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RESEARCH ARTICLE

Formation of a comprehensive approach to developing the scientific and educational infrastructure of a modern engineering university

Stanislav A. Kudzh, Natalia B. Golovanova @, Yuri G. Grafov

MIREA – Russian Technological University, Moscow, 119454 Russia
@ Corresponding author, e-mail: golovanova@mirea.ru

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Abstract

Objectives. The work sets out to develop a comprehensive approach to grounding decisions aimed at advancing the scientific and educational infrastructure of an engineering university. This includes selecting modernization policies for the scientific and educational infrastructure, substantiating the format of scientific and educational infrastructure objects in light of the diversity of current tasks, involving industry partners in implementing infrastructure policies, as well as addressing resource support issues using mathematical formalization and analytical evaluation tools.

Methods. Methods of systems and strategic analysis, comparison and formalization, modeling and statistical indicators, as well as change management, risk assessment, and strategy actualization approaches, were used.

Results. Ensuring the contribution of modern engineering universities to technological leadership is an ambitious task that requires a focused approach to the development of scientific and educational infrastructure. One effective solution consists in the creation of specialized laboratories, or mega-laboratories, which are considered as an optimal format for the scientific and educational infrastructure. Such laboratories combine educational, research, and communication zones, along with their respective advantages and typologies. The importance of collaboration with industry partners in driving innovation, helping to ensure that educational programs, research, and development align with market needs, is demonstrated. A mathematical model is developed for evaluating projects associated with the establishment of a mega-laboratory based on a comprehensive system of indicators. This model was used to formalize the procedure for selecting and financing of newly created scientific and educational infrastructure.

Conclusions. Infrastructure constraints defined at the state level in the context of technological development and the need to ensure technological independence are becoming a key challenge for engineering universities. This necessitates the development of tools for seeking, justifying, and making managerial decisions. The described comprehensive approach takes into account current requirements for scientific and educational infrastructure facilities, including a high degree of integration between education and science, and the involvement of industry partners in the development process in order to bridge the gap between education, science, and the demands of the real economy. The formulated recommendations and proposed solutions effectively address the issues faced by modern engineering universities within development programs.

Keywords: engineering university, scientific and educational infrastructure, mega-laboratories, industrial partnership, infrastructure project assessment, strategic planning, interdisciplinary research, technological development, mathematical model, performance indicator system

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НАУЧНАЯ СТАТЬЯ

Формирование комплексного подхода к развитию научно-образовательной инфраструктуры современного инженерного университета

С.А. Кудж, Н.Б. Голованова @, Ю.Г. Графов

МИРЭА – Российский технологический университет, Москва, 119454 Россия
@ Автор для переписки, e-mail: golovanova@mirea.ru

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Резюме
Цели. Целью статьи является разработка комплексного подхода к обоснованию решений, направленных на развитие научно-образовательной инфраструктуры инженерного университета, включающего выбор политики модернизации научно-образовательной инфраструктуры, обоснование формата объектов научно-образовательной инфраструктуры с учетом многообразия актуальных задач, вовлечение индустриальных партнеров в реализацию инфраструктурной политики, а также вопросы ресурсного обеспечения, реализуемого с применением инструментов математической формализации и аналитической оценки.
Методы. В исследовании использованы методы системного и стратегического анализа, методы сравнения и формализации, методы моделирования и статистических показателей, методы управления изменениями и рисками, а также метод актуализации стратегии.
Результаты. Масштабные задачи по обеспечению вклада современных инженерных университетов в достижение технологического лидерства требуют особого внимания к вопросам развития научно-образовательной инфраструктуры. Эффективным решением является создание лабораторий особого типа – мегалабораторий, которые рассматриваются как оптимальный формат объекта научно-образовательной инфраструктуры, сочетающий учебные, исследовательские и коммуникационные зоны с их преимуществами и типологией. Обоснована значимость партнерства с индустриальными партнерами как ключевого драйвера развития, обеспечивающего соответствие образовательных программ, исследований и разработок потребностям рынка. Разработана математическая модель оценки проекта создания мегалаборатории, основанная на комплексной системе показателей, позволяющая формализовать процедуру выбора и принятия решения о финансировании вновь создаваемых объектов научно-образовательной инфраструктуры.
Выводы. Определенные на государственном уровне инфраструктурные ограничения в условиях технологического развития и необходимости достижения технологического лидерства становятся для инженерных университетов ключевым вызовом, требующим формирования инструментария поиска, обоснования и принятия управленческих решений по развитию объектов научно-образовательной инфраструктуры. Использование комплексного подхода позволяет максимально учесть актуальные требования к объектам

научно-образовательной инфраструктуры, включая высокий уровень интеграции образования и науки, необходимость учета и включения в процесс развития индустриальных партнеров как залог сближения образования, науки и потребностей реальной экономики. Сформулированные рекомендации и предложенные решения позволяют эффективно решать задачи, стоящие перед современными инженерными университетами в рамках программ развития.

Ключевые слова: инженерный университет, научно-образовательная инфраструктура, мегалаборатории, индустриальное партнерство, оценка инфраструктурных проектов, стратегическое планирование, междисциплинарные исследования, технологическое развитие, математическая модель, система показателей эффективности

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INTRODUCTION

During a strategic session on education development in autumn 2024, which was chaired by the Prime Minister of the Russian Federation, M.V. Mishustin[1], and also attended by the Minister of Science and Higher Education of the Russian Federation, V.N. Falkov, infrastructure limitations were highlighted as one of the current challenges faced by the higher education system and engineering universities[2]. Therefore, university management focuses on developing the required material and technical basis, which largely determines the ability to train qualified engineering personnel for the Russian high-tech economy, conducting scientific research and development (R&D) to achieve technological leadership, and thus ensuring technological independence.

In today's socioeconomic climate, the development of the material and technical infrastructure of an engineering university presents a complex challenge. While the search for funding is undoubtedly an important aspect, universities also need to adapt to the rapidly evolving technological landscape and respond to ongoing changes. The "Concept of Technological Development of the Russian Federation until 2030," approved by Directive No. 1315-r of the Government of the Russian Federation on May 20, 2023[3], identifies the rapid acceleration in the creation and diffusion of novel technologies, including digital technologies that are radically changing markets and production systems, as one of the main threats to technological advancement. If an engineering university fails to address this issue effectively, it may be forced to adopt a "catch-up" development model, resulting in a lag in training engineering personnel and a decline in innovative R&D efforts.

The main task of any university administration is to create favorable conditions for learning. This includes maintaining buildings, structures, and land plots in a state that is conducive to education and scientific research, e.g., carrying out preventive maintenance on air conditioning and ventilation systems, etc. It is also necessary to provide constant support for developing the interest of students in mastering modern, innovative solutions, software and hardware complexes, conducting advanced scientific research, as well as organizing closer cooperation with leading companies in the Russian Federation, including in the production of goods and the introduction of new product quality control methods. The key to effective learning consists in motivating the desire of students for continuous improvement and the acquisition of new knowledge. In this regard, the students' conviction that their practical skills are being developed using the latest equipment and modern instruments becomes a crucial element.

STRATEGIC DEVELOPMENT DIRECTION OF SCIENTIFIC AND EDUCATIONAL INFRASTRUCTURE

One of the key areas of development for a modern engineering university, since underpinning its educational and scientific activities, is widely considered to lie in the modernization of material and technical resources, primarily laboratories. However, despite the importance of considering approaches to infrastructure policy implementation, issues related to laboratory facility development strategy and proposed project evaluation have not received adequate attention.

[1] http://government.ru/news/53144/. Accessed February 04, 2026. (In Russ.).

[2] https://www.minobrnauki.gov.ru/press-center/news/novosti-ministerstva/90823/. Accessed February 04, 2026. (In Russ.).

[3] The Concept of Technological Development of the Russian Federation until 2030. Directive of the Government of the Russian Federation of May 20, 2023 г. No. 1315-r. http://government.ru/docs/48570/. Accessed February 04, 2026. (In Russ.).

Research into engineering university development, particularly in terms of the training of engineering personnel, is attracting increased interest[4] [1–4]. With regard to scientific and educational infrastructure, only isolated statements acknowledge the role and importance of laboratories without revealing the full depth and complexity of the issue of creating and developing such infrastructure. For example, it is stated in the study by L.B. Sobolev that "only strong (and wealthy) scientific laboratories at universities are capable of creating a basis for the transition to a digital economy" [5]. According to F.F. Sharipov, educational and scientific laboratories at universities are one of the key elements in tackling the tasks set out in the Strategy for Scientific and Technological Development [6]. Nevertheless, the study fails to adequately address the question of how to create laboratories that will actively contribute to scientific and technological development or how to solve the problems that inevitably arise as part this process.

Clearly, infrastructure policy can be implemented in a variety of ways, with the specific approach taken depending on the particular strategy adopted for developing scientific and educational infrastructure. However, it is clear that the development of a university's material and technical base is will require active management. Otherwise, "the lack of proper attention to this issue... has a negative impact on the quality of the educational process as a whole" [7].

RTU MIREA's strategy involves the creation of mega-laboratories (mega-labs) as unique scientific and educational complexes. At present, mega-labs form the core of RTU MIREA's scientific and educational infrastructure. Boasting the most advanced technological solutions, these facilities offer a wide range of possibilities for use in both educational and research activities.

In addition to identifying a location for laboratory work or a researcher's workspace, the establishment of a mega-lab involves also entails organizing the procurement and installation of equipment, along with its appropriate placement in a designated space. A mega-lab is a specialized type of educational and research facility, encompassing a scientific and academic complex that includes classrooms, areas for collaborative research, offices, communications spaces, and informal areas. It is designed to be a comfortable working environment with various infrastructure components for all concerned parties.

Several compelling reasons can be adduced to justify the emphasis on establishing mega-labs.

Firstly, the mega-lab concept structures the development of large, well-equipped facilities focused on executing significant educational and research initiatives, which are capable of addressing their own resource requirements.

Secondly, it provides an opportunity for the implementation of interdisciplinary projects that are strategically significant for the overall development of the university, the realization of its development program, and the enhancement of the volume and quality of work and services provided for the benefit of all concerned parties.

Thirdly, mega-labs provide a convenient means of attracting industrial partners and leveraging co-financing mechanisms for projects that utilize the mega-lab concept for educational and research activities.

Fourthly, economies of scale are achieved through the introduction of the most advanced equipment, sophisticated systems, technologies, software, and hardware solutions, which are utilized by various departments of institutes for education and research. This serves to reduce unit costs and operating expenses.

Fifthly, there is an opportunity to apply for state support in relation to the implementation of regional and national projects, as well as securing co-funding for basic or applied scientific research in areas where RTU MIREA has achieved significant progress. This is of particular relevance when participating in competitions organized by the Russian Ministry of Education and Science (Minobrnauka)[5], Ministry of Industry and Trade (Minpromtorg)[6], etc., for the implementation of which projects the university is required to attract external funding.

Sixthly, the concept structures the upgrading of material and technical infrastructure of previously established mega-labs that have proven their efficacy in terms of providing an excellent basis for developing professional expertise.

Finally, the establishment of mega-labs develops model solutions for scientific and educational infrastructure that can be scaled and replicated to further enhance engineering education and improve the effectiveness of scientific R&D in line with the national scientific and technological development agenda. For this reason, all mega-lab projects are equipped with a comprehensive range

[4] Analytical report of the HSE Labor Market Research Laboratory: "Graduates of Engineering Specialties: Resistance of Materials in the Russian Labor Market." https://www.hse.ru/data/2025/04/15/1951597714/Report_20250415.pdf. Accessed February 04, 2026. (In Russ.).

[5] The Ministry of Science and Higher Education of the Russian Federation (Minobrnauka). https://minobrnauki.gov.ru/. Accessed February 04, 2026. (In Russ.).

[6] The Ministry of Industry and Trade of the Russian Federation (Minpromtorg). https://minpromtorg.gov.ru/. Accessed February 04, 2026. (In Russ.).

of methodological, educational aids, and materials, including video lectures for conducting classes at universities at which programs and projects are carried out in collaboration with strategic partners of RTU MIREA. This is certainly beneficial for partner organizations that need to select a site for testing technological and organizational solutions as model solutions for future implementation.

When developing the university's scientific and educational infrastructure through the establishment of mega-labs, the decision regarding the feasibility of a given project should be informed by its typological differentiation. This is important since each identified type of mega-lab is characterized not only by its specific functional purpose and objectives, but also by its financial model.

One typological approach includes projects for developing mega-labs focused on fundamental disciplines. While the primary purpose of such mega-labs consists in the provision of support for educational activities, they may also serve as platforms for conducting fundamental research. Funding for these projects is provided through the RTU MIREA centralized fund.

The second type of mega-lab is associated with projects that are developing future technologies. These are research and development platforms where work is carried out on tasks that may not have an identified end user at the current stage, but whose results are likely to be in high demand in the near future. These labs can be "seen as a testing ground for promising ideas and for identifying potential leaders who will organize new areas of research."[7] Financial support for these projects is provided through the RTU MIREA centralized fund, taking into account the obligations of the educational and research departments to explore new areas of activity.

The third—most prevalent—type of mega-lab focuses on addressing urgent practical issues, such as the training of engineering personnel, as well as the conduct of scientific research and development that is in high demand. These laboratories primarily concentrate on interdisciplinary and multidisciplinary projects within educational and research activities, as well as the creation of experimental production facilities. There is "increasing demand for technical universities to act as production laboratories for promising innovations."[8] The establishment of such mega-labs necessitates active collaboration with industrial partners.

[7] https://www.rbc.ru/society/14/11/2022/63720d159a794767085e7261. Accessed February 04, 2026. (In Russ.).

[8] https://rectorspeaking.ru/tekhnicheskie-vuzy-dolzhny-stat. Accessed February 04, 2026. (In Russ.).

PARTNERSHIP AS A DRIVER OF SUSTAINABLE DEVELOPMENT OF THE ENGINEERING UNIVERSITY

The interaction between universities, organizations, and businesses is a rapidly evolving trend in modern higher education [8]. Such interaction, which allows engineers to be trained to meet specific employer needs, involves research and development carried out on products and technological solutions that align with a company's current technical capabilities and future goals.

The issue of collaboration between universities and industry partners is not new [9]. However, as noted in one publication, "domestic universities often implement traditional and conventional technologies and methods for working with companies," and "the scope and effectiveness of such collaboration is often constrained by a lack of a systematic approach" [10].

Active collaboration can clearly emerge where the interests and expertise of universities and businesses intersect, creating a continuous scientific and industrial chain "from concept to implementation" for specific products. Therefore, partnerships between engineering institutions and business entities, which should be long-term rather than one-time events or initiatives, must be aimed at promoting university growth. However, such expansion and development will only occur if the collaboration satisfies the interests of both parties, with mutual benefit acting as a sort of "strategic screening mechanism" that allows for informed management decisions and guarantees advantages for each participant.

The interaction between universities and industry partners is developing especially dynamically among those participating in the Priority 2030 program. As noted by D.N. Chernyshenko, Deputy Prime Minister of the Russian Federation, universities are "building and strengthening partnerships with companies in the real economy. Over the past two and a half years, more than 420 consortia have been formed as part of the program, uniting universities, research organizations, and businesses. Over 6000 agreements have been concluded with industrial partners totaling more than RUR 62 bn."[9]

In light of the ongoing collaborative efforts between universities and industry partners, a strategic approach should set out to involve industry representatives in the development the university's academic and research infrastructure. Partner involvement is essential for several reasons. Firstly, it involves the formulation of a comprehensive schedule for establishing a new academic and research environment that addresses current challenges. Such an environment should provide physical and technical facilities that take into account the interests

[9] https://www.minobrnauki.gov.ru/press-center/news/novosti-ministerstva/90675/. Accessed February 04, 2026. (In Russ.).

of all concerned parties. Secondly, establishing each mega-lab at a major engineering institution like RTU MIREA is a costly undertaking that requires significant financial resources. Through partnership with industry, universities can share costs and leverage expertise and resources to ensure the success of the associated projects.

The financial strategy of a modern university necessarily involves the development of initiatives to diversify the sources of funding for its operations, including attracting investments from employers and other concerned parties [11]. This diversification process is based on the engagement of various parties in innovative activities such as the implementation of R&D results in the operations of existing enterprises and the establishment of new ones. Additionally, it involves collaboration with partners in research and design activities, which enhances the potential for scientific research and innovation.

In most cases, opportunities for collaboration and engagement with an industrial partner are realized in mega-lab projects of the third type, which are the most ambitious and focus on interdisciplinary and multidisciplinary development. The financial model for these projects involves co-funding from an industrial partner who acquires the status of strategic partner to the university. This includes the replication of proposed solutions across universities throughout the country, as well as the implementation of research and project activities through network interaction and networked educational projects and programs (including continuing education programs).

The development of these processes is facilitated by a number of developments in higher education. These include the transition of educational organizations to autonomous status, the establishment of a financing system that is aligned with modern economic conditions, and the development of an endowment fund system. Such developments should contribute to enhancing the independence of educational institutions. However, in order to attract such funding, a well-established system of collaboration, cooperation, and partnership with businesses and organizations becomes essential.

EVALUATION OF MEGA-LAB DEVELOPMENT PROJECTS FUNDED BY THE CENTRALIZED FUND

Although the mega-lab development projects at RTU MIREA receive funding from a centralized fund, a substantial portion of this funding comes from revenue-generating activities. This constitutes an important financial asset for the university today, enabling it to pursue its development objectives, including those pertaining to its scientific and educational infrastructure [12].

In light of the increasing need to modernize the material and technical infrastructure, as well as the development of new areas of scientific and academic activity, it is essential that the decision regarding funding be justified based on established criteria. Since the choice regarding which project to pursue for the development of the scientific and academic infrastructure is a managerial decision, the selected criteria must be clearly related to the institution's operations and aimed at achieving strategic goals [13]. Given limited resources, the primary criterion for making such a decision should be to maximize the project's benefit to the institution. Simultaneously, it is critical to ensure transparency in competitive processes, which enhances employee confidence in management decisions and, ultimately, improves the efficiency and efficacy of operations.

Given the limited financial resources available to educational institutions, a transparent process is necessary for the selection of laboratory development projects. This process serves as a reliable and efficient tool for university administration in the development of scientific and educational infrastructure [14].

The creation of a system to select mega-lab projects supported by the university has resulted in the following research goals being identified: the development of a set of indicators to provide a comprehensive evaluation of the proposed projects; the selection and validation of an approach for integrating project evaluation; and the creation of a rating system to inform decisions regarding project support.

The primary consideration for selecting a project is the expected value and potential benefits of the mega-lab in addressing challenges in critical areas of activity. Based on this criterion, a framework of indicators has been established to describe the key aspects of the proposed mega-lab. This framework consists of five groups of indicators, which are further divided into specific sub-indicators (Table 1):

These include:

- educational activities;
- research and development;
- collaboration with industry partners;
- relevance and significance of the project;
- uniqueness of the project.

The list of indicators above shows how each project is evaluated. The evaluation is based on two main types of activity: education and research. The involvement of industrial partners is also evaluated as an indicator of the project's value to the real economy. In addition to the aforementioned three components, the proposed system of indicators incorporates image characteristics that take improved perceptions of the project into account.

Except for those in the fifth group, each indicator's logical formula is based on the principle of relative value in the form of an index (Table 2). This ensures the comparability of all heterogeneous indicators and results, and enables them to be aggregated into a summary indicator despite the multidimensionality of the source information [15].

Table 1. Comprehensive system of indicators for evaluating the mega-lab project

No.	Group of Indicators	Sub-indicator
1	Educational activities	1.1. Expected workload of the mega-lab with training sessions 1.2. Expected coverage of students in classes at the mega-lab 1.3. Expected involvement of educational and research departments in using the mega-lab for educational purposes
2	Research and development (R&D)	2.1. Profitability of research projects conducted at the mega-lab 2.2. Publication activity aligned with the focus of the mega-lab 2.3. Contribution of R&D outcomes generated at the mega-lab to the university's overall research efforts 2.4. Efficiency in human resource utilization 2.5. Engagement of young researchers in R&D
3	Collaboration with industry partners	3.1. Participation of an industry partner in co-funding the establishment of a mega-lab 3.2. Use by the industry partner of a targeted training program for personnel development 3.3 Employment of university graduates in enterprises and organizations of an industrial partner
4	Relevance and significance of the project	4.1 Correspondence of the topics of scientific and educational projects and mega-lab activities with the national technological leadership project (NTLP) directions. 4.2 Integration of mega-lab's core activities into RTU MIREA strategic goals
5	Uniqueness of the project	5.1 Absence of analogues: A fundamentally new mega-lab 5.2 Uniqueness of individual mega-lab components 5.3 Modernization of existing mega-lab

Table 2. Index system for evaluating projects for the development of scientific and educational infrastructure

1	**Educational activities** $I_{\mathrm{EA}} = \dfrac{I_1 + I_{\mathrm{cov}} + I_{\mathrm{con}}}{3}$ is the index of the mega-lab workload in educational activities
1.1	I_1 is the index of the mega-lab expected load. $I_1 = \dfrac{\mathrm{TCH}}{\mathrm{ML}}$, where TCH is total volume of classroom hours scheduled (prescribed) for laboratory work and practical exercises in mega-lab for the academic year, in hours; ML is the maximum possible workload of mega-lab, in hours
1.2	I_{cov} is the index of the expected coverage of students. $I_{\mathrm{cov}} = \dfrac{\mathrm{C}_1 + \mathrm{C}_2 + ... + \mathrm{C}_i}{\mathrm{C}_{\mathrm{total}}}$, where C_i is the expected number of students (or individuals) from academic departments participating in the mega-lab activities, persons; $\mathrm{C}_{\mathrm{total}}$ is the total number of students at the university at the time of applying, persons
1.3	I_{inv} is the index of expected involvement of academic and research departments. $I_{\mathrm{inv}} = \dfrac{N}{M}$, where N is the number of academic and research departments whose students plan to participate in mega-lab activities; M is the total number of academic and research departments at the university
2	**Research and development** $I_{\mathrm{R}} = \dfrac{I_{\mathrm{profit}} + I_{\mathrm{hr}} + I_{\mathrm{yr}} + I_{\mathrm{inv}} + I_{\mathrm{pa}}}{5}$ is the index of mega-lab utilization for R&D
2.1	I_{profit} is the profitability index of research projects carried out at mega-lab. $I_{\mathrm{profit}} = \dfrac{(\mathrm{P}_{\mathrm{exp}} + \mathrm{P}_{\mathrm{spec}} + \mathrm{P}_{\mathrm{exist}}) - (\mathrm{E}_{\mathrm{exp}} + \mathrm{E}_{\mathrm{spec}} + \mathrm{E}_{\mathrm{exist}})}{\mathrm{P}_{\mathrm{exp}} + \mathrm{P}_{\mathrm{spec}} + \mathrm{P}_{\mathrm{exist}}}$, where: $\mathrm{P}_{\mathrm{exp}}$ is the expected profit for research projects scheduled to be carried out at the mega-lab, RUR mln; $\mathrm{P}_{\mathrm{spec}}$ is the profit gained by the university from completed research projects under existing contracts (stages) in the relevant field of specialization over the past three years, RUR mln; $\mathrm{P}_{\mathrm{exist}}$ is the expected profit from research projects under existing contracts (stages) within the relevant field of specialization, RUR mln;

Table 2. Continued

2.1	E_{exp} is estimated expenses (excluding contributions to the centralized fund of the university) for research projects scheduled to be conducted at the mega-lab, RUR mln; E_{spec} is expenses (excluding contributions to the centralized fund of the university) for completed contracts (stages) for research projects within the relevant field of specialization over the past 3 years, RUR mln; E_{exist} is expected expenses (excluding contributions to the centralized fund of the university) for research projects (stages) with the relevant field of specialization, RUR mln
2.2	I_{hr} is the human resource utilization index. $I_{hr} = \frac{C_{emp}}{C_{fte}}$, where C_{fte} is the number of full-time equivalents allocated for carrying out R&D projects; C_{emp} is the number of full-time employees in R&D projects, person
2.3	I_{yr} is the recruitment index for young researchers to carry out R&D. $I_{yr} = \frac{P_{yr}}{P_{emp}}$, where P_{yr} is the number of young researchers involved in the R&D implementation: up to 35 years old without an academic degree, up to 35 years old with the Candidate of Science degree or up to 40 years old with the Doctor of Sciences degree, persons; P_{emp} is the number of employees actually involved in the R&D implementation, persons
2.4	I_{con} is the contribution index of the R&D performed at the mega-lab to the results of the university's research activities. $I_{con} = \frac{C_{fsp}}{C_{total}}$, where C_{fsp} is the cost of field-specific projects performed over the past 3 years (certificates of acceptance of works), RUR mln; C_{total} is the total cost of completed R&D projects at the university over the past 3 years (certificates of acceptance of works), RUR mln
2.5	I_{pa} is the publication activity index related to the mega-lab specific field. $I_{pa} = \frac{PUB_{sf}}{PUB_{total}}$, where PUB_{sf} is the number of publications related to the specific field of the mega-lab in the year preceding the project application; PUB_{total} is the total number of university publications in the year preceding the project application
3	**Collaboration with industrial partners** $I_{eng} = \frac{I_{cof} + I_{tgt} + I_{empl}}{3}$ is the industrial partner engagement index into the mega-lab project
3.1	I_{cof} is the index of industrial partner's participation in co-funding the establishment of a mega-lab. $I_{cof} = \frac{F_{cof}}{F_{total}}$, where F_{cof} is the amount of funding that the industrial partner plans to allocate to the implementation of the project, RUR mln; F_{total} is the total project cost, in million rubles
3.2	I_{tgt} is the index of industrial partner's use of target training mechanisms for personnel training. $I_{tgt} = \frac{S_{tgt}}{S_{tgt\ total}}$, where S_{tgt} is the number of target students from an industrial partner, persons; $S_{tgt\ total}$ is total number of students enrolled in target training, persons
3.3	I_{empl} is the employment index for the university graduates in the entities affiliated with the industrial partners. $I_{empl} = \frac{G_{empl}}{G_{empl\ tgt}} = \frac{G_{empl}}{28}$, where G_{empl} is the number of university graduates employed in the industrial partner organization over the past 4 years, persons; $G_{empl\ tgt}$ is the number of graduates employed by an industrial partner's organization over the past 4 years, persons. This is based on an annual target of recruiting at least 70% of the current year's graduates, in the interests of the industrial partner
4	**Relevance and significance of the project in relation to the strategic objectives of university development** $I_{rel} = \frac{I_{NTLP} + I_{sg}}{2}$ is the index of the project's relevance and significance for the university development
4.1	I_{NTLP} is the correspondence index between the topics of educational projects along with mega-lab specialization and NTLP specialization. $I_{NTLP} = \frac{NTLP_{sched}}{NTLP}$, where $NTLP_{sched}$ is the number of NTLP whose tasks will involve work scheduled to be done at the mega-lab; and NTLP is the total number of ongoing NTLPs

Table 2. Continued

4.2	I_{sg} is the index of integration of the main fields of the mega-lab specialization in achieving the strategic goals of RTU MIREA, as set out in the Priority 2030 program. $I_{sg} = \frac{SI_{sched}}{SI}$, where SI_{sched} is the number of strategic initiatives under the Priority 2030 that will involve work at the mega-lab; SI is the total number of strategic initiatives specified in the Priority 2030
5	**Uniqueness of the mega-lab project** $I_{uniq} = \frac{A/C/U}{5}$ is the project uniqueness index
5.1	A is the absence of analogs in the Russian Federation, meaning the establishing of a fundamentally new laboratory (5 points)
5.2	C is the presence of separate laboratory components in other organizations (2 points)
5.3	U is the upgrade of existing mega-lab complexes (1 point)

As a result, the overall assessment index for the project to establish a mega-lab includes five sub-indices:

- I_{EA} is the index of the mega-lab utilization for educational activities;
- I_R is the index of the mega-lab utilization for R&D;
- I_{eng} is the engagement index of an industry partner into a mega-lab project;
- I_{rel} is the index of the project relevance and significance for the university advancement;
- I_{uniq} is the project uniqueness index.

Each I_i index can range from 0 to 1, with 1 representing the maximum possible score and therefore the highest potential value and usefulness of the mega-lab.

To ensure the ability to defend the submitted project and address any issues that may arise during the review process, a project presentation assessment (PP) is incorporated as a separate component of the overall estimation. In order to make it comparable with other estimations presented in a similar format, PP assessment is binary, meaning it can only take one of two possible values: 0 or 1.

Therefore, the integral estimation of the submitted project (IEP) is as follows:

$$\text{IEP} = F(I_{EA}, I_R, I_{eng}, I_{rel}, I_{uniq}, \text{PP}).$$

The following mathematical formulation is derived from the current practice of obtaining a comprehensive assessment in the form of a composite index:

$$\text{IEP} = K_1 \frac{I_{EA} + I_R + I_{eng}}{3} + K_2 \frac{I_{rel} + I_{uniq}}{2} + K_3 \text{PP},$$

where K_i represents the weighting coefficient of each IEP component.

Since K_1 is a weighting factor for indicators that are directly linked to and represent strategically significant areas of activity, the first three indicators are included in the comprehensive assessment with a relative importance of 3. The remaining two components of the comprehensive assessment are included with an equal weighting of 1. Accordingly, the following integrated estimation model is derived:

$$\text{IEP} = 3 \cdot \frac{I_{EA} + I_R + I_{eng}}{3} + \frac{I_{rel} + I_{uniq}}{2} + \text{PP}.$$

The maximum possible score for the integral estimation of the mega-lab project is 5 points. To assess the level of the project presented, the actual estimation value must be compared to the maximum possible value:

$$\gamma = \frac{\text{IEP}_{actual}}{5}.$$

This demonstrates how close the actual project estimation value is to the maximum possible value of 5. As a result, the decision is based on the following ratios:

- $0.7 \le \gamma \le 1.0$: the project is accepted for implementation;
- $0.4 \le \gamma < 0.7$: “grey area,” meaning that the project is proposed for revision, primarily by strengthening its integration into the solution of tasks that are strategically important for the university;
- $0 \le \gamma < 0.4$: the project is rejected.

The primary benefit of the proposed methodology is its comprehensive and objective nature. This ensures that the resulting integrated estimation of the project provides a robust basis for appropriate decision-making.

CONCLUSIONS

The dynamic, sustainable, and socially-beneficial development of engineering universities greatly depends on the effective modernization of their material and technical infrastructure. Experience shows that, in addition to financial investment, this process requires well-planned infrastructure policies and strategic planning for the development of scientific and educational facilities. These measures enable decisions that ensure the long-term sustainability and development of educational organizations, as well as the achievement of goals set out in their development programs.

The diverse range of activities currently undertaken by engineering universities, coupled with the significant cost of establishing and maintaining scientific and academic infrastructure, necessitates a structured and formal approach to the selection of projects aimed at enhancing the material and technological base of these institutions. Such an approach, as proposed by educational, research, and academic units, ensures maximum objectivity in the evaluation process. The implementation of the systematic and comprehensive project selection methodology proposed in this paper will facilitate the identification and development of effective solutions within the core areas of university operations, particularly in the context of interdisciplinary initiatives in innovation, education, and research.

Authors' contribution

All authors contributed equally to the research work.

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About the Authors

Stanislav A. Kudzh, Dr. Sci. (Eng.), Professor, Rector, Professor, Department of Instrumental and Applied Software, Institute of Information Technologies, MIREA – Russian Technological University (78, Vernadskogo pr., Moscow, 119454 Russia). E-mail: kudzh@mirea.ru. Scopus Author ID 56521711400, ResearcherID AAG-1319-2019, RSCI SPIN-code 8173-1572, https://orcid.org/0000-0003-1407-2788

Natalia B. Golovanova, Dr. Sci. (Econ.), Professor, Deputy First Vice-Rector, Professor, Department of Economics, Institute of Management Technologies, MIREA – Russian Technological University, (78, Vernadskogo pr., Moscow, 119454 Russia). E-mail: golovanova@mirea.ru. Scopus Author ID 57191447039, RSCI SPIN-code 7197–9948, https://orcid.org/0000-0002-9901-8897

Yuri G. Grafov, Cand. Sci. (Econ.), Vice Rector (Digital Transformation and Finance), MIREA – Russian Technological University, (78, Vernadskogo pr., Moscow, 119454 Russia). E-mail: grafov@mirea.ru. RSCI SPIN-code 5584-6010

Об авторах

Кудж Станислав Алексеевич, д.т.н., профессор, ректор, профессор кафедры инструментального и прикладного программного обеспечения, Институт информационных технологий, ФГБОУ ВО «МИРЭА – Российский технологический университет» (119454, Россия, Москва, пр-т Вернадского, д. 78). E-mail: kudzh@mirea.ru. Scopus Author ID 56521711400, ResearcherID AAG-1319-2019, SPIN-код РИНЦ 8173-1572, https://orcid.org/0000-0003-1407-2788

Голованова Наталия Борисовна, д.э.н., профессор, заместитель первого проректора, профессор кафедры экономики, Институт технологий управления, ФГБОУ ВО «МИРЭА – Российский технологический университет» (119454, Россия, Москва, пр-т Вернадского, д. 78). E-mail: golovanova@mirea.ru. Scopus Author ID 57191447039, SPIN-код РИНЦ 7197–9948, https://orcid.org/0000-0002-9901-8897

Графов Юрий Германович, к.э.н., проректор (цифровая трансформация, экономические и финансовые вопросы), ФГБОУ ВО «МИРЭА – Российский технологический университет» (119454, Россия, Москва, пр-т Вернадского, д. 78). E-mail: grafov@mirea.ru. SPIN-код РИНЦ 5584-601

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