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TRAINING BIM SPECIALISTS: THE ROLE OF TRAINING AND PRODUCTION CENTERS

BIM МАМАНДАРЫН ДАЙЫНДАУ: ОҚУ-ӨНДІРІС ОРТАЛЫҚТАРЫНЫҢ РӨЛІ

ПОДГОТОВКА СПЕЦИАЛИСТОВ ПО BIM: РОЛЬ УЧЕБНО-ПРОИЗВОДСТВЕННЫХ ЦЕНТРОВ

B.E. Makhiyev[1]*, **A.V. Khapin**[1], **V.V. Talapov**[2], **M. Kulisz**[1], **L.V. Kamenskikh**[1]
[1]D. Serikbayev EKTU, Ust-Kamenogorsk, Kazakhstan
[2]NGASU (Sibstrin), Novosibirsk, Russian Federation
*Corresponsing author: Махиев Бекболат Еспулович, e-mail: bmahiev@ektu.kz

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ABSTRACT
This article discusses a new technology for training personnel in BIM design. It analyzes the engineering staff of design organizations, which consists of experienced specialists who are older and have poor command of BIM programs, and young specialists who are proficient in computer technology but have no real design experience. Universities are encouraged to create BIM training and production complexes (BIM T&PC) with a high degree of integration between educational and production processes. Experienced employees of design organizations can teach special subjects at these centers on a part-time basis and supervise diploma projects or master's theses. The BIM T&PC is engaged in full-scale work on projects, parts of which will be the final projects of students who will become the personnel reserve of designers. This article describes the experience of using such a complex at the NPJS D. Serikbayev EK.

Түйінді сөздер:
кадрларды даярлау, BIM-жобалау,интеграция, оқу-өндірістік кешен, біліктілікті арттыру

ТҮЙІНДЕМЕ
Мақалада BIM-жобалауына арналған кадрларды даярлаудың жаңа технологиясы негізделді. BIM бағдарламаларын нашар меңгерген, бірақ құнды практикалық тәжірибесі бар тәжірибелі «жасы келген» мамандардан және компьютерлік техниканы меңгерген, бірақ нақты жобалау тәжірибесі жоқ жас мамандардан тұратын жобалау ұйымдарының инженерлік құрамына талдау жүргізілді. Жоғары оқу орындары жанынан оқу және өндірістік процестерді интеграциялаудың жоғары дәрежесі бар BIM оқу-өндірістік кешендерін (BIM УПК) құру ұсынылды. Осы орталықтардағы қосымша жобалау ұйымдарының тәжірибелі қызметкерлері арнайы пәндерді оқыта алады және дипломдық жобалауды немесе магистрлік диссертацияларды басқара алады. BIM УПК-де жобалар бойынша толыққанды жұмыс жүргізілуде, олардың бөліктері жобалаушылардың кадрлық резерві болатын студенттердің бітіру жұмыстары болады. Мұндай кешеннің жұмыс тәжірибесі «Д. Серікбаев атындағы ШҚТУ» КЕАҚ-да келтірілген.

Ключевые слова:
подготовка кадров, BIM-проектирование, интеграция, учебно-производственный комплекс, повышение квалификации

АННОТАЦИЯ

В статье обосновывается новая технология подготовки кадров для BIM-проектирования. Проведен анализ инженерного состава проектных организаций, состоящих из опытных «возрастных» специалистов, слабо владеющих программами BIM, но имеющих ценный практический опыт, и молодых специалистов, владеющих компьютерной техникой, но не имеющей опыта реального проектирования. Предложено при вузах создавать учебно-производственные комплексы BIM (УПК BIM) с высокой степенью интеграции учебного и производственного процессов. Опытные сотрудники проектных организаций по совместительству в этих центрах могут преподавать специальные дисциплины и руководить дипломным проектированием или магистерскими диссертациями. В УПК BIM ведется полноценная работа над проектами, части которых будут выпускными работами студентов, которые будут кадровым резервом проектировщиков. Приводится опыт работы такого комплекса в НАО «ВКТУ имени Д. Серикбаева».

INTRODUCTION

One of the main factors hindering the widespread adoption of building information modelling (BIM) technologies is the insufficient level of training of qualified specialists, as well as the existence of organisational constraints arising at various stages of their implementation and application. The results of recent studies confirm the relevance of this problem. According to a survey conducted by the ERZ.RF portal in 2023 on the implementation of information modelling technologies, one of the priority tasks in the transition of the construction industry to BIM is the formation of an effective personnel training system (Itogi_oprosa_TIM, 2025).

According to the results of this study, 56.3% of respondents who do not use BIM in their professional activities and 63.4% of specialists who already use these technologies noted the need to improve the training system. The results indicate that, despite the growing interest in and need for BIM technologies, the current level of training for specialists remains insufficient and requires further development and improvement.

One of the main problems is the lack of specialists with the necessary competencies in BIM technologies. There is a shortage of trained personnel at all stages of a construction project's life cycle, including design, construction, and operation, which significantly limits the possibilities for the effective application of information modelling (Mishra A., Hasan A.,. Jha K. N 2024), (Ademci E., Gundes S., 2021).

An additional factor hindering the implementation of BIM is the resistance of specialists to traditional working methods. Many participants in the construction process prefer to use familiar design and construction technologies, viewing BIM as a complex and resource-intensive tool that requires significant time and organisational costs (Leśniak A., Górka M., Skrzypczak I., 2021)

In some cases, the use of BIM is perceived as an additional burden that does not provide immediate practical benefits, which reduces the motivation of specialists to master and use it (A. Adepoju A. O., Akanbi T., Adebambo H., Lawal F. M., 2023).

Another significant problem is the insufficient effectiveness of the existing system for training specialists. Educational programmes at higher education institutions and vocational training systems do not always provide practical skills in working with BIM technologies, which leads to a gap between the requirements of the construction industry and the level of training of graduates (Gamil Y., Rahman I. A. R., 2019). Software is constantly evolving: some systems strengthen their leading positions by expanding their functionality, while others eventually lose ground to their competitors (Talapov V.V., 2015).

Global practice shows that the effectiveness of BIM implementation is only 20% determined by the choice of software, while the main role (80%) is played by organisational, managerial and human resources factors, including the level of training of specialists (Talapov V.V., 2011).

Training specialists in the field of computer-aided design, taking into account the specifics of BIM, requires improvement and reorganisation of the structure of the educational process (Makhiiev B.E., 2019). In this regard, it is important to define the current directions for the development of the BIM technology training system.

MATERIALS AND METHODS OF RESEARCH

The first direction is the peculiarities of training of existing engineering personnel in the transition to BIM.

The technology of information modeling implies joint and almost simultaneous work of all team members to create a model of a construction facility (Talapov V.V., 2022). This assumes, in addition to a good individual professional level of employees in their discipline, also:

1) a high level of understanding by each member of the design team of the goals and objectives of the work being performed, as well as modeling methods and regulations;

2) a high level of mastery by each employee of the software used in the work;

3) well-developed interaction of all participants of the information modeling process.

If the organization, first of all design organization, has established the goal to transfer its activities to work in BIM, then in the field of personnel it will have to raise all employees to the level of the above requirements. To do this, the following must be done.

1). Let's assume that professionally, in terms of design disciplines, all existing organization employees are sufficiently experienced and trained. However, they need help understanding the goals and objectives of the work being performed in light of the use of information modeling technology. This will require special training in the theoretical foundations of BIM.

It will be more difficult with methodologies and regulations, as they require BIM skills, but a well-thought-out information modeling process across the entire organization can help here. It is not easy, but without it, BIM will not be implemented in the organization.

2). With the mastery of the software at a high level is even more difficult. Practice shows that to achieve from all employees the same high level of proficiency in software use, even after repeated training, is not possible.

The situation is particularly challenging with older employees, who are the most experienced and valuable members of the workforce. This is not solely due to age, although the ability to quickly adapt to new technologies does diminish over time. The overall workload of these employees also plays a role, as does their established conservatism, which is linked to the increased responsibility for the work they perform, and their ability to work with “old” technologies, which has been honed to perfection and will now have to be almost completely dismantled.

So, problems arise with the most valuable employees, but these people cannot be lost in order to avoid lowering the professional level and image of the entire organization.

3). Well-developed teamwork is only possible if each member has sufficient individual mastery of information modeling technology, which is again problematic for experienced employees for the reasons described in the previous paragraph.

In addition, collective and well-organized interaction is required during information modeling, and this must be long-term, which is again problematic if the organization has not yet switched to BIM.

Thus, there are problems, and the most serious of them is the danger of losing experienced employees.

The second direction is the peculiarities of training new, young specialists.

No design organization can do without constantly replenishing its staff with new young employees. This becomes particularly important when transitioning to building information modeling technology, which requires employees who are already familiar with BIM concepts. Universities are responsible for training such specialists.

Let us consider university graduates according to the criteria outlined above. First of all, it is well known that their individual professional level in the relevant field of design, even if it is quite high, requires many years of training to reach the level required in the industry.

Now let's consider the requirements (Talapov V.V., 2016) for information modeling.

1. Even while still studying, young professionals can gain a thorough understanding of the goals and objectives, as well as the methods and regulations of BIM and the relationships between participants in the information modeling process, i.e., the theoretical foundations of BIM.

2. New specialists also tend to graduate from universities with a high level of proficiency in information modeling programs and general training in information technology.

3. University graduates have no serious experience of interacting with other information modeling process participants or of working on real projects.

Now let's compare “older employees” and young specialists in terms of their level of compliance with basic personnel requirements.

A brief description of the situation with BIM personnel for the positions considered during the transition of a design organization to building information modeling technology is summarized in the table below.

Table 1. Compliance of existing employees and young specialists with key staffing requirements

Key staffing requirements	"Old" employees	Young specialists
Mastery of their design discipline	Yes	No
Understanding of BIM tasks and techniques	No	Yes
Individual BIM software proficiency	No	Yes
Experience in collective use of BIM	No	No
Note – compiled by the authors		

So, it is clear that neither existing nor new specialists fully meet the requirements for the transition to BIM. But it is also clear that they can complement each other with their knowledge and skills. However, for this to happen, the training of young specialists in higher education must go hand in hand with the training of existing employees of design organizations through advanced training courses and interaction with them, for example, by involving them as teachers of specialized disciplines.

Building Information Modelling (BIM) technology only delivers its full benefits when multiple project participants actively share models, data and decisions. Collaborative participation eliminates fragmentation, provides control and traceability, and results in better coordination, fewer conflicts and improved project outcomes (Chen H., Ying F., 2020).

However, today, the training of specialists in universities and the additional training of existing employees are carried out in parallel, but not in a coordinated manner, with students from different categories having no contact with each other.

This approach to training specialists, in which students are taught everything first and then sent out to work, is entirely consistent with centuries-old traditions and can rightly be called classic. Moreover, it used to be quite effective. However, modern industrial technologies, especially information technologies, show that this view of training is outdated and no longer

produces the desired results (Mahiev B.E.,2019, Talapov V.V.,2022). Therefore, if this approach is not changed, the training of BIM specialists will continue to be ineffective and out of step with the demands of the modern world.

Based on the above analysis, we will formulate proposals for adapting the process of training BIM specialists in the modern technological conditions of the design and construction industry.

1. Three-stage training.

Comprehensive training in information modeling technology should be carried out in three stages:

1) theoretical training in the basics of BIM (including familiarization with the basic concepts and principles of information modeling, as well as various ideas for implementation in the process of studying international experience using BIM). The main task of theoretical training is to teach students to think in terms of information modeling (Underwood J., Isikdag U., 2010);

2) familiarization with the main information modeling software (developing skills in selecting such software for specific tasks and acquiring individual expertise in its use);

3) practical mastery of BIM (participation in collective work on projects, improvement of individual skills, and practice in methods of teamwork)

2. Training specialists in close cooperation between educational institutions and design and construction organizations.

In fact, this involves creating BIM training and production complexes (BIM TPCs) with a high degree of integration between educational and production processes.

The most expedient approach is to establish educational and industrial BIM complexes at universities with the participation of one or more design and construction organisations interested in implementing this technology. In this case, students are not limited to short-term internships but are involved in real production processes over a long period of time. Along with their main professional activities, specialists from design and construction organisations can participate in the educational process by teaching specialised disciplines or providing scientific guidance for graduation and master's theses, which contributes to joint learning and the exchange of practical experience with students.

At the same time, the structure of the educational and production BIM complex requires further development, since one university can interact with several organisations at the same time. In addition, the creation of such a complex involves improving the organisation of the educational process and attracting teachers with a new level of training who have competencies in the field of information modelling technologies.

3. Joint theoretical training within the BIM TPC.

This approach will save time and resources and teach everyone to think in terms of information modeling.

4. Initial training in software programs is best conducted separately.

Students will still outpace organization employees in mastering BIM software, but this is actually a good thing. Later, while working together on projects, they will pass on their advanced knowledge and skills in using computer software to organization employees, who will in turn share their additional knowledge of design disciplines with the students.

5. The process of collective work on a project should bring students and employees together.

To do this, small work cells (one employee + 3-5 students) should be created among students and organization employees, and these cells should be treated as responsible production units instead of individual employees being responsible for the work done. This is possible within the BIM TPC.

It is in these cells that the mutual exchange of experience between students and practicing specialists should take place (lines 1-3 of the table).

6. Full-scale work on the project within the BIM EPC. It seems optimal for this work to be carried out during the final year of students' studies at the university, with the part of the project they complete being considered as their final qualification work.

At the same time, all project participants (who are also continuing their education) gain real experience in the comprehensive use of BIM under the guidance of the customer (Talapov V.V., Nesipbaev, A.S., Khapin, A.V., Mahiev, B.E., 2022), students find themselves in the real working environment of a potential employer, and design and construction organizations, in addition to improving the qualifications of their specialists, also have the opportunity to recruit new personnel.

The implementation of this concept at our university began with the creation of scientific and production centers, in particular, the «BIM Scientific and Production Center», as a precursor to the BIM TPC. Initially, the main task of the center was to assist construction industry production and design organizations in surveying and seismically reinforcing existing buildings and structures. This task was related to the need to assess the seismic safety of existing buildings located in earthquake-prone areas of the Republic of Kazakhstan after the seismic zoning map was changed. As a rule, existing buildings were constructed before the new maps were introduced, and mandatory requirements for the design of buildings and structures were not provided for.

With the emerge of new projects designed and built using BIM technologies, information models started to be used to assess the seismic safety of such buildings. For example, during the upgrade of an enrichment plant in the city of Aktogay in the East Kazakhstan region, collisions were found when installing new equipment, which allowed the location of the main process pipeline to be refined, and its routing was changed (Hapin A.V., Mahiev B.E., Kenetbaev B.S., 2025). At the same time, work was carried out to assess the seismic safety of the building, as after it was put into operation, the seismic zoning map was changed and the seismicity of the construction site was increased from 6 to 7 points.

Methods based on the analysis of the dynamic characteristics of frames are used to assess the technical condition of existing buildings. This task was solved at the center with the participation of specialists from Kazzinc LLP. It was necessary to create a 3D model of the frame and examine its behavior under impact dynamic loads. A modal diagram developed at the center was used to assess the frame's vibration parameters. An experiment conducted by Kazzinc LLP specialists confirmed the results of the frame inspection: based on the analysis of vibration periods and logarithmic damping decrements, the degree of wear of the building was established and the need for its replacement was confirmed.

Work on the inspection of buildings and structures can be carried out in collaboration with companies engaged in similar research. For example, the results of the survey of steel structures of the railway bridge across the Irtysh River, carried out by Ulbatechcenter LLP, were presented at the BIMAC international conference in St. Petersburg (Hapin A.V., Mahiev B.E., Udarceva A.N., 2023).

The center uses various digital technologies, including video cameras, to inspect the technical condition of buildings. Expanding the use of video cameras made it possible to reliably determine the causes of roof damage during a gusty squall (Hapin A.V., Mahiev B.E., Udarceva A.N, 2023).

The center has carried out a series of works on the digitization of existing buildings in order to create information models containing technical attributes necessary for the operational stage, such as those characterizing the condition of utility networks. This work has been carried out for the educational buildings of our university by master's degree students of the Construction educational program under the guidance of the center's teachers.

The ongoing reconstruction of existing buildings using BIM technologies creates a wide range of tasks that are performed by master's degree students. In recent years, the topics of master's theses have been developed in this direction (Eastman C., Teicholz P., Sacks R., Liston K., 2011., Hardin B., 2009).

Thus, the center implements the integration of educational and production processes. Employees from manufacturing companies who are proficient in digital methods of building design using BIM technologies are invited to teach master's degree students. When solving practical problems, the center has been able to combine the work of senior teachers with a good knowledge of technical issues and master's degree students who are quickly mastering BIM technologies while still at university. The BIM models creations are complete with technical attributes as a result of a joint project between the older generation and young specialists, an information model suitable for building operation is born.

RESULTS AND DISCUSSION

A little about global experience.

In 2012, one of the world's leading developers of BIM software, the American company Bentley Systems, and the British company Crossrail Ltd (construction of the Crossrail high-speed railway in London) created a special training and information academy. The academy began to collect, develop, and disseminate best practices in the field of building information modeling not only among Crossrail employees, but also among project contractors. The fact is that Crossrail is a grandiose pilot project for the UK to test the application of BIM at all stages of the life cycle of construction projects. At the same time, it is the largest and most complex infrastructure project in Europe in recent decade.

The Bentley Crossrail BIM Academy can be described as Crossrail's training and consulting division, which is continuously supported by Bentley Systems. In fact, it is a joint venture between two companies that are equally interested in mutual success, as Bentley Systems' BIM programs are the main tools for implementing information modeling technology in the project, i.e., for executing the project itself. The emergence of such an academy is linked to a clear understanding of the well-known fact that the success of BIM implementation depends 20% on the right software and 80% on the right organization of its use.

During its first two years, the Bentley Crossrail BIM Academy, which had a team of 10 consultant instructors, trained (brought up to the required professional level in the use of BIM) more than 1,800 specialists from the main Crossrail company and its subcontractors. The training process itself was clearly divided into two stages: in the classroom and on the job. In the first stage, students gained experience in using the software under the guidance of instructors. In the second stage, instructors visited their students' workplaces and worked with them to find solutions to specific production tasks.

Of course, Crossrail is a large company and deserves ongoing supervision from the vendor. However, the successful experience of the Bentley Crossrail BIM Academy led to the creation of similar departments in the HS2 London-Birmingham high-speed rail project in the UK, as well as in Shell's US division, albeit under different names. Bentley Systems then moved on to implement a large program to open similar training centers in India, China, and a number of other countries in partnership with public and private companies under the umbrella of the Bentley BIM Advancement Academy.

It is easy to see that Bentley Systems' training and consulting programs are a type of research and production complex, as discussed in this article, but they are aimed only at retraining and upgrading the skills of existing personnel, while the BIM Scientific and Production Center, created on the basis of a university, can primarily train new personnel for the construction industry.

CONCLUSION

The formation of BIM training and production complexes (BIM SPC) requires comprehensive organisational and methodological support from higher education institutions, as well as the participation of design, construction, and administrative organisations interested in implementing information modelling technologies. The implementation of this concept involves improving the existing structure of interaction and reorganising production and educational processes based on modern innovative approaches. An important condition for the effective functioning of such complexes is the involvement of highly qualified practitioners with expertise in BIM technologies in the educational process.

This provides enormous benefits both in terms of training new personnel to use information modeling technology and in terms of retaining "old" personnel by integrating them organically into new technological relationships.

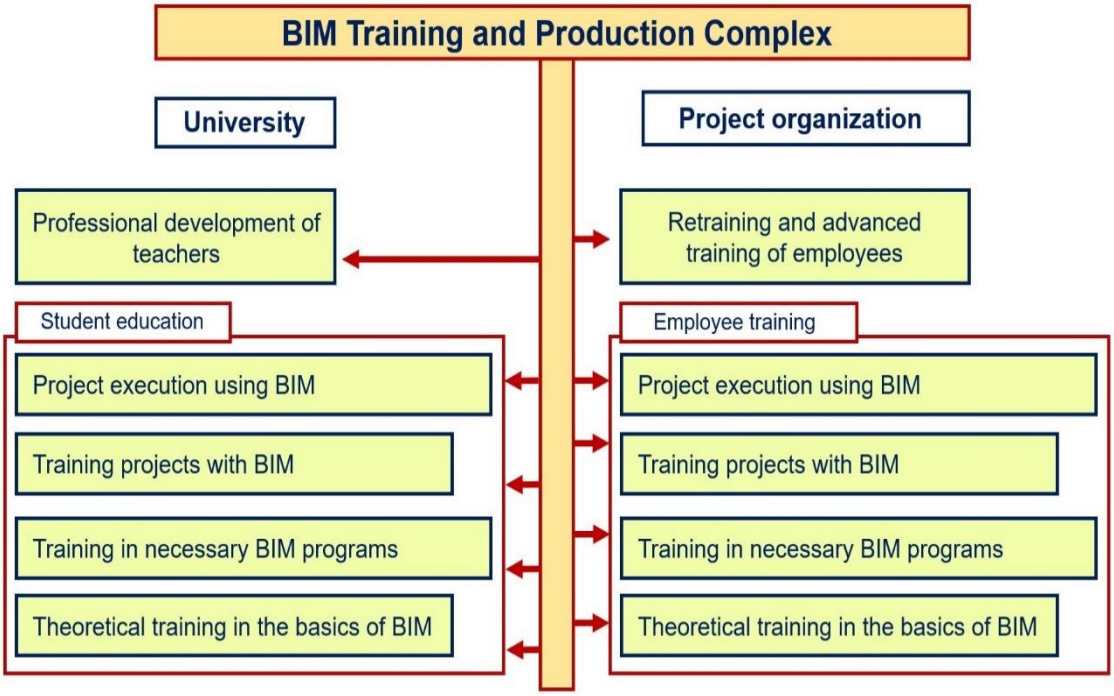

Figure 1. The following scheme delineates the manner in which interaction is to be conducted between the University and the project organization through the BIM Training and Production Complex

Note – compiled by the authors

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Официальный сайт Bentley. URL: https://www.bentley.com // Ofitsial'nyy sayt Bentley [Official website of Bentley]. URL: https://www.bentley.com

Авторлар туралы мәліметтер
Информация об авторах
Information about authors

Махиев Бекболат Еспулович – «Құрылыстағы BIM-жобалау» ғылыми-өндірістік орталығының жетекші ғылыми қызметкері, Д. Серікбаев атындағы Шығыс Қазақстан техникалық университеті, Өскемен, Қазақстан

Махиев Бекболат Еспулович – ведущий научный сотрудник научно-производственного «BIM-проектирование в строительстве», Восточно-Казахстанский технический университет имени Д.Серикбаева, Усть-Каменогорск, Казахстан

Makhiyev Bekbolat – Senior Researcher at the Scientific and Production Centre for BIM Design in Construction, D. Serikbayev East Kazakhstan, Technical University, Ust-Kamenogorsk, Kazakhstan

E- mail: bmahiev@ektu.kz

ORCID: https://orcid.org/0000-0001-7345-3930

Хапин Александр Владимирович – «Құрылыстағы BIM-жобалау» ғылыми-өндірістік орталығының басшысы, *Д*. Серікбаев атындағы Шығыс Қазақстан техникалық университеті, Өскемен, Қазақстан,
E-mail: ahapin@ektu.kz
Хапин Александр Владимирович – Руководитель научно-производственного центра «BIM-проектирование в строительстве», Восточно-Казахстанский технический университет имени *Д*. Серикбаева, Усть-Каменогорск, Казахстан
Khapin Alexandr - Head of the Scientific and Production Center for BIM design in Construction, D. Serikbayev East Kazakhstan Technical University, Ust-Kamenogorsk, Kazakhstan.
E-mail: ahapin@ektu.kze-mail
ORCID: https://orcid.org/0000-0002-3693-9277

Талапов Владимир Васильевич – Новосибирск мемлекеттік сәулет-құрылыс университетінің ақпараттық жүйелер және технологиялар кафедрасының доценті, Новосибирск, Ресей Федерациясы.
Талапов Владимир Васильевич – доцент кафедры информационных систем и технологий Новосибирского государственного архитектурно-строительного университета, Новосибирск, Российская Федерация.
Talapov Vladimir – Associate Professor, Department of Information Systems and Technologies, Novosibirsk State University of Architecture and Civil Engineering, Novosibirsk, Russian Federation.
E-mail: talapoff@yandex.ru

Monica Kulisz – *Люблин* технологиялық университетінің басқару факультеті кәсіпорындарды ұйымдастыру кафедрасының доценті, *Люблин қ*., Польша**.**
Monica Kulisz – доцент кафедры организации предприятий факультета управления *Люблинского* технологического университета, г. *Люблин*, Польша
Monica Kulisz – Associate Professor, Department of Business Organization, Faculty of Management, Lublin University of Technology, Lublin, Poland
E-mail: m.kulisz@pollub.pl
ORCID: https://orcid.org/0000-0002-8111-2316

Каменских *Лариса* Валентиновна – сәулет және құрылыс мектебінің оқытушысы, *Д*. Серікбаев атындағы Шығыс Қазақстан техникалық университеті, Өскемен қ., Қазақстан
Каменских *Лариса* Валентиновна – преподаватель школы архитектуры, строительства и энергетики, Восточно-Казахстанский технический университет имени *Д*. Серикбаева, г. Усть-Каменогорск, Казахстан
Kamenskikh Larisa – lecturer of the School of Architecture, Civil Engineering and Energy, D. Serikbayev East Kazakhstan Technical University, Ust-Kamenogorsk, Kazakhstan
E-mail: lkamenskih@ektu.kz
ORCID: https://orcid.org/0009-0001-1304-1579