



# PROJECT APPROACH IN HIGHER ENGINEERING EDUCATION

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## ABSTRACT

The subject of the article is the project approach in higher engineering education, the object of the article is higher engineering education in the conditions of the sixth technological way, the purpose of the article is to increase the quality of higher engineering education to the conditions of the sixth technological way; to achieve this goal, the following tasks are solved: studying the specifics of project engineering higher education; developing the methodology of project engineering higher education; performing a comparative analysis of the methodologies of project and subject engineering higher education; analysis of the risks of using the project approach in engineering higher education; description of the methodology for implementing an educational engineering project by students; in the article, the research methods are system analysis, comparative analysis, synthesis, forecasting theory, expert methods; the scientific novelty of the article is related to the development of the methodology of project engineering higher education in universities.

## 1. INTRODUCTION

The relevance of the article is related to the need to improve the quality of engineering higher education in the situation of the formation of the sixth technological order in the economy.

The hypothesis of the article is the statement that the development of the methodology of the project approach in engineering higher education can improve the quality of such higher education.

The purpose of the article is to increase the quality of higher engineering education to the conditions of the sixth technological order.

To achieve this goal, the following tasks are solved:

- study of the specifics of project engineering higher education;
- development of the methodology of project engineering higher education;
- description of the methodology for the implementation of an educational engineering project by students;

- performing a comparative analysis of the methodologies of project and subject engineering higher education;
- analysis of the risks of using the project approach in engineering higher education.

The object of the article is higher engineering education in the conditions of the sixth technological order.

The subject of the article is the project approach in higher engineering education.

In 2021, the project method in higher engineering education is considered as one of the tools for improving the quality of higher education [1], p. 370-373]. Trends in the development of design engineering higher education are observed [2], p. 51-54]. Project-based education technologies are considered as a tool for implementing new standards in higher education [3], p. 92-95]. In this regard, they study the international practice of higher project education [4], p. 32-59]. The introduction of the project method in higher education reveals the existence of problems in this area [5], p. 136-143]. Design engineering higher education is considered as a paradigm of higher education in the 21st century [6], pp. 156-167].

Foreign scientists study the theoretical foundations of problem-based and project-based higher education [7], p. 3-24; [8], p. 236-274].

It can be justified that project-based higher education is an independent model of higher education [9], p. 25-37]. The paradigm of higher engineering project education is being developed [6], p. 156-167; [10], p. 7-15]. Develop methodological issues of improving the effectiveness of the centers of project activity of universities [11], p. 12-24].

The admission of representatives of millennials and post-millennials (generation Z) to universities gives special relevance to the problems of the development of higher project education [12], c. 109-111]. It is necessary to predict the further development of higher education [13], p. 2]. Development of higher design education you need to manage [14], p. 2]. In the process of development of the higher education project, it is recommended to use a scientific theory of the teams [15], pp. 272-287]. In the process of developing higher project education, it is necessary to take into account the following factors::

- Development of the sixth technological order in the economy [16], p. 30-46];
- the need for closer integration of science, education and practice in the 21st century [17], p. 25-40];
- the need to customize the scientific and educational activities of universities [18], p. 65-87];
- development of the system-activity model of educational processes in primary, secondary and higher education [19], p. 5-25];
- formation of the product approach in higher education [20], p. 37-56];
- the existence of the crisis of philosophy and science [21], p. 4], associated with the development of the sixth technological order;
- the great influence of science and education on the development of the economy. It is believed that up to 80% of economic development is determined by scientific research and the quality of education [22], p. 7].

At the same time, the theoretical foundations of project engineering higher education in 2021 are in the stage of their development. The formation of the sixth technological order creates the need for a conceptual modernization of the higher education system. An important task is to adapt the entire system of higher education and individual universities to work in a new technological order. The higher education sector should be the leader of scientific and technological progress. Without innovative development of the higher education system, it will be difficult to ensure the competitiveness of the national economy.

In this situation, the project approach can be considered as one of the directions of innovative development of the higher education system. The analysis of the affiliation of the authors of publications on the topic of higher project education suggests that 5-10% of Russian universities systematically use the methodology of project education in their work. Therefore, the introduction of this innovative method of higher education can have much greater scope and effects.

This confirms the relevance and great practical significance of this article.

The increased relevance of the implementation of the project approach in universities is also indicated by the fact that Generation Z students have clip thinking. Such thinking is a consequence of the increasing spread of information technology. For students with clip thinking, reality is displayed as a sequence of unrelated images. At the same time, students have a decrease in the ability to think logically [12], p. 109-111]. Such students are

increasingly becoming addicted to gadgets. For students with this mindset, it is difficult to combine the information received during the study of various academic disciplines in the thought process. This may be one of the reasons for the decline in the quality of higher education. In addition, employers recommend developing an activity component in the training of students.

The implementation of the project approach in higher engineering education makes it possible to develop in the process of such education: the system component-to logically link the knowledge received by the student in the project; the activity component in the implementation of the project.

It should be noted that the project approach is always a problem-oriented approach. This is due to the fact that each project solves a problem in the system form. For example, the problem of increasing labor productivity by automating it. However, not every problem-oriented higher education is also project-oriented.

An additional important circumstance is that the problem-oriented approach can be used both in the process and project models of the functioning of organizations in the real economy. The process model of organizations was described by A. Fayol in the early 20th century. This model consists in the fact that the entire functioning of the organization is divided into three types of processes: main production processes; supporting processes; auxiliary processes. This model is more suitable for describing routine, rather than innovative, activities of an organization.

The development of innovations in the economy has led to the formation of a project approach in the activities of organizations. In the period of the sixth technological order, innovations become permanent. With the project approach, the entire activity of the organization can be represented as a set of projects. These projects are at different stages of their implementation. With the project approach, all the activities of the organization can be divided into different projects.

Increasing practical interest in projects and project management leads to the development of the project approach in higher engineering education. Design higher engineering education needs to develop the theory of such education [8], p. 236-274; [9], p. 25-37; [10], p. 7-15].

The use of the project approach in universities creates the basis for the systematic integration of subject knowledge and skills to the student. This basis is the structure of the project object. The sequence of actions to achieve the goals of the project forms the activity component of such higher education. Such project skills of the student make it easier for them to find and use knowledge in real work in organizations in the economy.

In prognostics, the concept of "project" is interpreted as a certain image in the future [13], p. 9]. At the same time, the word "project" can mean: a plan of a structure, mechanism, or device. In the design case, a project is a set of documentation that defines the device of an object or technical product [23], p. 63-75].

In terms of activity, a project is called a system of actions of participants in a small project group. This system of actions should be aimed at achieving a specific project goal in the future.

The project development process includes a set of operations aimed at creating a project of any product, building, mechanism, product ( service or product).

In the process of project development, the stage of such design includes one or more operations. This operation should be a relatively independent part of the entire design process [14], p. 174].

Under the project approach in higher engineering education, we will understand such a model of education, which is characterized by the following:

- university graduates are purposefully trained to implement projects in the real economy;
- the implementation of educational projects is an independent part of the program of training students at the university.

A distinctive organizational feature of the project approach in higher engineering education is the implementation of educational projects by students as part of small project groups. The implementation of educational projects is carried out by students in conditions as close as possible to the conditions of the real economy. A university professor advises such a project group. Such a professor must pass special training under the program of additional education [24], p. 38-51].

The features of higher project engineering education reflect its roles and functions. The functions of higher project engineering education include:

- providing a systematic perception of knowledge and skills by students with clip thinking;
- students gain skills in the practical use of knowledge;
- students gain the ability to work practically as part of a small project group;

- formation of a creative organizational culture in the project group;
- collective generation of ideas;
- development of students' creative thinking, their research abilities and skills;
- development of students' professional and personal communication skills;
- students gain practical skills in the distribution of work among the members of the project team;
- development of students' practical skills in resolving conflicts between project team members in the course of their joint activities;
- development of practical skills of integration of science, education and practice in the implementation of innovative projects and others.

Higher project engineering education fulfills the following roles:

- 1) improving the quality of higher engineering education in the conditions of: clip thinking of students; accelerating scientific and technological progress;
- 2) the mechanism of adaptation of higher engineering education to the development of the sixth technological order;
- 3) accelerate the implementation of the results of scientific and technological progress;
- 4) the formation of a productive organizational culture among students in their preparation for work in the real economy.

From the point of view of the organization of the educational process in universities, the features of the project approach in higher engineering education can be called:

- the allocation of work on the implementation of educational projects as a separate type of educational activity at the university in the curricula of student training;
- development by the university of the methodology of the project approach in scientific and educational activities;
- construction of the presentation of educational material with a focus on the project model of organizations' activities in the economy;
- allocation of project activity centers in the organizational structure of the university, as an independent division, and others.

All of the above allows us to recognize the project approach in higher engineering education as an independent innovation paradigm of the university. At the same time, educational projects act as a tool for adapting the educational process at the university to the formation of the sixth technological order.

The center of project work (activity) of the university in this paradigm of higher education can perform the following tasks: the center for the development of the methodology of higher engineering project education; the formation of a list of projects proposed for students; the selection of project supervisors; the organization of the formation of project groups; the preparation of a schedule of project classes; the approval of quality control procedures for projects performed; the collection of information about real projects in industries and clusters of the economy, and so on.

The most promising tasks of the centers of project activity of universities are: the development of the scientific and methodological basis of the project approach in higher education; additional education for the preparation of participants in project activities; research of the project activities of organizations in the real economy, and others.

Under the paradigm of higher engineering project education, we will agree to understand the system integration: the philosophy of the project approach; the organizational culture of such higher education; the ideology of project higher education in universities.

The main factors of quality improvement in higher project education can be called:

- customization of the areas of training, education, and research in the direction of implementing projects in the real economy;
- students follow the logic of work when implementing projects in real conditions;
- freedom of choice of the project supervisor;
- an opportunity for students to put their knowledge into practice;

- the opportunity for students to show their leadership skills;
- freedom to set tasks when implementing projects;
- development of students' skills integration of education, science, practice in one educational project;
- practical application of the methodology for creating small project groups of students [15], p. 272-287];
- deep understanding of values, development of professional organizational culture of students, and more.

The philosophy of development of design higher engineering education should be called the most general view of the essence of this type of education.

There are two methods of forming the philosophy and organizational culture of higher education: from theory to practice of higher education; from practice to theory of such higher education. In the second method, it is believed that project-based higher education gradually forms its own philosophy. The values of the organizational culture of project-based higher education can be considered what is useful for the development of such education.

At the beginning of the 21st century, the philosophy of higher project education is synthesized as a result of generalization of the practical experience of universities using this model of education.

In practice, the philosophy of the project approach in universities is expressed in the following principles:

- the educational project should be specific to the professional sphere of the student;
- the project can be: with a previously unknown result (open) project; a project with a previously known result;
- the project must correspond to the level of knowledge of the student;
- the task for the project should reflect the actual level of scientific and technical development of the industry or cluster of the economy;
- the conditions for the implementation of the project should be as close as possible to the real ones and others.

In the field of organizational culture, these principles become the basic values of the project approach in universities.

The elements of the philosophy of the project approach in engineering universities include: the philosophy of scientific research in the form of projects; the philosophy of knowledge transfer in the learning process; the philosophy of educating students in the course of projects; the philosophy of integrating education, science, and practice in the process of implementing educational projects at the university, and others.

The philosophy of the project approach includes: the study of the project model of the work of organizations in the real economy; the study of the features of the relations of team members in project activities; the methodology of the implementation of educational projects in universities.

The organizational culture of higher project education will be called: a set of norms of behavior of members of the project team; a set of beliefs, beliefs, values accepted by participants of the project higher engineering education; the ways the team responds to the problems of the project; the norms of interaction with project customers.

The ideology of the project approach in higher education can be understood as: first, the main idea of this form of higher engineering education; second, the method of distributing power in the process of such higher education.

The main idea of higher project education can be called: the systematic integration of knowledge in the process of their use in the implementation of the project. Project education performs customization of the processes of scientific and educational activities of the university. The result of the implementation of the project form of higher education should be an increase in the quality of higher education. In the conditions of clip thinking of students, project education is a form of integration: science, education and practice.

A feature of the method of power distribution in project engineering education can be called an increase in the value of horizontal information links. The professor is a consultant for the project team. The professor carries out horizontal interaction with the members of the project team. The tasks of the professor are to advise the members of the project team on such issues: setting project goals; developing the characteristics of the project result; drawing up a project implementation plan; solving specific project tasks, and others. This approach expands the possibilities of students' creative approach. When solving the project tasks, students should: systematically use the acquired knowledge; quickly obtain the missing knowledge.

The innovative nature of project-based higher education will develop the joint creativity of all subjects of such education.

Project-based higher education is focused on the capabilities and abilities of a particular student. With such a higher education, the student has much greater freedom of choice in all areas of their professional training at the university. In such education, the opportunities for students to demonstrate their leadership qualities increase. The student's participation in the implementation of the project creates conditions for the disclosure of the intellectual potential of this student in his projects.

The policy of development of higher project education at the university will refer to all public activities: educational activities of the university; scientific activities of the university; labor social relations; professional work of teachers. All these activities should be aimed at the development of the project form of higher education.

At the same time, the policy for the development of project-based higher education can also be called a set of activities at the university. These activities are aimed at developing the methodology of the project method of teaching students. The policy of higher project education may include measures that are aimed at the following::

- 1) development of the methodology of project activities of real economy organizations;
- 2) development of methodology for the implementation of educational projects;
- 3) increase the motivation of students in the course of project activities;
- 4) increasing the level of motivation of teachers in the process of educational project activities;
- 5) ensuring the sustainability of the work of universities during their transition to the project model of higher education.

The policy of project-based higher education can be divided into two parts: the development strategy; the tactics of developing the project approach in professional higher education.

The strategy for the development of the project approach in higher professional education can be understood as a set of measures that are aimed: first, at adapting the university to changing external conditions in the real economy; second, at internal coordination of the university's work in the process of such a transition to the project model of engineering education.

Due to the development of the sixth technological order, an increase in the number of educational projects in the following areas can be expected: the synthesis of nanotechnologies; the development of neuro technologies; the development of information technologies; the improvement of digitalization technologies; the creation of environmentally friendly technologies; and the improvement of the efficiency of energy-saving technologies.

The number of projects for the modernization of enterprises ' products may increase during their transition to the sixth technological order. Projects in the field of modernization of the means of production will be popular during their transition to the sixth technological order [16], p. 30 – 46].

We will call a set of short-term measures a tactic for the development of project-based higher education. These activities should be aimed at maintaining the level of higher education in the transition of the university to the project model of work.

Under the technology of higher project education at the university, we agree to understand a complex combination of: educational facilities and infrastructure of the university; methodology of project higher education; qualification skills of the teaching staff; methods of selecting educational projects. The technology of such education should provide the necessary quality of such higher education.

A large role in achieving the goals of the project model of higher education belongs to the preparation and selection of educational projects.

In the institutional approach to the development of project-based higher education, it is necessary to focus on the development of new relations in education. This applies to the relationship between a professor and a student in an educational project.

Scientific supervisors of project teams communicate their explicit and implicit knowledge about the essence of the project in the process of communication. Scientific supervisors generate a favorable moral and psychological environment. Research supervisors create a productive project-based organizational subculture in a group of students.

The effectiveness of the project model of higher education is ensured by a high-quality selection of educational projects. Projects should be diverse in their fields of activity, students ' courses, and other characteristics. The analysis shows that a general scheme of project implementation can be proposed. This scheme allows its addition and / or removal of individual stages.

At the same time, the implementation of the project can be divided into such steps.

- 1) Research of the legal framework of entrepreneurship in the field of innovative projects. Development of the organization's constituent documents.
- 2) Study of the theoretical foundations of innovation. Description of the idea of the educational project. Determining the market capacity for the project's innovative product.
- 3) Mastering the concept and essence of investment. Description of the sources of financing for the innovation project.
- 4) Definition of the main characteristics of the project product.
- 5) Description of the main stages of the project implementation. Formation of the mission, goals, vision, tasks and stages of the innovation project. Preparation of a forecast cost estimate for the project. Forecasting the break-even point of the project.
- 6) Mastering the methods of assessing the competitiveness of innovative products and projects. Conducting an assessment of the project's competitiveness.
- 7) Study of pricing methods in industry and / or project activities. Determining the price of the project's products.
- 8) Research and risk analysis of innovative projects. Development of measures to reduce the risks of innovative projects.
- 9) Research of the possibility of conducting the initial issue of securities for the project financing.
- 10) Mastering the ways of forming project teams. Creating a project team. Strategic planning of the project team.
- 11) Study of the function of motivation in project management. Creating a system of motivation for the project team of an innovative project.
- 12) Formation of a system for monitoring the implementation of an innovation project.
- 13) Synthesis of the project's marketing policy, formation of an advertising and PR campaign to promote the project.
- 14) Formation and management of the brand (branding) of the innovation project. If necessary, rebranding the project.
- 15) Study of methods for evaluating the financial results of innovative projects. Evaluation of the financial results of the project.
- 16) Development of a business plan for an innovative project.
- 17) Implementation of the business plan of the innovation project.
- 18) Evaluation and control of the results of the innovation project [24], p. 38-45].

At the same time, the analysis of the content of the project stages indicates that the standard project is based on the integrated use of information from various fields of knowledge. For the successful implementation of the project, you need a set of knowledge from: a certain professional field in which the project is carried out; the field of legal support for project activities (law); market research, marketing policy and brand formation (marketing); knowledge in the field of pricing; management accounting information (accounting); knowledge in the management of organizations; knowledge in the field of personnel management; knowledge in the field of investment and investment analysis; knowledge of methods for evaluating financial results (finance), and more.

This list of knowledge from various subject areas is used in the project method. This knowledge is applied in the process of their system integration. The set of knowledge should take into account the subject specifics of the project.

The supervisor should promptly make a rapid assessment of the level of knowledge and psycho-physical characteristics of students. These estimates should be taken into account in the process of work distribution (division of labor) in the project group. In addition, it is necessary to take into account the nature of the relationship of the project team members, their competition. To do this, the project supervisor must have medical knowledge, knowledge in the field of psychology and organizational behavior.

All this suggests that the project model of higher education imposes high and complex (knowledge of up to 10 subject areas) requirements for the qualifications and human qualities of scientific managers of educational projects.

Most modern universities are characterized by a conglomerate organizational structure. The development of project-based higher education may require universities to move to a matrix organizational structure of the university.

The advantage of the matrix structure of the university is its ability to respond to changes in the external environment.

The reasons for the risks in the transition to the project model of the university can be:

- low assessment of the value of the project model of the real economy organizations ' activities;
- lack of consideration of the influence of clip thinking of students on the quality of subject higher education;
- insufficient assessment by the university of the advantages of the project model of higher education;
- insufficient support of the business community for the implementation of the project model of higher education;
- lack of motivation of universities to switch to the project model of higher education;
- the delay in understanding the trends associated with the formation of the sixth technological order, and others.
- Project-based higher education can be considered as a reaction of the education system to such environmental factors:
  - development of technologies of the sixth technological mode and clip thinking of students [16], p. 30-46];
  - increasing the resource intensity of scientific research, which leads to customization in the scientific activities of universities [18], p. 65-87];
  - increasing the importance of the project model of the real sector organizations ' activities[23], p. 63-75].

It is possible to apply project-based higher education in all segments of the higher education system. The project model of higher education is a fairly universal way to solve the problem of improving the quality of higher education.

In the conditions of post-industrial development, the share of education and science accounts for up to 70-80% of economic growth [22], p. 15]. Therefore, increasing the level of higher education can accelerate the entire process of socio-economic development. Such an acceleration of development can occur at the regional, national and global levels.

## 2. CONCLUSION

The article examines the essence, advantages and risks, factors of higher efficiency of the project model of higher education. The paper describes the philosophy, ideology, and policy of project-based higher education. The article examines the relationship between professors and students in project-based higher education. The article describes the content of the educational project at the university. The paper lists the risks of implementing the project model of higher education. It was proved that such a project-based higher education can be used in various segments of education; it has good prospects for development in the context of the formation of a new (sixth) technological order.

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## CONFLICT OF INTEREST

The author have declared that no competing interests exist.

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