ABSTRACT

of the dissertation for the degree of Doctor of Philosophy (PhD) in the educational program 6D042000 – «Architecture» by Nabiyev Abdulhalyk Sadykhozhaevich on the topic « The phenomenon of digital culture in architectural form shaping»

Currently, digitalization has firmly entered all spheres of modern life. The main role of digital culture in architectural form shaping lies not only in facilitating the creation of architectural projects within the shortest possible timeframes but also in supporting architects in mastering a new form-making paradigm without creating a 'digital' dependency. The dissertation is dedicated to exploring the main directions and features of this process.

The relevance of the research topic is determined by the strategic task of transitioning to an innovative development path in accordance with the "Digital Kazakhstan" program and the urgent need to implement digital technologies in architectural and construction design [1],[2],[3],[4].

The issue of form-making in architecture remains one of the key tasks in the sign-symbolic space, closely related to the generation of form. In the modern world, various spheres of human activity intensively interact with diverse types of digital technologies. In architectural morphogenesis, which closely interacts with virtual images, any shifts related to digital features to some extent transform not only the surrounding world but also human consciousness itself.

Digital culture is a term that denotes new forms of culture and social interaction that have emerged due to the development of digital technologies and the internet. This phenomenon is closely linked to technological changes in society and culture, affecting not only individuals' lifestyles but also nearly all aspects of modern society, from education and economics to art and science. By adapting to new technological and sociocultural realities, this phenomenon becomes a driving force in digitalization, integrating technologies into cultural, labor, and domestic processes. In architecture, it acts as a catalyst, stimulating the emergence and development of new digital approaches to architectural creativity, thus significantly influencing architectural practice and expanding horizons for innovation and creative approaches to form shaping.

In the context of architecture and form shaping, "Digital Culture" opens new horizons and provides architects with modern tools and methods for creating architectural projects. This includes the use of digital technologies and processes in the design and construction of buildings, such as computer modeling and

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[1] Стратегия «Казахстан-2050. Государственная программа «Цифровой Казахстан». «Умные» города. Постановление Правительства Республики Казахстан от 12 декабря 2017 года № 827. https://www.akorda.kz/ru/official_documents/strategies_and_programs 23.09.2019.

[2] Государственная программа. «Цифровой Казахстан». https://egov.kz/cms/ru/digital-kazakhstan 23.09.2019.

[3] Об утверждении Государственной программы «Цифровой Казахстан». https://adilet.zan.kz/rus/docs/P1700000827 25.08.2019.

[4] Международный Инновационный Форум «Цифровой Казахстан: BIM технологии в архитектуре и строительстве». https://www.normy.kz/index.php/novosti/15-novosti/324-i-mezhdunarodnyj-innovatsionnyj-forum-tsifrovoj-kazakhstan-bim-tekhnologii-v-arkhitekture-i-stroitelstve 23.08.2019.

visualization, as well as more complex processes like augmented reality, virtual reality, 3D printing, artificial intelligence, and algorithmic design.

Overall, the topic under study is relevant and significant for architectural science and practice, as it reflects the transition to a new understanding and use of space and form in the era of digitalization. Digital culture not only transforms our lives but also impacts the physical space around us, including architecture and the urban environment. It offers new approaches to the design, construction, and operation of buildings and structures, which will contribute to a more efficient, innovative, and sustainable appearance of our cities. Moreover, digital culture raises questions about the role of the architect in modern society, the interaction between people and buildings, and the social and cultural significance of architecture. Exploring these issues can help architects better understand the opportunities and respond to the challenges of the digital age.

Thus, the study of the formation of the phenomenon of digital culture within a systematic approach defines the goal and objectives of this dissertation research, making it relevant and practically significant. This is the timeliness of the present dissertation, "The Phenomenon of Digital Culture in Architectural Form Shaping," the results of which will reflect advancements in the field of architectural science, practice, and education in the context of the spread of digital technologies in society.

The key concepts of the dissertation are the terms "digital culture" and "digital form shaping" in architectural form creation. The author analyzes these aspects from both theoretical and technological perspectives.

The object of research is digital culture in architectural form shaping.

The subject of the research is the interrelationship and mutual influence of digital culture and architectural form shaping, as well as the analysis and evaluation of various tools and methods, such as computer modeling, algorithmic design, virtual and augmented reality, and their impact on the process of creating architectural forms.

The aim of the research is to identify the influence of digital culture on architectural form shaping, analyze modern architectural design methods based on digital technologies, and determine prospects and opportunities for creating innovative architecture in Kazakhstan.

Research objectives:

- To study and analyze the evolution of digital culture in architecture and identify the key elements and aspects of digital culture that influence architectural form shaping;
- To identify the main mechanisms and factors of the development of digital technologies that affect architectural form shaping;
- To determine global trends and the interaction of digital culture in architectural form shaping;
- To analyze modern architectural design methods based on computer modeling;
- To analyze the prospects of architectural form shaping in the context of the strategy for the development of digital culture in Kazakhstan;

- To develop comprehensive theoretical models of the interaction between architecture and digital culture.

Degree of research. With the rapid development of digital technologies and their impact on various fields, architecture is also undergoing revolutionary changes. There are numerous studies on digital form shaping in architecture, which confirms its relevance. To gain a deeper understanding of this interrelationship, the following aspects have been considered:

Historical Overview of the Development of Digital Culture: To understand the interaction between current technological trends and society, the origins of digital culture were studied. Manuel Castells, who developed the concept of the "Network Society," revealed a new understanding of the dynamics of globalization and technological changes in society. His research is extensive and has had a significant impact on many disciplines. Jean Baudrillard, in his works on hyperreality and simulations, provided new insights into the relationships between reality, symbols, and society in the digital age. Lev Manovich, in "The Language of New Media," explored the principles and forms of digital cultural production and described the technologies transforming visual media. Yuval Noah Harari, in his insightful works, speculated on the impact of technology on the future of human evolution, the economy, and social structure. Donna Haraway, in "A Cyborg Manifesto," reflected on the merging of humans and machines, offering new perspectives on gender, identity, and technology. Nicholas Negroponte, who proposed the idea of moving from atoms to bits, became a driving force for innovation and research at the MIT Media Lab. Pierre Lévy viewed digital technologies as tools for collective intellectual activity, predicting a new era of social interaction and learning. Sherry Turkle analyzed the impact of digital technologies on personal and social relationships, especially in the context of emotional connections. Yelkina E.E. comprehensively examined the influence of social media on youth behavior, identifying new forms of communication and socialization. Charlie Gere focused on the intersection of digital art and technology, exploring how digital tools expand the boundaries of creativity.

Integration of Digital Technologies in Architectural Projects: To understand the impact of computer technologies, the works of authors whose research has directly influenced modern architectural design were studied:

Charles M. Eastman developed methodologies for automated design, providing a platform for integrating digital tools into the architectural process.

Patrik Schumacher, being one of the main theorists and practitioners, supports and applies parametric design, allowing for the creation of complex and adaptive architectural forms through algorithms.

Kas Oosterhuis explored "living" architecture, creating dynamic buildings that can respond to the environment through embedded digital systems. In his landmark publication "Hyperbodies: Towards an E-motive Architecture," he presents the concept of "e-motive architecture," describing architectural objects that

can adapt and respond to various external stimuli, creating an interactive and "living" architectural space.

Mark Burry advances research in digital fabrication, enabling architects to design buildings that can be quickly and accurately brought to reality. He argues that modern digital tools allow architects to rethink complex geometric structures and implement them in physical reality. He actively applied this approach in the Sagrada Familia project, using 3D modeling to interpret and realize Antoni Gaudí's ideas.

Mario Carpo discusses the transition from manual to computer design, analyzing how digital technologies change the very essence of the architectural process.

Greg Lynn applied computer modeling tools to develop nonlinear and organic forms in architecture. He emphasizes the importance of "smooth" and "continuous" forms in contemporary architecture, achieved through digital modeling, as opposed to the traditional "sharp" and "angular" forms of past eras. He argues that digital tools not only expand the possibilities of architectural design but also provide new ways of perceiving form, space, and material.

Achim Menges developed methods for integrating materials science into digital design, creating adaptive and sustainable architectural solutions. He explores how computers and digital technologies can work with natural materials and biological principles. He believes that such a collaborative approach helps create buildings that fit well into the environment.

Sina Mostafavi explores the application of artificial intelligence in architectural design, automating and optimizing the design process.

L.N. Avdotin made a breakthrough by proposing the first textbook of its kind, which highlights the use of computer technologies in architectural and urban design. He summarizes and systematizes the knowledge and experience of using computers, previously scattered in the practice of leading design organizations, thus emphasizing the transformation of traditional design methods under the influence of computing technology.

The issues of studying the phenomenon of digital culture as a factor of socio-cultural growth, in the context of digitalization and the development of artificial intelligence in architectural form shaping, were considered in the works of authors such as Evallyo V.D., Altunyan A.O., Barchugova E.V., Benze M., Braslavsky P.I., Vesnin A.A., Vilkovsky M., Volichenko O.V., Voronina T.P., Gavrilov A.A., Galanin R., Danilov D.S., Dedovets R.V., Demidova M.A., Jencks C., Dobritsyna I.A., Emelyanova O.I., Ivanov V.F., Ivanova A.S., Igumnova A.S., Isabayev G.A., Ishodzhanova G.R., Kavtaradze S., Kalinina E.E., Kalnitskaya E., Kobzeva I.A., Kolodiy V.V., Kondratiev E.A., Korsuntsev I.G., Krylov D.A., Arbel O., Lurie D.A., Luchkova V.I., Meerovich M.G., Mokshantseva O.A., Nadyrshin N.M., Nosov N.A., Orzunova O.E., Pomorov S.B., Repkin D., Rochegova N.A., Ryabova O.V., Savelieva L.V., Samoylov K.I., Saprykina N.A., Somov G.Yu., Stepanov A.V., Sterlikova A.I., Talapov V.V., Taratuta E.E., Takhir B.N.,

Abdrasilova G.S., Trambovetsky V., Khutornoy S.N., Chernichenko E.A., Agkathidis Ast., Aiello C., Andadari S. Tri, Angulo A., Ascott R., Baitenov E., Bhooshan S., Carlos L. Marcos, Chaillou S., Mokeeva O.D., Daniela B., Duffy Alex H.B., Efanova T.A., Engelbart D., Esaulov G.V., Feist S.T., Garcia M., Gero J.S., Hansmeyer M., Hauwa O.Y., Iwamoto Li, Grisaleña Ar. Jon, Kaiyang W., Knish V.I., Kolarevic B., Terzidis Ko., Krawczyk R.J., Lee J., Malakhov S.A., Maver T., Mikhailov S.M., Morel P., Moussavi F., Leach Ne., Milgram P., Raina A., Ramilo Ru., Roussou M., Stsesel S., Uhrík M., Werner Liss C., Volynskov V.E., Novikova A.N., Lapshina E.G., Saleh M.S., Asanovich A., Prokhorov S.A., Mamedov S.E., and other authors.

To analyze the current state and prospects of digital technologies in Kazakhstan, information portals on the Internet provide the most objective picture.

Based on the material studied on the dissertation topic, it can be seen that the development of digitalization and its influence on the form-shaping process in architecture have been the subject of many studies. However, the interaction of digital technologies with broader aspects of digital culture, including openness, collaboration, and network interaction, requires further exploration. Additionally, the question of how architecture can adapt to the changing needs and expectations of a digital society and how digital technologies can contribute to sustainability in architecture, along with the issue of architecture's dependence on modern technologies, remains open for further research.

Scientific novelty. Developed models of the interaction between digital culture and architectural form shaping, including the socio-cultural aspects of digitalization in architecture, to study the impact of digital technologies on architectural form shaping, where the models combine theoretical and practical approaches for analyzing modern architectural projects.

The reliability of the scientific results is confirmed by quantitative and qualitative analysis of the collected material, research of various digital sources, scientific-theoretical systematization of the obtained data, and graphical presentation.

Methodological basis of the research:

- comparative analysis of historical and contemporary examples of architecture to identify the influence of digital culture;
- synthesis of theories on the evolution of architectural form shaping and the context of digital culture;
- analysis of existing approaches to the impact of digital technologies on architectural form shaping;
- quantitative and qualitative analysis of data on the use of digital technologies in architecture;
- application of practical methods, including in-depth surveys of architects, theorists, researchers in digitalization, and experts using digital tools in their work.

- reflection on how digital culture changes approaches to architectural form shaping and how this may influence the future of architecture

The research methodology in this paper is a combination of several approaches. First, a theoretical analysis of specific examples of architectural projects where elements of digital culture are used is carried out in order to illustrate theoretical ideas and give an in-depth understanding of the issue. Then an interdisciplinary approach is applied that takes into account methodology from various fields of knowledge, including information and communication technologies, architecture and algorithmic design, which helps to identify the qualitative content of digital sources. Finally, a critical analysis of existing ideas, approaches and trends in the field of digital culture and architectural shaping is carried out in order to offer new perspectives and approaches in this area.

The hypothesis of the study is that digital culture has a significant impact on the process of architectural shaping, leading to its further evolution, while not excluding traditional approaches and methods, which stimulates the creation of new architectural forms and structures. This can be predicted through a detailed study of modern architectural trends, as well as through the development of new theoretical models and methods of architectural shaping based on the principles of digital culture.

The theoretical significance of the conducted research consists in generalizing knowledge on the influence of digital technologies on the process of architectural shaping and, on this basis, identifying the direction of development of this process. The results obtained can be used in the course of further study of this problem.

The practical significance of the dissertation can be reflected in the following aspects: in the development of new methods and approaches in the field of architectural shaping, which take into account the influence of digital culture; in the effective use of digital technologies, which in turn can lead to an improvement in the quality of architectural design; the results of the study can help theoretically comprehend and interpret modern trends in architecture related to digital culture; It can help teachers and students better understand the impact of digital culture on architecture and equip them with new approaches and execution techniques in this area; contribute to a deeper understanding by future researchers of social and cultural processes, the relationship between digital culture and architectural shaping taking place in our time, and lead to the creation of architecture that will better meet the needs of and the values of the modern information society.

Provisions, results submitted for protection:

- The influence of digital technologies on the evolution of architectural shaping;
- The role of digital culture in modern architectural design methods;
- global trends in the interaction of digital culture and

architecture;

- The contribution of digital technologies to the formation of architectural shaping;

- prospects for the influence of digital culture on the creation of innovative architecture in Kazakhstan.

The research methodology in this work represents a combination of several approaches. First, a theoretical analysis of specific examples of architectural projects where elements of digital culture are applied is conducted to illustrate theoretical ideas and provide an in-depth understanding of the issue. Then, an interdisciplinary approach is used, which takes into account methodologies from various fields of knowledge, including information and communication technologies, architecture, and algorithmic design, helping to identify the qualitative content of digital sources. Finally, a critical analysis of existing ideas, approaches, and trends in the field of digital culture and architectural form shaping is conducted to propose new perspectives and approaches in this area.

Research hypothesis. The hypothesis of the research is that digital culture has a significant impact on the process of architectural form shaping, leading to its further evolution, without excluding traditional approaches and methods, thereby stimulating the creation of new architectural forms and structures. This can be predicted through a detailed study of contemporary architectural trends and the development of new theoretical models based on the principles of digital culture.

Theoretical significance. The theoretical significance lies in the development of new theoretical models of the interaction between digital culture and architecture, providing further prospects for architectural science within the framework of digitalization.

Practical significance of the dissertation. The proposed new methods and approaches in the field of architectural form shaping, taking into account the influence of digital culture, allow for the improvement of the quality of architectural design. The results of the research include methods and approaches to interpreting contemporary trends in architecture related to digital culture, which provide educators and learners with a comprehensive understanding of the influence of digital culture on architecture. They also contribute to a deeper understanding by researchers of the social and cultural aspects, as well as the interrelationship between digital culture and architectural form shaping. All of this should lead to the creation of architecture that better meets the needs and values of contemporary information society.

Propositions and results submitted for defense:

– the impact of digital technologies on the evolution of architectural form shaping;

– the role of digital culture in modern architectural design methods;

– global trends in the interaction of digital culture and architecture;

– the contribution of digital technologies to the formation of architectural form

shaping;

– prospects for the influence of digital culture on the creation of innovative architecture in Kazakhstan.

Volume and structure of the research: The dissertation consists of an introduction, five sections, a conclusion, a list of references - 318 titles, and six appendices. The total volume of the dissertation is 192 pages, with the main text being 146 pages.

Keywords: digital culture, digital architecture, digital technologies in architecture, artificial intelligence, BIM technology, interdisciplinary approach, digital shaping, digital architecture of Kazakhstan.

MAIN CONTENT OF THE WORK

In the first section of the dissertation, the concept of digital culture is defined, and its influence on architectural form shaping is examined. The main characteristics of digital culture are described, such as historical prerequisites and the use of computer technologies, the internet, social networks, etc. The analysis focuses on how these technologies affect the design process and the creation of architectural objects, as well as the perception and evaluation of these objects by society.

Conclusions on the first section

1. The evolution of the influence of design technology on the creation of architectural imagery from a historical perspective has been analyzed. The timeline clearly shows the transition from the simplest tools to modern software and its impact on architectural form creation. Thus, each stage of technological progress influenced architectural forms, reflecting, among other things, the technological changes of the era.

2. The concept of "digital culture" in the context of architectural form shaping has been defined. The prerequisites of digital culture in architecture have been traced from the times of Pythagoras to the present day. Key moments in the beginning of the use of computer technologies in architecture, the birth and development of computer-aided design (CAD) systems have been highlighted. In this context, the history of the development of digital culture in architecture shows how technological progress affects this field and how architecture, in turn, influences the development of technologies.

3. The prerequisites and factors that contributed to the integration of digital culture into architectural form shaping have been analyzed. Changes in design in the context of the use of digital culture, especially in terms of technological innovations, have been noted.

In the second section, the "embedding" of digital culture into architectural form shaping is examined, along with the factors and mechanisms of this process that contribute to the creation of sustainable architecture.

Conclusions on the second section

1. The research identified key mechanisms and factors influencing the integration of digital technologies into architecture. Special attention was paid to socio-economic, cultural, and technological aspects. This helps to understand how the development of technologies, changes in public perception, and economic factors contribute to the adoption and adaptation of digital approaches in architecture.

2. By studying the obtained data, it can be asserted that the theoretical models developed effectively describe the mechanisms of digital form shaping in architecture. These models are based on contemporary methods such as algorithmic, parametric, and generative design, and they help to understand how digital tools and algorithms can contribute to the creation of innovative architectural forms.

3. The research showed that factors such as functional capabilities, methods, and processes in digital architecture play a key role in shaping the modern architectural landscape. Parametric modeling, algorithmic design, and BIM enable architects to work more efficiently, creating projects of a qualitatively higher level, meeting the modern requirements of sustainability and innovation.

In the third section, the influence of digital culture on architectural form shaping is examined, along with the analysis of the main trends and directions of the development of this process.

Conclusions on the third section

1. A comprehensive analysis of the impact of digital technologies on modern trends in architectural form shaping, including a detailed study of specific building examples, showed that digitalization opens new horizons in the design and planning of architectural spaces. The use of innovative tools such as 3D modeling and virtual reality allows for the creation of more complex and simultaneously functional forms, significantly enriching the architectural landscape.

2. Based on the analyzed data, it can be concluded that the key directions of digitalization in architecture and their influence on form shaping emphasize the importance of algorithmic and generative design. These approaches contribute to the creation of innovative and functionally justified architectural solutions, as demonstrated by examples of modern buildings with unique geometry and functional structure.

3. The research showed that the developed model describing the interaction between digital culture and architecture effectively illustrates the relationship between technological innovations and the evolution of architectural forms. This demonstrates how the integration of digital technologies facilitates the adaptation and growth of architectural art.

4. The created model, illustrating the influence of digital technologies on the stylistic and formal aspects of architecture, demonstrates the transition from traditional methods to innovative technological approaches. It reflects how innovations in artificial intelligence and machine learning lead to the emergence of new architectural styles and forms, enriching the architectural landscape and offering new opportunities for experimentation.

5. Based on the study of the problems and negative consequences of the application of digital technologies in architecture, important aspects related to sustainability, ethics, and technology accessibility have been identified. This underscores the need for a balance between innovation and the preservation of traditional architectural values, as well as highlights the potential risks and challenges that the architectural field may face.

In the fourth section, the possibilities of BIM and VR technologies are examined, through which experimental projects are created in virtual digital cyberspace, influencing the aesthetic worldview of architects and the design process as a whole. One of the main achievements is the ability to foresee results in the process of generating architectural forms. Since algorithmic and parametric methods in architectural form shaping are fundamental in form generation, they become the factors leading to the emergence of new aesthetic properties.

Conclusions of the Fourth Section

1. The relevance and importance of using computer programs in architectural design, including for creating complex architectural forms, have been identified. Modern programs such as Autodesk Revit, Rhino, and SketchUp allow architects to experiment with unconventional forms and structures, opening new horizons in architectural design.

2. Based on the analysis of collected data, it can be stated that the systematized main directions of digitalization in architecture and their influence on the form-shaping process enrich design practice with new methods and techniques. Special attention is given to algorithmic and generative design, which allow for the creation of innovative and functional architectural objects.

3. The developed concept of a software product for architects reflects the requirements and needs of modern architectural practice. This software product offers tools for optimizing design, project management, and client interaction, contributing to the increased efficiency and quality of architectural projects.

4. The research showed that the developed model describing the issues of BIM technology implementation in the industry highlights both its opportunities and challenges. BIM technology ensures improved collaboration among project participants but also presents challenges such as the need for training and adaptation of workflows.

5. The created model demonstrating the areas of application of VR technologies in architectural design reveals their role in enhancing development and visualization processes. VR technologies allow architects and clients to better understand and evaluate architectural projects, providing an immersive experience of interacting with virtual space.

6. Based on the provided information, the developed model identifies key difficulties and limitations associated with the use of virtual reality (VR) technologies. These challenges include the need for significant investments and resources for the development and implementation of VR projects. Additionally, potential issues related to user interface and perception of the virtual environment have been identified, which may hinder the effective use of these technologies.

7. Conducted surveys among practicing architects and experiments using Autodesk Revit to study form shaping (including work with students on projects such as Khan Shatyr and EXPO-2017) demonstrate the practical application of theoretical knowledge in architecture. These experiments showed how digital technologies can be integrated into practice and the educational process, providing the creation of new architectural forms and valuable experience for students in working with modern architectural tools. The results of these experiments are also documented in the act (Figure E.1, Appendix E).

In the fifth section, the possibilities of new digital approaches in design are examined, which give rise to new stylistic directions. In this regard, the prospects of artificial intelligence and its integration into architecture at all levels are extremely important. The challenges of this order, along with the hidden dangers, including in architecture, imply the need for flexible solutions, which is the vector of development for architecture under new conditions. Research in this area inevitably leads to the synthesis of "culture" and "technology" as a symbiosis capable of providing new value orientations. This is especially relevant in the context of modern Kazakhstan.

Conclusions of the fifth section

1. A model of Industry 4.0 possibilities in architecture has been created, highlighting their significant contribution to the digitalization and optimization of the construction industry. This model illustrates how new technologies, such as the Internet of Things and smart building materials, contribute to improving the efficiency of construction processes and project management.

2. Based on the results of the analysis, it becomes clear that the developed simplified scheme of the generative adversarial network illustrates its potential in architectural design. This scheme demonstrates how the use of artificial intelligence can contribute to the creation of innovative architectural forms and structures.

3. The research showed that experiments conducted on creating architectural forms and layouts using neural networks demonstrate their capabilities in design creation. These experiments show how neural networks can be used to generate and optimize architectural solutions.

4. The developed model describing the problems and challenges associated with the use of neural networks in architectural design highlights the need for a balanced approach to integrating this technology. The main difficulties include complexities in interpreting results, high costs for equipment and software, and the potential threat of job reduction in the industry.

5. Based on the above, it can be said that the analysis of the development of digital culture in architecture in Kazakhstan has identified key aspects and directions. The research emphasizes the importance of integrating new technologies to create sustainable and innovative architecture that meets modern needs and standards.

6. The created model of the impact of digital technologies on the architecture of Kazakhstan in the future represents an integral approach to assessing their effect. The model highlights how digitalization can contribute to the creation of smarter,

more sustainable, and functional architectural solutions that meet future needs in various regions of Kazakhstan.

7. The "Future Architecture of Kazakhstan" model reveals directions for integrating advanced technologies into architectural design, considering the natural-climatic, socio-economic, and cultural-historical features of the regions of Kazakhstan.

The results obtained can contribute to the promotion and development of digital architecture. They will also help practicing architects, educators, and students adapt to changing digital methods, enabling the creation of new, innovative forms and spaces, including in the architecture of Kazakhstan.

Conclusion

In the study of the phenomenon of digital culture in architectural form shaping, the following results were obtained:

1. The causes and factors that allowed digital culture to integrate into architectural form shaping from antiquity to the present have been identified. These changes have led to new approaches to design, materials, and interaction with the environment. Each stage of technological progress has resulted in changes to architectural forms, from the simplest tools to modern computer-aided design (CAD) systems, which significantly influence the creation of architectural images. This enables a more precise understanding of the historical dynamics of the development of architectural technologies and their impact on form shaping.

2. The key elements and aspects of digital culture that play a significant role in contemporary architectural design have been identified. Based on the analysis of the influence of digital technologies on the creation of architectural forms, a model has been developed that demonstrates their impact on the design process. The model encompasses algorithmic, parametric, and generative design, as well as includes technologies such as artificial intelligence, virtual reality, BIM, IoT, and additive technologies, which contribute to the creation of innovative and functionally justified architectural solutions.

3. The mechanisms and factors that facilitate the integration of digital technologies into architecture include socio-economic, cultural, and technological aspects that cover changes in public perception of technologies, economic factors affecting their accessibility, and cultural trends promoting the adoption of new working methods. A comprehensive online survey among researchers and users of architectural software has shown that the influence of digital culture on architectural form shaping requires a critical approach to the integration of digital technologies and highlights the importance of artificial intelligence, algorithmic, and generative design. It is important to maintain a balance between technologies and traditional architectural values to ensure social sustainability.

4. Practical experiments using Revit and 3DS Max software for architectural form shaping, based on examples of well-known buildings such as Khan-Shatyr and

EXPO-2017, have demonstrated high efficiency in studying and designing digital forms, allowing for more precise and efficient modeling of complex architectural forms. Based on these results, it is recommended to include various digital modeling methods in the mandatory curriculum of architectural faculties to provide students with practical experience in working with advanced design tools. To improve the use of digital technologies in architectural form shaping, including artificial intelligence, virtual reality, Industry 4.0, the Internet of Things (IoT), additive technologies, "smart" building materials, and neural networks, more active implementation is recommended. However, it should be taken into account that digitalization creates new challenges related to high costs, difficulties in interpreting results, and potential threats to jobs in the industry, which requires special attention in research.

5. Modern trends in digital form shaping have been systematized, and a model of the influence of innovative digital technologies on the formation of the future architecture of Kazakhstan has been developed, taking into account regional characteristics. The state program "Digital Kazakhstan" in the field of architecture should develop considering all the above factors and the dynamics of their development. It is important to take into account both global issues (ecology, energy efficiency, and energy saving) and regional characteristics. In this context, digital culture will be able to comprehensively contribute to the development of the future architecture of Kazakhstan.

List of publications

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