



Indonesian Journal of Educational Research and Technology



Journal homepage: <http://ejournal.upi.edu/index.php/IJERT/>

Development of The Project Approach in Engineering Higher Education

V.V. Glushchenko*

Moscow Polytechnic University, Moscow, Russia Federation

*Correspondence: E-mail: valery.v.glushchenko@gmail.com

ABSTRACT

The purpose of this article is the methodological aspects of the development of project-based higher education at a machine -building university , the object of the article – higher education in mechanical engineering, the purpose of the article is to increase the efficiency of the processes of development of project higher education at the University of mechanical Engineering , to achieve this goal, the following tasks are solved: research of the essence of project education in mechanical engineering , clarification of the concept of "paradigm of development of project higher education in mechanical engineering", description of the structure and content of the elements of the structure of the paradigm of development of the named project education at the University of mechanical engineering , structure discussion , the essence and content of the directions of development of such project education ; research methods are historical , logical , structural analysis, qualitative analysis, predictive analysis, synthesis , search and heuristic forecasting , heuristic assessments ; scientific novelty of the work is associated with the study of the essence of project education in mechanical engineering and the formation of methodological foundations for the development of the concept and policy of development of project higher education in mechanical engineering universities in the interests of improving the quality of higher education.

ARTICLE INFO

Article History:

Submitted/Received 06 May 2023

First Revised 23 Jun 2023

Accepted 14 Aug 2023

First Available online 15 Aug 2023

Publication date 01 Dec 2023

Keyword:

Approach,
Culture,
Development,
Ecosystem,
Education,
Element,
Element goal,
Ideology,
Mechanical engineering,
Methodology,
Paradigm,
Philosophy,
Project,
Structure.

1. INTRODUCTION

The relevance of this article in 2023 is determined by the fact that the task of developing a design form of higher education in the field of mechanical engineering is very important in connection with the transition of higher education to a new technological way. The new technological order is closely connected with the development of innovative design activities in mechanical engineering (Glushchenko, 2023a). This is because projects are the main form of innovation activity (Rizaldi & Linasari, 2021; Theophilus, 2023). Consequently, the development of innovations leads to an increase in the relevance of project higher education in the field of mechanical engineering. At the same time, the transition to work in a new technological way should be accompanied by an increase in the quality of higher education in technical universities.

The hypothesis of this article is the statement that to accelerate the implementation of the project form of higher education in engineering universities, it is necessary to develop a methodology for such a form of higher education.

The purpose of the article is to increase the efficiency of the processes of development of project higher education in engineering universities against the background of the formation of a new technological order in the economy and society.

To achieve this goal, the following tasks are solved in this study:

- (i) the essence of project education in mechanical engineering during the development of a new technological order;
- (ii) the concept of the "paradigm of development of project higher education" at the University of Mechanical Engineering;
- (iii) the structure and content of the structural elements of the paradigm of development of project education at the University of Mechanical Engineering;
- (iv) the structure of the development process of such project-based higher education.

The object of the article is higher education in the field of mechanical engineering during the formation of a new technological order.

The subject of this article is methodological aspects of the development of project higher education at the engineering University.

The study of scientific publications on the topic of the article shows the following. Project management and project education can be considered tools for improving the quality of all levels of education (Saidova, 2021). Project education can include the processes of self-organization of students (English & Kitsantas, 2013; Smakova, 2020). The development of the project approach is considered a way to modernize the national system of higher education (Machekhina, 2017; Sari & Faiz, 2021; Onia & Rmadan, 2023). Scientists are considering new concepts and technologies for project educational activities (Benavides *et al.*, 2020). Project activity is considered a structural element of the educational process (Orishev & Achilov, 2023). Teachers consider it important to develop a project culture at universities (Enegbuma *et al.*, 2014). Some technical universities have accumulated considerable practical experience in project higher education, as evidenced (in particular) by such publications (Chang *et al.*, 2022; Panova *et al.*, 2020; Glushchenko *et al.*, 2020). In the conditions of the formation of a new technological order, forecasting the development of regions and sectors of the economy is carried out. The increasing role of innovation is associated with the need to modernize products and production capacities of enterprises (Glushchenko, 2021a; Caraka *et al.*, 2021). It should be taken into account that during the formation of a new technological order, an ecosystem approach in higher education is developing (Glushchenko, 2022; Glushchenko,

2023b). At the same time, the methodology of project higher education in technical universities is developing (Glushchenko, 2021b). At the same time, the analysis shows that the well-known franchising method can be used to spread the sphere of project higher education as soon as possible (Glushchenko, 2021c; Khamitovna, 2022).

In addition, the analysis of information posted on the websites of engineering universities, and the analysis of the publication activity of the teaching staff of such universities on the subject of higher project education allows us to conclude the following:

- (i) In 2023, in most of the leading engineering universities, the project form of higher education is not the main one;
- (ii) there are engineering universities where project education is used, but the methodology of such education is not described, nothing is known about it;
- (iii) some universities have established project activity centers, but they do not have a serious impact on the quality of higher education;
- (iv) the publication activity of the teaching staff of key engineering universities in the field of project higher education (judging by the information reflected in the Russian Science Citation Index) is not very high.

This can be seen as evidence of the relevance of the development of the methodology of higher project education in engineering universities. In general, the analysis of scientific publications and other information allows us to talk about the relevance of the topic of this article.

2. METHODS

This study is a literature survey. Data were obtained from internet sources, especially articles in international journals, which were then collected and summarized to get a conclusion.

3. RESULTS AND DISCUSSION

The period of development of a new technological order (structure) can be characterized by the transition of organizations in the machine-building industry to increasingly active use of the project model of organizations' activities. This is because, in the period of a new technological order, innovations become almost continuous. At the same time, innovative projects are the main organizational form of innovation in mechanical engineering. Such a trend objectively forms a request for the development of a project form of higher education in mechanical engineering.

During the transition to a new technological order, a new quality of these products can be formed through the modernization of mechanical engineering products. Mechanical engineering products integrated with technologies of a new technological order (information, intelligent technologies, etc.) can get their qualitatively new state (cyber-physical systems) (Al Husaeni & Nandiyanto, 2022; Glushchenko, 2023b).

Research shows that to effectively manage real and educational projects in the field of mechanical engineering, it is necessary to have competencies from (7-8) or more fields of activity. These are competencies from the following areas: technical sciences, finance, innovation, marketing, management, investment, management psychology, branding, and more. Is it likely that the lack of teachers (project supervisors) with such multidisciplinary and complex competencies in key branch engineering universities may be one of the key factors hindering the development and implementation of project higher education in mechanical engineering?

An analysis of the publications of the teaching staff of various universities on the topic of project-based higher education in the Russian Science Citation Index shows the following. The project methodology of educational activity is used to some extent in about 50 universities out of about 1,256 Russian universities and their branches (data for 2017). Thus, can we say that the project form of higher education is actively used in less than 5% of Russian universities? These figures may indicate the existence of great potential for the development of project higher education, in particular, in the field of mechanical engineering.

At the same time, there are engineering universities for which project activity centers have been created, but they practically do not have a significant impact on the educational process at the university. All this further increases the relevance of this scientific article.

Project higher education in this article can be understood as the educational activity of the engineering university (university), which regularly uses the implementation of educational projects by students under the guidance of scientific supervisors (university staff) as one of the main forms (subject form, project form, practical training, etc.) of the educational process.

In a machine-building university, the center for the organization of project higher education can be concentrated in the deans of faculties or a separate administrative and educational division of the university.

In the first case (project education is organized within the faculty), the advantage is the approximation of the subject of projects to the peculiarities of the branches of mechanical engineering. In the second case (there is a separate administrative unit), there are great opportunities for intersectoral integration in project education.

An educational project as a form of educational activity in mechanical engineering is characterized by: the presence of a specific goal of the project; the existence of a certain time limit; the presence of restrictions on the resources used; the collective executor of the project is the project team and more. The essence of project higher education in mechanical engineering can be expressed in its functions. Generalization of information about the practice of implementing educational projects suggests such functions of project higher education in mechanical engineering:

- (i) creating interdisciplinary competencies among students in the process of implementing educational projects;
- (ii) teaching skills of practical use of the subject knowledge obtained during training;
- (iii) acquisition of acting skills by students in the field of integration of science, practice, and education in mechanical engineering;
- (iv) integration and integrated use of explicit and implicit knowledge during the implementation of innovative projects;
- (v) formation of the project organizational culture within the project team, and design bureau;
- (vi) education of students in the process of implementing an educational project in mechanical engineering within the framework of the project culture and group;
- (vii) integration of all types of acquired knowledge, skills (competencies), and organizational subculture in the structure of the implemented engineering project;
- (viii) development of culture and skills of personal and business communication between members of the educational project team during the implementation of the educational project;
- (ix) mutual training of team members during the implementation of an educational project;
- (x) formation of a mechanism for mutual control by members of the project team of the level and assessment of the sufficiency of the student's competencies, verification of the

adequacy of the project culture based on the results of the educational project, and more.

The roles of project higher education in mechanical engineering can be called:

- (i) customization (adaptation) of the educational process to changing the requirements of practice, basic engineering enterprises by implementing projects in the interests of the real economy;
- (ii) optimization (increasing the level of thrift) of the processes of obtaining, transferring and using scientific knowledge in the educational process and project;
- (iii) improving the quality of higher professional education and more. Therefore, during the transition to a new technological order, the introduction of the methodology of higher project education in industrial engineering universities can be considered as one of the directions of the development strategy at universities. All this speaks about the prospects for the development of the project form of higher education in engineering universities, the relevance of improving the methodology and technologies of such higher project education.

The most productive from the point of view of the development of the theoretical foundations of project higher education in the field of mechanical engineering may be the formation of a general theory of this type of education. We describe and discuss the functions of the general theory of project higher education in the field of mechanical engineering according to the general scientific scheme. With such a scheme of structuring the functions of the general theory of project higher education, such functions can be inherent in it:

- (i) the methodological function of the general theory of project higher education in mechanical engineering covers the formation of such components of this theory: the conceptual basis (apparatus) of research; the theoretical basis, the methodology of objective (scientific) research of facts, processes, and phenomena in the introduction of this form of higher education and the implementation of educational engineering projects;
- (ii) the cognitive function of this general theory of project education in mechanical engineering is to develop the methodology of the processes of research, extraction, and transfer of knowledge to students, registration, classification, analysis of knowledge, evaluation of the significance of this knowledge in the project model of higher education in mechanical engineering;
- (iii) in this theory, its instrumental (regulatory) function is to create effective tools, concepts, techniques, ways of implementing project educational activities in mechanical engineering, management methods in the project educational process;
- (iv) in the theory under consideration, the development of the legislative basis of project educational activity in mechanical engineering is the meaning of the legislative function of this general theory of project education;
- (v) the optimization function of the general theory of project education consists in finding the best methods and tools for implementing educational projects following a certain criterion, analyzing, evaluating, and choosing the best option for the student's educational trajectory;
- (vi) the prognostic function of the general theory of project education is to form probabilistic assessments of the state of project education, probabilistic assessments of the impact of project higher education in mechanical engineering on the course of socio-economic development at various levels of the hierarchy;
- (vii) the study of the causes of possible negative deviations in the development of project education, the implementation of educational projects in mechanical engineering, and

the formation of a system of measures aimed at minimizing the risks of such projects refers to the preventive function of the general theory of higher project education in mechanical engineering;

- (viii) the psychological function of the general theory of project higher education in mechanical engineering is to form a sense and adequate perception of the properties and features of the methodology of the such project higher education in society and the economy;
- (ix) the function of knowledge socialization in the theory of higher project education in mechanical engineering includes structuring, classification of information, ideas, skills, and their dissemination in society and the economy, promotion of information about the advantages of the project form of higher education in mechanical engineering;
- (x) the aggregative (system-forming) function in the theory of project higher education in mechanical engineering consists in the formation of a system and platform of scientific and educational knowledge, and the complex practical use of subject knowledge in such project higher education.

The roles of the general theory of project higher education in mechanical engineering can be called:

Firstly, increasing the socio-economic efficiency of the project form of higher project education in mechanical engineering, society, and the economy;

Secondly, the reduction of risks and damages during the implementation of educational, social, and economic (real) projects in mechanical engineering, in the economy and society;

Thirdly, the further development of knowledge, the formation of a scientific platform, the development of methodology and practice of the project approach, and its application in education, society, and the economy.

The following laws of the general theory of project higher education in mechanical engineering can be described:

- (i) the socio-economic role of higher design education in mechanical engineering increases in the tenth technological order due to the intensification of design innovation activities of machine-building organizations in the real economy and society in the situation of accelerating scientific and technological progress,
- (ii) the product in higher project education in mechanical engineering is a complex that includes: knowledge and skills (competencies), project professional and organizational culture, project communication and behavior, behavioral readiness of students to put forward a new idea, implement a project in real economy and society, and more,
- (iii) the project form of higher education is based on the integrated use in educational projects of subject knowledge, motivation of participants, special pedagogical skills, professional and organizational culture, behavioral readiness for innovation,
- (iv) any educational project goes through the stages of origin (emergence), youth (development), maturity (stable work), aging (deterioration of characteristics), and modernization of the project, and altogether these stages of the implementation of an educational project in mechanical engineering from the full life cycle of an educational project,
- (v) the implementation of any educational project takes place in a certain time interval, is provided by the expenditure of a certain amount of sufficiently diverse resources, and is associated with the level of risks characteristic of this educational project,
- (vi) the greater the level of complexity of an educational project in mechanical engineering, the higher the risks of this educational project,

- (vii) the greater the potential profitability of an educational project in mechanical engineering, the higher the risks of this project,
- (viii) in the educational project business, it is recommended to maintain a balance between potential risks and profitability of an educational project in mechanical engineering,
- (ix) for the implementation of any educational project, a project team (group) is formed, which is characterized by the following: its scientific, technical, and intellectual potential, external and internal motivation of participants, the amount of authority to make managerial decisions, a certain responsibility for the socio-economic results of the educational project,
- (x) the effectiveness of the project form of higher education in mechanical engineering is related to the effect of such factors: the peculiarities of the organization of project higher education in the university, the level of interaction of the university with the basic organizations of the industry in the implementation of educational projects, the level of qualification of scientific and pedagogical workers (NPR) of the university, the level of development of the methodology of higher project education in mechanical engineering and others.

The functions of the general theory of project education in mechanical engineering can be considered as directions of development of its methodology and factors of formation of the scientific and educational platform of higher project education.

Theoretical and practical tasks of the general theory of the design form of higher education in mechanical engineering can be called:

- (i) the creation of a scientific and educational platform for higher project education in mechanical engineering;
- (ii) further development of project education in mechanical engineering;
- (iii) development of the organizational culture of higher project education in mechanical engineering and others.

With the most general approach, the structure of the scientific and educational platform of higher project education can be divided into segments related to:

- (i) firstly, the five levels of the technological pyramid in the field of mechanical engineering (conceptual level, the level of synthesis of technologies, the level of technical means (mechanical engineering products), the level of organizations operating mechanical engineering products, the level of organizations of technical service and personnel training in the field of mechanical engineering,
- (ii) secondly, the segments that are associated with the stages of the life cycle of the products of the engineering industry (design, production, market circulation, operation, modernization, disposal) and others.

An important factor influencing the system of higher education in mechanical engineering is the development of information technologies. The consequence of the influence of information technology is the development of "clip thinking" among students. With such students' thinking, reality (real activity, learning, etc.) appears in the form of a sequence of "pictures" (images). These "pictures" are logically unrelated. Clip thinking is manifested in the fact that the student has a decrease in the ability to think logically.

The development of clip thinking among students increases the need for the development of project higher education in mechanical engineering as a form of education based on logical thinking.

In project education in mechanical engineering, it should be taken into account that it is difficult for students with clip thinking to correlate and logically link the information obtained in various subjects into a single picture. Clip thinking complicates the assessment of the

consequences of their actions. According to foreign experts, only 37% of employees of organizations are aware of the consequences of their actions for their organization, while 63% of employees do not understand how their activities and their level of knowledge affect the activities of their entire organization.

The application of design technologies in higher education in mechanical engineering makes it easier for students and practical workers to identify the necessary knowledge and their successful practical application within the project. Understanding the essence of the project the student makes it possible to extract and apply practically necessary knowledge promptly with greater probability and practical efficiency.

Let's define the concept of "development of the project form of higher education" taking into account the results of the work.

As part of the development of the project form of higher education in engineering universities, we agree to understand the following:

- (i) development of new methodological approaches, development of new areas of project activity in mechanical engineering;
- (ii) synthesis of new methods of integration of science-practice-education in the process of developing educational design technologies in mechanical engineering;
- (iii) the development of new markets, in particular, the expansion with the use of franchises of the range of specialties within which it is possible to use project educational technologies in mechanical engineering;
- (iv) development of the organizational structure of the project in mechanical engineering as such. At the same time, such development of higher project education: affects the interests of the people included in it; which means the process of adaptation of the University's Project Activity Center to the needs of the machine-building industry, machine-building university, society, and economy. Thus, the development of the Project Activity Center at the Engineering University can be considered a key element of the university's business activity and such development of project education can be attributed to the entrepreneurial model in engineering education.

At the same time, project education in engineering universities can be considered as part of the innovation system and the process of development of the national innovation system, the national economy, and society in the process of their adaptation to the new technological order.

The paradigm of development of project education at a machine-building university is a systematic combination of the following elements: the philosophy of the development of project education as a structural element of the educational process of a given machine-building university; the ideology of development of project higher education at such a university; the organizational culture of project higher education at a machine-building university; policies (including strategy and tactics) of development of project education at the university and others.

At the same time, the paradigm of the development of project education should be coordinated with the trends in the development of the higher education system and the innovation system of the national and global economy.

The goal of the development of project-based higher education at a machine-building university can be considered participation in the formation of a significant competitive advantage of this university based on the introduction of a project approach in certain market segments of educational and research services in mechanical engineering.

The basis for the formation of a paradigm for the development of project-based higher education should be the philosophy of the development of such education at the engineering

university as part of the philosophy of the development of the university as a whole. The philosophy of project education at a machine-building university can be defined as the most general view of the process of development of the project form of education at a machine-building university in the period of a new technological order. The practical significance of the philosophy of project higher education at the Engineering University is the formation of a system of principles that guide stakeholders in the development of the engineering university. One of the promising concepts of doing business in the period of the 10th technological order is the concept of conducting educational activities within the framework of the ecosystem approach.

In this article, it is proposed to name the following principles as the principles of the development of the engineering university's project activities within the framework of the ecosystem approach:

- (i) the principle of comprehensive service to the educational needs of students and society in mechanical engineering as a whole;
- (ii) formation of the quality of higher education, at the level necessary for the innovative development of mechanical engineering and the national economy;
- (iii) the principle of minimizing resource losses (the principle of lean production) in the provision of educational services by the university;
- (iv) the principle of maximum satisfaction by the engineering university of the requirements (including contradictory) of stakeholders;
- (v) increasing the level of motivation of students and research and teaching staff in the development of project methodology of educational activities and the growth of the quality of higher education;
- (vi) integration of innovative initiatives and experience of real projects in the activities of the Center for Project Activities of the University of Mechanical Engineering and others.

The ideology of the development of project education at the Engineering University can be called: firstly, the basic idea of such development; secondly, the principle of the distribution of power and influence in the process of such development. The main idea of the development of project-based higher education can be called: firstly, the idea of improving the quality of education; secondly, the idea of adapting higher engineering education to the conditions and requirements of a new technological order.

The solution to the problem of the distribution of powers in the development of project higher education at the engineering University is to distribute the degree of influence of various stakeholders on this process (students, teachers, university administration, employers, government agencies, etc.). All these categories of stakeholders in the development of project higher education should be allowed to adequately influence the process and create a mechanism for their influence on the development of project-based higher education. The mechanism of stakeholders' influence on the development of project higher education can be understood as a system of ways and tools for exercising such influence and receiving feedback signals from these stakeholders.

At the same time, the ideology of the development of project-based higher education (understood as a way of distributing power in the development process) should take into account the post-industrial nature in the marketing of tools for the development of such education. In addition, the management of the development process of project-based higher education should be participatory (participatory) concerning all stakeholders of this process.

The policy of development of project higher education in mechanical engineering can be understood as the general orientation (resulting component) of the activities of all stakeholders in the process of developing such education at the university. In addition, the

policy of development of project higher education in mechanical engineering can be understood as a set of measures aimed at the development of such education in engineering universities. The policy of development of project-based higher education can be divided into strategies and tactics for such development.

The methodology of the development of project higher education is called the general theory of the method of development of project higher education in universities. The following methodological components of the development process of project higher education at the university can be distinguished: methodology of project activities of organizations of the real economy and the third sector (social entrepreneurship, public organizations); methodology of project higher education in general; methodology of scientific management of educational projects; methodology of creation and management of project teams; methodology of implementation of educational projects; methodology of the interaction of the university with organizations of the real economy and the third sector; pedagogy and psychology of project higher education; methodology of planning, organization, motivation, and control in project higher education; management of the development of the organizational culture of project activities and project groups, and more.

Under the organizational culture of the development of project higher education in mechanical engineering, we understand a set of rules of behavior, beliefs, and values of participants in the process of development of project higher education at a machine-building university. The values of the organizational culture of educational project activities include the generation of innovative ideas, a manifestation of the initiative of participants, recognition of the right to make mistakes, willingness to share knowledge with colleagues, friendly attitude to the ideas of their colleagues, and others.

The description of the content components of the paradigm of the development of project higher education at the University of Mechanical Engineering can be carried out using a well-known approach based on the allocation of various "slices" in the university's activities.

In the paradigm of the development of project-oriented higher education at a machine-building university, the following sections of the development under consideration can be considered:

- (i) an innovative "slice" covering a complex of innovative ideas that underlie the development of project-based higher education at the university (this may also include a methodology for the synthesis of such ideas);
- (ii) a humanitarian "slice" of the development concept covers philosophy, culture, mission, vision, goals, and objectives of development, such a slice mediates the influence of the management and staff of the university the transformation of the image of project-based higher education, taking into account the reverse effect, this process affects the economy, the individual and society;
- (iii) the financial and economic "slice" of the development process of project-based higher education should form a general idea of the sources of financial resources, ways of using them, and the financial results of such innovative development of the university;
- (iv) the scientific and methodological "slice" of the paradigm of development of project higher education should describe the directions and level of development of methodology and technologies of project activity as part of the educational process at the university;
- (v) the design and technological "slice" of the paradigm of the development of project higher education is responsible for the sufficient level of production equipment, the availability of technologies necessary for the implementation of educational projects, the competence of personnel, organization, and other technical and technological aspects.

Based on this, it is possible to identify specific paradigms (sub-paradigms) in the concept of development of project higher education of an engineering university: humanitarian development, methodology of development of project education, financial and economic development, design and technological development, the paradigm of development of scientific and pedagogical personnel from the point of view of the university, etc.

Under the philosophy of the paradigm of the development of project-based higher education within the university, taking into account the trends of the development of the national economy, we mean the most general view (for a strategic period) on the mission, vision, goals, tools, financial sources, the policy of implementing a certain paradigm of university development.

The philosophy of the development of project-oriented higher education can be characterized by the following functions:

- (i) the function aimed at the formation and verification of various options for the development of project-based higher education (as a structural element of the university's educational process) during the development of a new technological order in society and the economy (taking into account the observed global crisis) is called the ontological function;
- (ii) the function that is focused on the knowledge of the future results of the implementation of a certain paradigm of the development of project higher education of a machine-building university is called the prognostic function of the philosophy of the development of this university;
- (iii) the function that provides an increase in knowledge about the essence and role of certain options for the development of project-based higher education is called the epistemological function of the philosophy of university development;
- (iv) the function that creates techniques, methods of studying, designing, implementing projects, and monitoring the effectiveness of the paradigm of development of project-oriented higher education at the university is called the methodological function of the philosophy of university development;
- (v) the function, which is aimed at the formation of ideological, and value attitudes in the process of synthesis and implementation of the paradigm of development of project higher education at the university, is called the axiological function of the philosophy of university development;
- (vi) the function, in the implementation of which philosophy forms the basis for determining acceptable or optimal variants of the development paradigm of project-oriented higher education, is called the selective function of this philosophy of the university;
- (vii) the function of the criterion of truth (philosophy as a derived indicator) concerning the paradigm of development of project-oriented higher education, allows us to supplement the quantitative and qualitative assessment of the practical effectiveness of the paradigm of university development;
- (viii) the function, the content of which is aimed at aggregation (system integration) of all elements of the development process of project higher education, within the framework of a specific paradigm, is an aggregating (integrative, synthetic) function of the philosophy of the development of project higher education at a given university;
- (ix) the critical function of the philosophy of the development of project-oriented higher education at the university can be called the function of the philosophy of the development of project-oriented higher education, which allows for a value assessment, to determine the strengths and weaknesses of the development process, external and internal problems of such development.

The material of this article shows that for the successful transition of the engineering university to the methodology of higher project education, a deep transformation of the entire philosophy and ideology of the work of the engineering university, an expansion of the range of competencies of the teaching staff and much more is required.

Two approaches are possible in the formation and implementation of the entire paradigm, organizational culture, philosophy, ideology, and policy of the implementation of the paradigm of development of project-oriented higher education at the university. A consensus approach is when all participants in the development process of project-based higher education accept the official paradigm of such development. A confrontational approach is when participants in the paradigm of development of project higher education at a machine-building university have different views on this process. Observations show that in practice, a confrontational approach is more often observed in the real processes of development of the project form of higher education. This is because a specific paradigm for the development of project-based higher education at a machine-building university may affect the interests of various stakeholders (groups of university employees, students, employers, higher education systems, etc.) and their workload, financial situation, authority, career prospects, etc.

The role of philosophy in the paradigm of development of project-based higher education also covers the processes of harmonization of organizational culture, ideology, policy, and goals of such development. Such harmonization of the elements of the paradigm leads to a reduction in risks when implementing the paradigm of university development.

The philosophy of the paradigm of development of project-based higher education is the basis of the organizational culture of the ecosystem approach in such development. In this process, the values of organizational culture are closely linked to the principles of the development of project-based higher education at the university in the conditions of the onset of a new technological order and the development of an ecosystem approach.

The mission of the development of project-based higher education at the university should describe the benefits that society and the university receive from just such a development paradigm. The mission is aimed at the external environment of the university and is designed to harmonize the university's relations with the outside world (other departments of the university, the higher education system, the economy, and society as a whole). The mission of the paradigm of ecosystem development of project-based higher education at the university may be to provide comprehensive services to the educational needs of the national economy and society in a new technological order. With the implementation of this mission, the high competitiveness of the engineering university and the entire higher education system of the state and society can be achieved during the formation of a new technological order.

The vision of ecosystem development of project-based higher education at the university can be understood as an inspiring scenario for the development of the university as a new type of scientific and educational ecosystem for stakeholders and participants in this process.

Such a vision of the development of the ecosystem of project-based higher education at the university can be formulated in the program statement of the university at the presentation of the program of such development of the project form of education. Such a political statement of the university management on the transition to the philosophy of the development of the ecosystem of project-based higher education should inform interested parties (society, employers, students, teachers) on the following issues: the scenario of such development; the goals of development of the ecosystem of the project form of higher education in mechanical engineering; methods and tools for the development of project-based higher education at the university as a scientific and educational ecosystem.

The objectives of the development of the ecosystem of the project form of higher project education at the university describe the desired state of this ecosystem of the university in the future. The objectives of the development of the ecosystem of project-based higher education of the university can be called: comprehensive provision of scientific and educational services; improving the quality of higher education based on the activity component, integration of science-practice-education; increasing the level of customer orientation of the university; adaptation of the university to the conditions of a new technological way.

The predicted effects and results from the ecosystem development of project-based higher education at the university include: increasing the customer orientation of the university; increasing the degree of integration on the market basis of science practice and education in project-based higher education of the university; increasing the degree of efficiency of spending all types of resources in scientific, educational and educational processes; increasing the global competitiveness of the Russian system of higher education, the real economy and society as a whole, increasing the stability and competitiveness of the state.

As the objectives of the development of the ecosystem of project higher education of the university, it is possible to recognize the steps included in the development plan for the development of the economic, technical, professional, humanitarian, social external, and internal environment of the university, which should contribute to obtaining the planned result from the development of the ecosystem of project higher education of the university.

At the same time, an important task may be the development of the organizational structure of the project higher education of the university. This development of the organizational structure of project-based higher education is designed to provide organizational support in the following promising areas of the university's activities:

- (i) development of consulting services provided by the university, through the development of programs for the transition of enterprises to activities in a new technological way, the use by organizations of the real economy of the project model of their functioning, improving the efficiency of project activities of organizations;
- (ii) scientific substantiation and consulting support of the processes of designing corporate ecosystems, and infrastructure projects in the real sector of the economy in the process of forming a new technological order, for example, in creating an ecosystem approach in the activities of technology platforms and clusters;
- (iii) development of additional education for the training of scientific and pedagogical workers and students in the field of project activities and project higher education;
- (iv) expansion of new types of interaction in the field of project activities and project higher education, for example, by creating a franchise aimed at expanding the application of the project approach in higher education, including in foreign universities;
- (v) expansion of scientific research in the field of project activities of organizations of the real sector of the economy to create a scientific basis for the activities of the consulting department of the university and more.

To assess the quality of higher project education, a four-level model of such an educational service can be used. The first level of this model reflects the main purpose of such a service: the formation of a comprehensive educational product in the learning process that allows the student to effectively solve the problems of real project activity in the economy. The second level of this model describes this educational service in real execution: the share of educational projects in the learning process, the total duration of the training, the cost of education, and much more. The third level of the educational services model (which describes measures to support the educational process) includes the possibility of obtaining education

on credit, the possibility of obtaining professional advice after completing the training course, and much more. The fourth level of the educational service model (project engineering education) reflects the strategic impact of this service on the long-term prospects for the development of the economy and society, and others.

4. CONCLUSION

The article develops the methodology of project higher education at the University of Mechanical Engineering, examines the factors, and describes the methodological foundations of the paradigm of development of project higher education at the University of Mechanical Engineering. The paper describes the methodological provisions of the general theory of higher project education. The mechanism of adaptation of the university's work through project education to changes in external conditions during the transition of the higher education system to functioning in the situation of the formation of a new technological order is considered. The article describes the structural elements of the ecosystem approach paradigm concerning the process of development of project-oriented higher education in universities. Project higher education is considered a structural element of the process of improving the quality of education and the creation of engineering universities in a new technological order.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

6. REFERENCES

- Al Husaeni, D.F., and Nandiyanto, A.B.D. (2022) Bibliometric computational mapping analysis of publications on mechanical engineering education using VOSviewer. *Journal of Engineering Science and Technology*, 17(2), 1135-1149.
- Anikina, I. D., Gukova, A. V., Golodova, A. A., and Chekalkina, A. A. (2016). Methodological aspects of prioritization of financial tools for stimulation of innovative activities. *European Research Studies Journal*, 19(2), 100-112.
- Benavides, L. M. C., Tamayo Arias, J. A., Arango Serna, M. D., Branch Bedoya, J. W., and Burgos, D. (2020). Digital transformation in higher education institutions: A systematic literature review. *Sensors*, 20(11), 1-22.
- Caraka, R. E., Chen, R. C., Yasin, H., Suhartono, S., Lee, Y., and Pardamean, B. (2021). Hybrid vector autoregression feedforward neural network with genetic algorithm model for forecasting space-time pollution data. *Indonesian Journal of Science and Technology*, 6(1), 243-266.
- Enegbuma, W. I., Dodo, Y. A., and Ali, K. N. (2014). Building information modelling penetration factors in Malaysia. *International Journal of Advances in Applied Sciences (IJAAS)*, 3(1), 47-56.
- English, M. C., and Kitsantas, A. (2013). Supporting student self-regulated learning in problem-and project-based learning. *Interdisciplinary Journal of Problem-Based Learning*, 7(2), 1-24.

- Glushchenko, V. (2021b). Development of a franchise and rating in the formation of programs for the development of higher project education. *International Journal of Information Technology and Applied Sciences (IJITAS)*, 3(2), 29-37.
- Glushchenko, V. V (2021c). Project approach in higher engineering education. *International Journal of Engineering Technologies and Management Research*, 8(3), 36-44.
- Glushchenko, V. V. (2021a). Forecasting the directions of modernization of economic sectors and regions of the country during the development of the eighth technological order. *International Journal of Engineering Science Technologies*, 5(6), 23-42.
- Glushchenko, V. V. (2022). Ergo design of mentoring in the national ecosystem of vocational education in the period of the 10th technological order. *Indonesian Journal of Educational Research and Technology*, 2(3), 223-236.
- Glushchenko, V. V. (2023a). The scientific and practical significance of the paradigm of the development of scientific support of the 10th technological order in the world economy. *ASEAN Journal of Science and Engineering Education*, 3(3), 245-264.
- Glushchenko, V. V. (2023b). Managing the process of creating the university's student ecosystem. *Indonesian Journal of Multidisciplinary Research*, 3(2), 191-202.
- Glushchenko, V. V. (2023c) Formation of a paradigm for designing cyber-physical systems: Educational perspective. *Indonesian Journal of Teaching in Science*, 3(1), 45-58.
- Glushchenko, V. V., Lepeshkin, I. A., Vlasova, K. N. (2020). Methodological aspects of the formation of the concept of development of the center of project activity of the university. *Kazakhstan Science Journal*, 3(9), 12-24.
- Khamitovna, K.K. (2022). Practical work on the transition of the educational process in higher educational institutions to the stage-stage credit-module system and their results. *ASEAN Journal of Educational Research and Technology*, 1(2), 147-154
- Machekhina, O. N. (2017). Digitalization of education as a trend of its modernization and reforming. *Revista Espacios*, 38(40), 1-6.
- Onia, S. I., and Rmadan, A. F. (2023). Policy for distance learning in education in higher education institutions: Experiences from Sudan. *Indonesian Journal of Educational Research and Technology*, 3(1), 59-68.
- Orishev, J., and Achilov, S. (2023). Digital technologies as an educational process in preparing future teachers for project activities. *Science and Innovation*, 2(B3), 425-429.
- Panova, E. P., Filimonova, N. Y., Bocharnikova, N. V., and Davydova, M. L. (2020). Project activities in the process of teaching foreign students. *Utopía y Praxis Latinoamericana: Revista Internacional De Filosofía Iberoamericana y Teoría Social*, 10, 151-162.
- Rizaldi, A., and Linasari, E. (2021). The influence of innovation models, micro small and medium enterprises, and development strategies towards cooperatives in industrial era 4.0. *International Journal of Entrepreneurship and Technopreneur (INJETECH)*, 1, 53-60.
- Saidova, H. R. Q. (2021). Quality of school education and factors of its modernization. *Current Research Journal of Pedagogics*, 2(6), 43-50.

- Sari, N. M., and Faiz, N. S. M. (2021). Internationalisation of higher education: The activity – process approach at Universiti Tun Hussein Onn Malaysia. *Indonesian Journal of Educational Research and Technology*, 1(2), 7-10.
- Theophilus, A. A. (2023). Literature review for civil engineering practice and technology innovation in civil engineering and educational sustainability. *ASEAN Journal of Science and Engineering Education*, 3(2), 183-192.