11 Lucas, H. C., Agarwal, R., Clemons, E. K., El Sawy, O. A., & Weber, B. (2013). Impactful research on transformational information technology: An opportunity to inform new audiences. Mis Quarterly, 37(2), 371–382. doi:10.25300/MISQ/2013/37.2.03.

12 Liu, H., Lobschat, L., Verhoef, P. C., & Zhao, H. (2019). App adoption: The effect on purchasing of customers who have used a mobile website previously. Journal of Interactive Marketing, 47(August), 16–34.

13 Neslin, S. A., & Shankar, V. (2009). Key issues in multichannel customer management: Current knowledge and future directions. Journal of Interactive Marketing, 23(1), 70–81. https://doi.org/10.1016/j.intmar.2008.10.005.

14 Verhoef, P. C., Kannan, P. K., & Inman, J. (2015). From multi-channel retailing to omni-channel retailing: Introduction to the special issue on multi-channel retailing. Journal of Retailing, 91(2), 174–181. https://doi.org/10.1016/j.jretai.2015.02.005.

15 Andrews, M., Goehring, J., Hui, S., Pancras, J., & Thornswood, L. (2016). Mobile promotions: A framework and research priorities. Journal of Interactive Marketing, 34, 15–24. https://doi.org/10.1016/j.intmar.2016.03.004.

16 Kannan, P. K., & Li, H. A. (2017). Digital marketing: A framework, review and research agenda. International Journal of Research in Marketing, 34(1), 22–45. https://doi. org/10.1016/j.ijresmar.2016.11.006.

17 Lamberton, C., & Stephen, A. T. (2016). A thematic exploration of digital, social media, and mobile marketing: Research evolution from 2000 to 2015 and an agenda for future inquiry. Journal of Marketing, 80(6), 146–172. https://doi.org/10.1080/15332969.2017.1394026.

18 Sorescu, A., Frambach, R. T., Singh, J., Rangaswamy, A., & Bridges, C. (2021). Innovations in retail business models. Journal of Retailing, 87(1), S3–S16. https://doi.org/10.1016/j.jretai.2021.04.005.

19 Verhoef, P. C., Broekhuizen, T. L. J., Bart, Y., Bhattarcharya, A., Dong, J. Q., Fabian, N. E., & Haenlein, M. (2019). Digital transformation: a multidisciplinary reflection and research agenda. J. Bus. Res. (in press).

20 Panfilova E. E. Digital Business Transformation: Trends and Models // Moscow Economic Journal. - 2019. - № 11. - С. 312-319. DOI:10.24411/2413-046X-2019-10127.

21 Stebluk I. Yu. Business processes in the conditions of digital transformation // Economics and Business: Theory and Practice. - 2019. - № 3(2). - С. 113-116.

22 Slugin O. V., Belentyeva T. N. Analysis of the impact of digital business transformation on the change in the business model of the company // Karelian Scientific Journal. - 2019. - № 4 (29). - С. 104-107.

БЛАГОДАРНОСТЬ

Эта публикация является результатом реализации проекта Erasmus+ «Передовой центр для докторантов и молодых исследователей в области информатики» (ACeSYRI), регистрационный номер 610166-EPP-1-2019-1-SK-EPPKA2-CBHE-JP.

UDK 004:725
IRSTI 67.23.15

Begeyev R. N., student, https://orcid.org/ https://0009-0002-8580-3891
NJSC «Zhangir Khan West Kazakhstan Agrarian-Technical University», Uralsk, st. Zhangir khan 51, 090009, Kazakhstan, begeev.rustrem@mail.ru
Sultanova Z.H, Associate Professor, https://orcid.org/0000-0003-3662-5267
NJSC «Zhangir Khan West Kazakhstan Agrarian-Technical University», Uralsk, st. Zhangir khan 51, 090009, Kazakhstan, zamzagulsultan267@gmail.com
Jan Rabcan, professor, https://orcid.org/0000-0003-2835-9114
University of Zilina, Zilina, Univerzitná 8215/1, 010 26, Slovakia, jan.rabcan@fri.uniza.sk

THE IMPORTANCE OF BIM TECHNOLOGIES IN THE TRAINING OF CIVIL ENGINEERS

ANNOTATION

This article will discuss the integration of Building Information Modeling (BIM) technologies into university programs. BIM has become a standard tool in the architecture, engineering, and construction (AEC) industry, and integrating it into university curricula can provide students with practical and real-world experience. The article will begin by defining BIM and explaining its importance in the AEC industry. It will then discuss the importance of integrating BIM technologies into university programs and the challenges that universities face in doing so. The article will also provide examples of best practices for integrating BIM technologies into university programs and highlight the importance of collaboration and partnerships with industry professionals and BIM software providers. Additionally, the article will explore the benefits that students, educators, and the industry can gain from the integration of BIM technologies in university programs and provide examples of how BIM integration has improved the learning outcomes of students and prepared them for their future careers. Overall, the article will emphasize the importance of integrating BIM technologies into university programs and encourage universities to consider this integration in their curricula.

Key words: *BIM, AEC industry, technology, university curriculum, integration, experience, skills, software, real-world, collaboration, discipline.*

Introduction. Building Information Modeling (BIM) is an intelligent 3D modeling process that enables the creation and management of digital representations of buildings and other structures throughout their entire life cycle. BIM technologies provide a collaborative platform for architects, engineers, contractors, and owners to visualize, simulate, and analyze the performance of a building before construction begins. BIM incorporates multiple dimensions, including time and cost, in addition to the physical model, making it a powerful tool for planning, designing, constructing, and operating buildings[1].

In recent years, BIM has become an increasingly popular tool in the Architecture, Engineering, and Construction (AEC) industry, as it offers significant benefits to the project stakeholders. BIM technologies allow stakeholders to work collaboratively, reduce errors, improve project delivery, and increase productivity. In addition, BIM provides accurate and up-to-date information about the building throughout its entire lifecycle, enabling efficient maintenance, renovation, and demolition [1,2].

BIM technologies also help stakeholders to reduce waste and optimize the use of resources, leading to environmental sustainability. By creating a digital model of the building, stakeholders can analyze the building's energy consumption, water usage, and waste production, and identify opportunities for improvement. In addition, BIM technologies can be used to optimize the use of renewable energy sources and reduce the carbon footprint of buildings [1,2].

The importance of BIM in the AEC industry is evident from the growing adoption of BIM technologies by organizations worldwide. According to a survey by the National Institute of Building Sciences [3], 71% of owners, 74% of architects, and 84% of contractors are using BIM technologies in their projects [3]. In addition, many countries have implemented BIM mandates and regulations to ensure the adoption of BIM technologies in public construction projects[2].

BIM is a powerful and increasingly important tool in the AEC industry. Its collaborative, multidimensional, and data-driven approach enables stakeholders to improve project delivery, reduce waste, optimize resources, and promote sustainability. As the adoption of BIM technologies continues to grow, it is crucial for organizations to integrate BIM into their workflows and invest in BIM training and education to prepare the next generation of AEC professionals [1,2].

Materials and research methods. The integration of Building Information Modeling (BIM) technologies into university programs is becoming increasingly important due to the rapid evolution of the architecture, engineering, and construction (AEC) industry. According to several studies, the use

of BIM technologies in the AEC industry is significantly enhancing the quality of construction projects, reducing project costs, improving collaboration among project stakeholders, and increasing the efficiency of project delivery [4,7,8].

Furthermore, BIM technologies are also playing a critical role in facilitating sustainability in the AEC industry, as they provide a platform for the analysis of a building's energy efficiency, carbon footprint, and environmental impact [5]. The integration of BIM technologies into university programs can, therefore, help produce professionals who are well-equipped to deliver sustainable and energy-efficient buildings.

Moreover, the incorporation of BIM technologies into university programs can enhance the quality of education in the AEC industry. For instance, it can provide students with hands-on experience in project management, data analysis, and collaboration, which are essential skills in the industry [6]. The use of BIM technologies can also help prepare students for the challenges of the evolving AEC industry, as they are becoming increasingly essential in modern construction projects [4].

BIM can enhance the learning experience of students by providing them with practical and real-world experience in the architecture, engineering, and construction (AEC) industry. Through the use of BIM, students can learn to work collaboratively on interdisciplinary projects, develop their problem-solving and critical thinking skills, and gain experience with modern software and technologies that are widely used in the AEC industry.

One example of how BIM can enhance the learning experience is by providing students with the opportunity to work on real-world projects. This can help them to understand the complexities of project management, coordination, and collaboration within interdisciplinary teams. Additionally, BIM can enable students to visualize and analyze projects in a virtual environment, helping them to develop their spatial thinking and design skills.

In a study conducted by Abdellatif et al. . [9], it was found that the integration of BIM into the architecture curriculum helped students to develop their design thinking skills and improved their ability to understand complex systems. Similarly, in a study by Alshawi et al. [10], it was found that the integration of BIM into construction management courses helped students to develop their problem-solving skills and improve their understanding of project management processes.

Furthermore, BIM can also help students to stay up-to-date with modern technologies and tools that are used in the AEC industry. By learning how to use BIM software, students can gain experience with industry-standard tools and technologies, making them more competitive in the job market.

Examples of current practices of integrating BIM technologies into university programs include:

1 Incorporating BIM courses into the curriculum: Universities around the world have started to offer BIM courses as part of their civil engineering, architecture, and construction management programs. These courses teach students how to use BIM software, manage data, and collaborate with team members, among other skills. For example, the National University of Singapore offers a BIM course that covers the basics of BIM as well as advanced topics such as 4D and 5D BIM [11].

2 Hands-on training: In addition to traditional classroom lectures, universities are

incorporating hands-on training opportunities for students to apply their BIM knowledge. This can include lab exercises and design projects where students work with BIM software to create 3D models of buildings and structures. For example, at the University of Houston, students in the Construction Management program are required to complete a capstone project that involves using BIM software to create a detailed construction plan [12].

Despite the benefits of integrating BIM technologies into university programs, there are several challenges that universities face when doing so. Some of these challenges include:

1 Lack of qualified instructors: As BIM is a relatively new technology, there is a

shortage of qualified instructors who are knowledgeable in BIM software and practices. This can make it difficult for universities to offer BIM courses and hands-on training opportunities [14].

2 Limited access to BIM software: BIM software can be expensive, and many

universities may not have the budget to purchase licenses for all their students. This can limit the ability of students to gain hands-on experience with BIM software [13] .

3 Resistance to change: Some faculty members and industry professionals may resist the integration of BIM technologies into university programs due to a lack of understanding or skepticism about its effectiveness [12].

Examples of best practices for integrating BIM technologies into university programs include:

1 Integration of BIM disciplines into the curriculum: Several universities have integrated BIM disciplines into their curriculum to train students in BIM technologies. For example, the University of Southern California offers a course called "Building Information Modeling in Architecture, Engineering, and Construction" that focuses on BIM tools and their application in the AEC industry.

2 Collaborative projects with industry partners: Collaboration with industry partners helps students to gain real-world experience and work on live projects. For instance, the University of Cambridge collaborated with Balfour Beatty, a UK-based construction company, on a project to develop BIM tools for infrastructure projects.

3 Incorporating BIM tools into design studios: Incorporating BIM tools into design studios can help students to apply BIM concepts and techniques to their design projects. The University of Kansas integrated BIM tools into their design studio curriculum to teach students how to use BIM tools in real-world design scenarios.

The importance of collaboration and partnerships with industry professionals and BIM software providers is critical to ensure successful integration of BIM technologies into university curricula. Industry professionals bring their practical experience and expertise in the application of BIM technologies, which helps universities to design relevant and effective courses. BIM software providers also play a crucial role in the integration process, as they provide access to the latest BIM tools and technologies, training materials, and technical support.

According to a study by Al-Hussein and AbouRizk [15], collaboration with industry partners and BIM software providers is crucial for successful integration of BIM technologies into university programs. The study found that collaboration with industry partners provides students with opportunities to work on real-world projects, learn about industry standards, and gain practical experience. The study also highlighted the importance of partnerships with BIM software providers, as they provide universities with access to the latest BIM tools and technologies, which can be used to design relevant and effective courses.

Overall, collaboration with industry professionals and BIM software providers is crucial for successful integration of BIM technologies into university curricula, as it provides students with practical experience and access to the latest BIM tools and technologies.

The integration of Building Information Modeling (BIM) technologies into university programs has numerous benefits for students, educators, and the industry as a whole. Firstly, students can gain practical and hands-on experience with BIM tools, making them more attractive to potential employers upon graduation. Secondly, educators can provide a more comprehensive and modern education to their students, which can improve student satisfaction and learning outcomes. Finally, the industry can benefit from having a more skilled and knowledgeable workforce that is better equipped to use BIM technologies in practice.

One example of the benefits of BIM integration can be seen in a study conducted by Ahmed et al. [16], where students who were exposed to BIM technologies in their coursework reported a significant improvement in their technical skills, problem-solving abilities, and communication skills. In another study, researchers found that integrating BIM technologies into university programs can improve student engagement and participation in coursework, leading to better learning outcomes [19].

Additionally, BIM integration can also help prepare students for their future careers. For example, a case study by Fong et al. [17] showed that students who were exposed to BIM technologies during their university studies were better prepared to use these tools in the workplace, which ultimately led to improved project outcomes and increased efficiency.

To ensure successful BIM integration, collaboration and partnerships with industry professionals and BIM software providers are essential. In a study by Giel et al.[18], it was found that industry partnerships can help universities to access the latest BIM technologies and provide students

with real-world project experience. Similarly, partnerships with BIM software providers can help universities to ensure that their coursework is up-to-date with the latest software and industry standards.

In conclusion, the integration of BIM technologies in university programs can provide numerous benefits for students, educators, and the industry. By providing practical experience with BIM tools, improving learning outcomes, and preparing students for their future careers, universities can help to ensure that the next generation of professionals in the industry is skilled and knowledgeable in the use of BIM technologies. However, to ensure successful integration, collaboration and partnerships with industry professionals and BIM software providers are crucial.

Building Information Modeling (BIM) is a rapidly developing field in the construction industry, and Kazakhstan is not an exception. According to the report published by the Kazakhstan BIM Association [21], the implementation of BIM in the country is still in the early stages. However, the construction industry in Kazakhstan is gradually adopting BIM technologies due to its numerous benefits.

The Kazakh government has shown support for the implementation of BIM by introducing a law that requires the use of BIM in public construction projects starting in 2021 [21]. This move is expected to encourage more companies to adopt BIM and improve the quality of construction projects in the country.

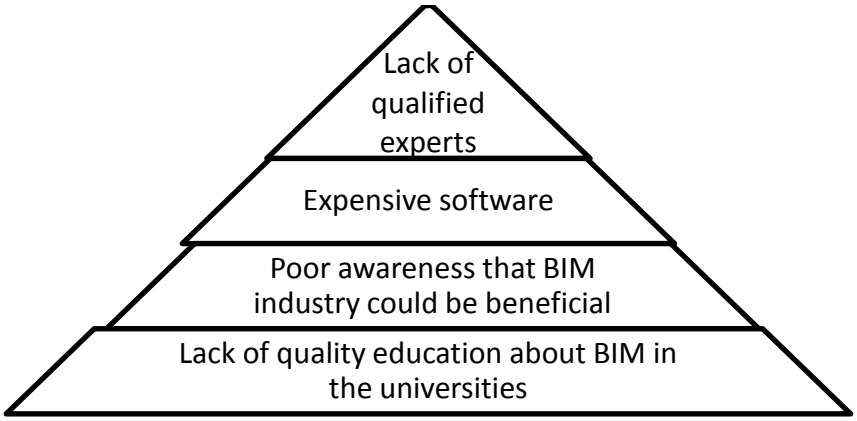

Diagram 1 – Obstacles that Kazakhstan faces in terms of integration of BIM industry

Despite the government's efforts, the adoption of BIM in Kazakhstan is still facing some challenges. One of the major challenges is the lack of awareness and education about BIM among industry professionals and stakeholders [21]. There is a need for more training programs and workshops to help raise awareness and educate stakeholders about the benefits and use of BIM in the construction industry.

Another challenge is the high cost of BIM software and hardware, which can be a barrier for smaller companies and individuals [20]. However, the increasing demand for BIM in the industry is expected to drive down the cost of BIM software and hardware over time.

Results and its discussion. One potential solution to integrating a design agency into Kazakhstan universities to promote students' knowledge in the BIM industry is by creating a project agency that will function based on the university. This project agency can be formed in collaboration with the industry partners, as they can provide the necessary resources and expertise to the agency. The agency can fulfill university design orders and involve students to work on them, providing them with practical experience in the field of BIM.

The agency can also include BIM disciplines into the university curriculum, ensuring that students have access to the latest BIM tools and technologies. This can be done by creating three levels for students depending on their current level of expertise in BIM. The first level can be an introduction to BIM, while the second level can focus on advanced BIM applications. The third level can be a capstone project, where students can apply their knowledge to real-world problems.

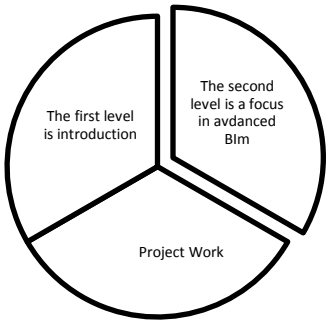

Diagram 2 – Three possible steps for students in developing their skills of BIM

To ensure effective learning, the educational material can be taught by designers who have practical experience in BIM. These designers can provide students with relevant examples and case studies, enabling them to understand the practical applications of BIM in the industry.

This solution can promote students' knowledge in the BIM industry and prepare them for their future careers. The project agency structure will allow students to work on real-world projects and gain practical experience, while the inclusion of BIM disciplines in the university curriculum can provide students with essential knowledge and skills. Collaborating with industry partners and involving experienced designers can ensure that the educational material is relevant and up-to-date with industry standards.

REFERENCES

1 Autodesk. (n.d.). What is BIM? Retrieved from https://www.autodesk.com/solutions/bim/overview

2 Chartered Institute of Building (CIOB). (2014). Understanding BIM: An Introduction to Building Information Modelling. Chartered Institute of Building.

3 National Institute of Building Sciences (NIBS). (2017). The National BIM Report 2017. Retrieved from https://nibs.org/nationalbimreport2017/

4 Azhar, S., Khalfan, M., Maqsood, T., & El-Hamalawi, A. (2012). Building information modelling (BIM): now and beyond. Construction Economics and Building, 12(4), 15-28.

5 Dhillon, B. S., Singh, V., & Arora, D. (2015). Building information modelling for sustainable building design: Review and case study. Journal of Cleaner Production, 107, 453-463.

6 Eastman, C. M., Teicholz, P., Sacks, R., & Liston, K. (2008). BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors. John Wiley & Sons.

7 Tse, T. H., Wong, K. D., Wong, K. W., & Wong, K. L. (2015). A study of the adoption of building information modeling (BIM) in Hong Kong's construction industry. Journal of Civil Engineering and Management, 21(5), 545-553.

8 Zhao, D., Li, H., Wong, K. D., & Tse, T. H. (2017). The impact of building information modeling (BIM) on construction performance. Automation in Construction, 75, 145-156.

9 Abdellatif, A., Kassem, M., & Amin, M. (2019). Integrating BIM in the architecture curriculum: Assessing students' perception. Journal of Information Technology in Construction, 24, 292-304.

10 Alshawi, M., Underwood, J., & Ismail, S. (2014). Building information modelling (BIM): A review of the literature. Procedia Engineering, 85, 478-486.

11 Hammad, A., El-Diraby, T., & Ahmed, M. (2021). A comprehensive building information modelling course for civil engineering students. Journal of Professional Issues in Engineering Education and Practice, 147(1), 04020022.

12 Jafari, A., Sheikhahmadi, A., & Esmaeili, B. (2020). Incorporation of BIM education in construction management curriculum: A case study. International Journal of Construction Education and Research, 16(4), 319-331.

13 Jalaei, F., & Zhang, X. (2019). Building information modeling education: status and challenges. International Journal of Construction Education and Research, 15(3), 186-203.

14 Mohamed, A., Tawil, N. M., Hamid, Z. A., & Haron, H. (2021). Barriers and enablers to implementing building information modeling (BIM) education in higher education institutions in

Malaysia. Journal of Engineering, Design and Technology. Advance online publication. https://doi.org/10.1108/JEDT-06-2020-0181

15 Al-Hussein, M., & AbouRizk, S. (2013). Integrating building information modeling (BIM) into construction engineering and management curriculum. Journal of Information Technology in Construction (ITcon), 18, 221-241.

16 Ahmed, Z., Muhammad, S., Sharif, A., & Aslam, A. (2017). The impact of Building Information Modelling (BIM) on construction industry. Journal of Engineering, Design, and Technology, 15(3), 340-352.

17 Fong, P. S. W., Wong, M. C. L., Wong, Y. W., & Leung, C. W. (2019). Implementing building information modelling education in construction-related programmes of higher education institutions. Journal of Professional Issues in Engineering Education and Practice, 145(1), 05018008.

18 Giel, B., Ghaffarianhoseini, A., Osman, M. T., & Oyedele, L. O. (2020). A comprehensive review on the integration of building information modelling (BIM) and construction project management. Journal of Building Engineering, 32, 101837.

19 Gope, N., Banerjee, A., Dutta, R., & Chakraborty, S. (2020). A study on the effectiveness of Building Information Modelling (BIM) tools in engineering education. Journal of Mechanical Engineering Research and Developments, 43(2), 62-72.

20 Baitelova, A., Kazhikenova, E., Saparova, A., & Nysanbayeva, G. (2020). Implementation of BIM technology in Kazakhstan: Challenges and prospects. Journal of Physics: Conference Series, 1565(5), 052031.

21 Kazakhstan BIM Association. (2019). BIM implementation in Kazakhstan: Status quo and perspectives. Retrieved from https://www.buildingsmart.org/wp-content/uploads/2019/11/BIM-implementation-in-Kazakhstan_EN.pdf

ТҮЙІН

Бұл ғылыми мақала ғимараттарды ақпараттық модельдеу технологияларын (BIM) университет бағдарламаларына енгізуді зерттейді және және BIM бағдарламалық қамтамасыз ету сала мамандарымен ынтымақтастық пен серіктестіктің маңыздылығын көрсетеді. Мақалада BIM технологияларын университет бағдарламаларына енгізудің ең жақсы тәжірибелерінің мысалдары келтірілген және студенттер, оқытушылар құрамы осы сала интеграциясынан алатын артықшылықтарды зерттейді. Мақалада келтірілген ықтимал шешімдердің бірі-университеттің базасында жұмыс істей алатын, университеттің дизайн тапсырыстарын орындай алатын және студенттерді BIM-ге практикалық тәжірибе бере отырып, нақты жобаларға тарта алатын жобалау агенттігін құру. Бұл шешім BIM индустриясындағы студенттердің білімін кеңейтуге және оларды болашақ мансапқа дайындауға ықпал етуі мүмкін, ал BIM пәндерін университеттің оқу бағдарламасына қосу студенттерге қажетті білім мен дағдыларды қамтамасыз ете алады. Тұтастай алғанда, мақала BIM технологияларын университет бағдарламаларына біріктірудің маңыздылығын көрсетеді және университеттерді өздерінің оқу жоспарларында осындай интеграцияны қарастыруға шақырады, өйткені бұл студенттердің оқу нәтижелерін жақсартып, оларды AEC индустриясының талаптарына дайындай алады.

АЛҒЫС

Бұл жарияланым Erasmus+ ACeSYRI «Компьютерлік ғылымдар саласындағы докторанттар мен жас зерттеушілерге арналған озық орталық» жобасын іске асыру нәтижесі, тіркеу нөмірі 610166-EPP-1-2019-1-SK-EPPKA2-CBHE-JP.

ӘОЖ 004.896
ҒТАХР 28.23.29

Бекенова А.С., техника ғылымының магистрі, https://orcid.org/0000-0002 -2010-1488
«Жәңгір хан атындағы Батыс Қазақстан аграрлық-техникалық университеті» КеАҚ, Жәңгір хан көшесі, 51, Орал қ., 090009, Қазақстан, inabat.77@mail.ru
Бекенова С.С., техника ғылымының магистрі, https://orcid.org/0000-0001-7707-5623
«Жәңгір хан атындағы Батыс Қазақстан аграрлық – техникалық университеті» КеАҚ, Орал қаласы, Жәңгір хан 51, Қазақстан, sandu79@mail.ru