1,00														
	Φ_{E5}	-0,06	0,01	0,02	-0,01	0,15	***0,73***	***0,47***	***0,51***	***0,45***	1,00													
	Φ_{E6}	-0,01	0,13	-0,03	0,02	0,20	***0,46***	0,29	***0,47***	***0,61***	***0,42***	1,00												
	PROCESS Φ_{E8}	0,04	0,14	0,03	-0,03	0,23	***0,66***	***0,53***	***0,51***	***0,66***	***0,63***	***0,65***	1,00											
	Φ_{E9}	0,06	0,15	0,04	-0,02	0,26	***0,64***	***0,40***	***0,52***	***0,57***	***0,49***	***0,57***	***0,66***	1,00										
	OUTCOME Φ_{E10}	-0,01	0,09	0,06	-0,04	0,17	***0,53***	0,30	***0,44***	***0,51***	***0,50***	***0,59***	***0,67***	***0,47***	1,00									
SCIENTIFIC (RESEARCH)	Φ_{S1}	0,02	0,05	-0,14	-0,05	0,01	0,26	0,06	0,04	0,14	0,19	0,09	0,17	0,12	0,07	1,00								
	Φ_{S2}	***0,32***	0,14	0,22	0,12	0,20	0,03	-0,02	0,01	0,00	0,03	-0,03	-0,01	-0,01	-0,02	0,18	1,00							
	Φ_{S4}	-0,01	-0,07	-0,07	-0,11	-0,14	0,13	0,13	-0,10	0,02	0,13	0,03	0,12	0,01	0,11	***0,53***	0,00	1,00						
	INCOME Φ_{S3}	0,06	0,12	0,10	0,02	0,15	0,17	0,06	0,06	0,09	0,12	0,06	0,12	0,06	0,15	0,22	***0,37***	0,03	1,00					
	Φ_{S5}	0,11	0,08	0,14	0,06	0,17	0,11	0,05	0,06	0,07	-0,02	0,04	0,02	0,12	0,07	0,09	***0,42***	-0,12	***0,56***	1,00				
	Φ_{S6}	0,08	0,05	-0,03	0,02	0,13	0,16	0,06	0,05	0,11	0,00	0,06	0,07	0,14	-0,01	***0,50***	***0,32***	0,15	***0,46***	***0,67***	1,00			
	PROCESS Φ_{S7}	0,14	0,08	0,08	0,02	0,07	0,09	0,03	-0,03	0,01	-0,07	-0,02	-0,03	0,05	0,03	***0,31***	***0,35***	0,27	***0,51***	***0,78***	***0,68***	1,00		
	Φ_{S9}	0,11	0,06	-0,04	-0,05	-0,01	0,00	-0,03	-0,07	-0,04	-0,12	-0,06	-0,08	0,04	-0,02	0,28	***0,32***	0,21	***0,40***	***0,72***	***0,67***	***0,78***	1,00	
	OUTCOME Φ_{S10}	0,18	0,05	0,02	-0,05	0,03	0,09	-0,01	-0,06	0,01	-0,06	-0,01	-0,03	0,09	0,00	***0,43***	***0,32***	0,30	***0,39***	***0,55***	***0,62***	***0,77***	***0,78***	1,00

Coefficient of correlation	0,1 — 0,3	0,3 — 0,5	0,5 — 0,7	0,7 — 0,9	0,9 — 0,99
Connection	weak	moderate	noticeable	high	very high
Color	-				-

Source: Prepared by the authors

The data presented in the table suggest that all the considered AGIs are significant. The strength of the connection is getting stronger. The AGIs of "income" and "process" have a considerable influence on the indicators of "outcome", which suggests they cannot be ignored in the assessment of the university's innovative activity.

Based on the data in Table 4, we can note the relationship between administrative, research, and educational innovative activities: the use of the advantages of an entrepreneurial university by the university (Φ_{A1}) is associated with the degree of preparation of innovative staff for the *scientific research* sphere (Φ_{S2}), correlation coefficient (hereinafter *r*) equals 0.32; the level of funding for innovative *educational* activity (Φ_{E3}) is linked with the level of engagement of *administrative staff* in innovative activities (Φ_{A2}), r = 0.30.

In the direction of educational activity, we can note a significant connection between deviation from the ideal value of the Φ_{E1} indicator (innovative policy) and the Φ_{E3} (level of funding for the direction) and Φ_{E5} (partnerships) indicators, as well as Φ_{E9} (non-economic effects), r = 0.60, 0.73, and 0.64, respectively.

In the direction of scientific research activity, a connection (r = 0.46) is observed between Φ_{S3} (budget financing for the direction) and Φ_{S6} (ability to attract funding for activity independently), i.e. budget funding here acts as a guarantee of the reliability and "competence"

of a particular university in conducting high-level scientific and technological research, which further contributes to the attraction of funding from extrabudgetary sources. A strong link is discovered between Φ_{S7} (characterized by indicators of the organization of the innovation process) and Φ_{S9} and Φ_{S10} (non-economic and economic effects of innovation activities), r = 0.78 and 0.77, respectively.

In the educational direction of innovation, a special influence on the "process" and "outcome" is produced by innovation policy in the field of education (Φ_{E1}) (contains the previously identified indicators), high-quality elaboration of which increases the level of intensity of partnerships (Φ_{E5}), as well as contributes to the development of innovative processes (Φ_{E8}) and affects the result (outcome) (Φ_{E9}), which influences the economic effect of innovative activity. This confirms the H3 hypothesis: the level of development of partnerships has a considerable effect on the level of organization of the process of innovative product creation at the university, and on the results of innovative activity.

In the course of the study, the respondents assessed the level of development of the university's innovative activity overall and in the three specific directions. Based on the data obtained, pairwise correlations were calculated.

Table 5 – Correlation analysis of the degree of connection between the level of innovation activity development in the university as a whole and its key directions on the example of the FEFU, 2019

Direction of innovation activity of the university	Innovation activity of the university as a whole	Scientific/Research innovation activity	Educational innovation activity	Administrative innovation activity
Innovation activity of the university as a whole	1.00			
Scientific/Research innovation activity	0.69	1.00		
Educational innovation activity	0.51	0.42	1.00	
Administrative innovation activity	0.56	0.47	0.46	1.00

Source: Compiled by the author according to questionnaire survey data

The coefficient of correlation of the general level of development of innovation activity with scientific activity is 0.69; with educational activity – 0.51; with administrative activity – 0.56.

Analysis of the correlation between the respondents' assessment of the "overall" state of the university's innovation activity and its key directions proves the substantial association

between these directions, which means that none of them can be excluded from the assessment of the university's innovative activity. This proves the H1 hypothesis: the level of development of the university's innovative activity depends on the degree of development of its main directions – scientific research, educational, and administrative, – but not to the same extent. The connection between the administrative direction of innovative activity and the educational and scientific research innovative activities is stronger than the link between the last two. This finding and the strength and nature of associations between the AGIs of development coefficients of administrative and other innovative activities confirm H2: administrative innovation activity has a significant impact on the research and educational areas of innovation activity, as well as on the level of development of innovation activity in general.

Discussion

Theorists and practitioners in the field of research on the innovative activity of universities agree unlike the business environment, in the sphere of higher education, it is impossible to quickly assess the effect of transformation of educational or research processes. In addition, it is not customary to talk about managerial successes in the university environment, unlike, for example, about scientific achievements (VOLIANSKAIA, 2019).

The obtained results give reason to assume that there is a link between the low resulting indicators of innovative activity of Russian universities and gaps in the chain of support for innovation activities (at the "income" and "process" stages), as well as an undeveloped innovation policy in the educational and administrative direction and the lack of connection between the main directions of innovation activity, which is supported by the results of earlier studies by us and other authors (EFREMOVA; ROMANOVA, 2016; GOKHBERG; ROUD, 2016; RVC, 2015).

Approbation of the proposed model and the system of indicators of the level of development of the university's innovative activity confirm the hypotheses put forward. At the same time, the limitation of the presented research methodology is the method assessment based on the subjective evaluation of respondents. This drawback is eliminated through the inclusion of questionnaire items for the respondents' self-assessment of their involvement in innovative activities. An additional limitation of this study is the authors' approach to the understanding of an "innovative university". In this work, we employed the approach of I.V. Abankina *et al*. (2013), under which Russian universities are divided into clusters based on their scientific and

educational efficiency and innovative potential. In view of this, we believe the research methodology to be applicable only to the universities included in the clusters of "Potential and real scientific-educational leaders", "Universities in good standing", and partially the "Market leaders" cluster.

Conclusion

The present study:

1. develops a model and a system of indicators to assess the level of development of innovation activities of the university in the following areas: research, educational, administrative;
2. identifies 10 AGIs in each direction of activity, including the income – process – outcome stages, which allows to account not only for the "result" but also for the "process" and "potential" in assessing innovative activity;
3. assesses the nature and strength of influence of the proposed indicators on one another through the calculation of pairwise correlations, including in aggregated groups, as well as in the individual areas of innovation activity of the university, particularly the effect of administrative innovation on the remaining areas of innovation activity.

The results of correlation analysis and the calculation of data prove the importance of each element of the proposed system of indicators for assessing a university's innovative activity, which means that none of them can be excluded for the assessment. In this regard, monitoring as an element of management has to be administered at each stage of the university's innovative activity: income – process – outcome. In order to ensure the functioning of innovation activity in the university, each stage of the innovation process should be supported by the basic or innovative infrastructure objects.

The main objectives of the innovation policy of the university should be enhancement of interaction between elements of the innovation system through the elimination of gaps in the chain of support for innovation activities of the university in all directions and reinforcement of connections between the controlling subsystems responsible for the directions and stages that have a significant impact on the results of the university's innovative activity and its overall competitiveness. The condition of interaction between the basic organizational structure and the innovation infrastructure is a truly important element. The development of measures in this direction can constitute the subject of further research.

REFERENCES

ABANKINA, I. V. *et al.* Tipologiia i analiz nauchno-obrazovatelnoi rezultativnosti rossiiskikh vuzov [A Typology and Analysis of Russian Universities' Performance in Education and Research]. **Foresight-Russia**, v. 3, p. 48-63, 2013.

BARBIERI, J. C.; ALVARES, A. C. T. Sixth generation innovation model: Description of a success model. **Revista de Administração e Inovação**, São Paulo, v. 13, n. 2, p. 88-112, 2016. Available in: https://www.revistas.usp.br/rai/article/view/102515. Access in: 17 Dec. 2022.

CHRISTENSEN, C. M. **Disrupting College**: How Disruptive Innovation Can Deliver Quality and Affordability to Postsecondary Education. Washington, DC: Center for American Progress, 2011.

EFREMOVA, P. V. Pokazateli otsenki effektivnosti razvitiia innovatsionnoi deiatelnosti vuzov [Indicators for assessing the effectiveness of the universities' innovative activity development]. **Russian Journal of Innovation Economics**, v. 9, n. 3, p. 989-1010, 2019.

EFREMOVA, P. V. Sovershenstvovanie sistemy upravleniia innovatsionnoi deiatelnostiu v vuze putem formirovaniia innovatsionnoi infrastruktury [Improving the innovation management system at the university by forming an innovative infrastructure]. **Russian Journal of Innovation Economics**, n. 2, p. 311-326, 2018.

EFREMOVA, P. V.; ROMANOVA, I. M. Osobennosti organizatsii innovatsionnoi deiatelnosti v vuzakh Rossii [Features of the organization of innovative activities in Russian HEI]. **The bulletin of the Far Eastern Federal University. Economics and Management**, n. 3, p. 61-75, 2016.

EFREMOVA, P. V.; ROMANOVA, I. M. Otsenka urovnia razvitiia innovatsionnoi deiatelnosti vuza. Chast 1: obosnovanie i aprobatsiia predlozhennogo podkhoda [Assessment of the development level of a university's innovative activity. Part 1. Validation and verification of the proposed approach]. **Russian Journal of Innovation Economics**, v. 3, p. 311-326, 2020a.

EFREMOVA, P. V.; ROMANOVA, I. M. Otsenka urovnia razvitiia innovatsionnoi deiatelnosti vuza. Chast 2: analiz strukturnykh vzaimosviazei mezhdu vnutrennimi elementami razvitiia innovatsionnoi deiatelnosti vuza [Assessment of the development level of a university's innovative activity. Part 2. Analysis of structural relationships between internal elements of university innovation development]. **Russian Journal of Innovation Economics**, n. 4, 2020b.

ETZKOWITZ, H.; LEYDESDORFF, L. The Triple Helix – University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development. Rochester, NY: SSRN, 1995.

FINAL Report of Delphi Study: E3M Project - European Indicators and Ranking Methodology for University Third Mission. n.d. Available in: https://www.pi.infn.it/~giorgio/INFN/3M/E3M/Delphi-E3M-project.pdf. Access in: 10 Jan. 2022.

GOKHBERG, L.; ROUD, V. How to design a national innovation system in a time of global innovation networks: A Russian perspective. *In*: **The Global Innovation Index 2016. Winning with Global Innovation**. Geneva; Fontainebleau; Ithaca, New York: Cornell University; INSEAD; WIPO, 2016. p. 159-166.

KRASNICKA, T.; GLOD, W.; WRONKA-POSPIECH, M. Management innovation and its measurement. **Journal of Entrepreneurship, Management, and Innovation**, v. 12, n. 2, p. 95-122, 2016.

MARINOVA, R.; PHILLIMORE, J. Models of innovation. *In*: SHAVININA, V. (Ed.). **International handbook on innovation**. Oxford: Elsevier Science Ltd., 2003. p. 44-53.

MOTHE, C.; THI, T. U. N. The link between non technological innovations and technological innovation. **European Journal of Innovation Management**, v. 13, n. 3, p. 313-332, 2010. Available in: https://hal.archives-ouvertes.fr/hal-00920069/document. Access in: 13 Apr. 2022.

ROTHWELL, R. Towards the fifth-generation innovation process. **International Marketing Review**, v. 11, n. 1, p. 7-31, 1994. Available in: https://www.emerald.com/insight/content/doi/10.1108/02651339410057491/full/html. Access in: 17 Aug. 2021.

RVC. Analiz innovatsionnoi ekosistemy vuzov i nauchnykh tsentrov [Analysis of the innovative ecosystem of HEIs and research centers]. 2015. Available in: http://www.rusventure.ru/ru/programm/analytics/docs/Innovation_ecosystem_analytical_report.pdf. Access in: 20 Sept. 2020.

VOLBERDA, H. W.; VAN DEN BOSCH, F. A. J.; HEIJ, C. V. Management innovation: Management as fertile ground for innovation. **European Management Review**, v. 10, n. 1, p. 1-15, 2013.

VOLIANSKAIA, V. (Ed.). **T - Universitety** [T - Universities]. Skolkovo: Education Transformation Center of the Moscow School of Management SKOLKOVO, 2019. Available in: http://www.skolkovo.ru/public/media/documents/research/sedec/SKOLKOVO_SEDeC_T-universities_ru.pdf. Access in: 1 Aug. 2020.

How to reference this article

EFREMOVA, P. V.; ROMANOVA, I. M.; BELKIN, V. G.; VASILYEVA, L. A. Indicators for assessment of the development of a university's innovative activity as a factor in its competitiveness in the national and international markets. **Nuances Est. Sobre Educ.**, Presidente Prudente, v. 33, n. 00, e022022, 2022. e-ISSN: 2236-0441. DOI: https://doi.org/10.32930/nuances.v33i00.9623

Submitted: 18/04/2022
Required revisions: 03/06/2022
Approved: 23/09/2022
Published: 10/11/2022

Processing and publication by the Editora Ibero-Americana de Educação.
Correction, formatting, standardization and translation.