ABSTRACT

of the dissertation for the degree of Doctor of Philosophy (PhD) in specialty 6D042000 – «Architecture» by Abdulkhalyk Sadykhozhaevich Nabiev on the topic «The Phenomenon of Digital Culture in Architectural Morphogenesis»

Currently, digitalization has become firmly embedded in all spheres of modern life. The main role of digital culture in architectural shaping is not only to contribute to the creation of architectural projects in the shortest possible time, but also to support the architect in mastering a new formative paradigm, without creating a "digital" dependence. The dissertation is devoted to the study of 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 path of development according to the "Digital Kazakhstan" program and the urgent necessity to implement digital technologies in architectural and construction design.[1]

The problem of shaping in architecture remains one of the key tasks in the symbolic space and is closely related to the generation of form. In the modern world, various spheres of human activity intensively interact with various types of digital technologies. In architectural shaping, by definition, associated with virtual images, any shifts, especially those caused by digital specifics, to a certain extent change not only the world around them, but also human consciousness itself.

In the context of architectural shaping, Digital Culture opens up new horizons and provides architects with new tools and methods for creating and presenting architectural projects. This applies to the use of digital technologies and processes in the design and construction of buildings, including the use of computer modeling and visualization, as well as more complex processes such as augmented reality, virtual reality, 3D printing, artificial intelligence and algorithmic design.

Digital culture is a term denoting new forms of culture and social interaction that have arisen on the basis of the development of digital technologies and the Internet. This phenomenon is closely related to technological changes in society and culture, affecting lifestyle and almost all aspects of modern society: from education and economics to art and science. Dynamic and constantly adapting to new technological and socio-cultural realities, this phenomenon is becoming the driving force of digitalization, integrating technology into cultural, labor and everyday processes. In architecture, it acts as a catalyst, stimulating the emergence and development of new digital approaches to architectural creativity, thereby

[1] On the approval of the State Program "Digital Kazakhstan" https://adilet.zan.kz/rus/docs/P1700000827,
I International Innovation Forum "Digital Kazakhstan: BIM technologies in architecture and construction" https://www.normy.kz/index.php/novosti/15-novosti/324-i-mezhdunarodnyj-innovatsionnyj-forum-tsifrovoj-kazakhstan-bim-tekhnologii-v-arkhitekture-i-stroitelstve

significantly influencing the practice of architecture and expanding horizons for innovation and creative approach to the creation of artificial spaces.

In general, 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 influences the physical space around us, including architectural images in an 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 maintenance of our cities. Moreover, digital culture raises questions about the role of the architect in modern society, about the interaction between people and buildings, about the social and cultural significance of architecture. Exploring these issues can help architects better understand and respond to the emerging challenges of the era using the capabilities of digital culture.

Thus, the study of the phenomenon of digital culture within the framework of a systematic approach determines the purpose and objectives of this dissertation research, making it relevant and practically significant. This is the timeliness of this dissertation "The phenomenon of digital culture in architectural shaping", where its results will reflect the advancement 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 denoted by the terms "digital culture" and "digital morphogenesis" in architectural form-making. The author analyzes these aspects in terms of theoretical and technological components.

The object of research is digital culture in architectural shaping.

The subject of the research is the relationship and mutual influence of digital culture and architectural 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 shaping, to analyze modern methods of architectural design based on digital technologies, as well as to identify the prospects and opportunities of digital architecture for creating innovative architecture in Kazakhstan.

Research objectives:

- study and analysis of the evolution of digital culture in architecture and identification of key elements and aspects of digital culture that influence architectural shaping;
- identification of the main mechanisms and factors of the development of digital technologies that affect architectural shaping, and the development of comprehensive theoretical models of interaction between architecture and digital culture.
- defining global trends and the interaction of digital culture in architectural shaping.
- analysis of modern architectural design methods based on computer modeling.

- To formulate and substantiate conclusions about the influence of digital culture on architectural shaping.

- analysis of the prospects of architectural shaping in the context of the strategy for the development of digital culture in Kazakhstan.

The degree of study. In the context of rapidly developing digital technologies and their impact on various fields of activity, architecture is also undergoing revolutionary changes. For a deep understanding of this relationship, the following aspects were considered:

Historical overview of the development of digital culture – in order to understand the interaction of current trends in technology and society, the origins of the development of digital culture were studied, scientists such as Manuel Castels developed the concepts of a "Network Society", revealing a new understanding of the dynamics of globalization and technological changes in society. His research is extensive and has a huge impact on many disciplines.

Jean B., in his works on hyperreality and simulations, gave a new understanding of the relationship 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, as well as how technologies transform visual media. Yuval Noah Harari has traced how technology can affect the future of human evolution, economics, and social structure in his insightful works. Donna Haraway, in The Cyborg Manifesto, reflected on the fusion of man and machine, providing a new perspective on gender, identity and technology. Nicholas Negroponte, who put forward the idea of moving from atoms to bits, became the engine of innovation and research at the MIT Media Lab. Pierre Levy considered digital technologies as tools of collective intellectual activity, predicting a new era of social interaction and learning. Sherry Turkle has deeply analyzed how digital technologies affect personal and social relationships, especially in the context of emotional connections. Yelkina E.E. profoundly researched the influence of social media on the behavior of young people, identifying new forms of communication and socialization. Gere Ch focused on the intersection of digital art and technology, exploring how digital tools expand the boundaries of creativity.

Integration of digital technologies into architectural projects – to understand the impact of computer technology, the works of authors whose research directly influenced modern architectural design were studied: Charles M. Eastman, developed computer-aided design methodologies, providing a platform for integrating digital tools into the architectural process.

Patrick Schumacher, being one of the main theorists and practitioners, supports and applies parametric design, allowing you to create complex and adaptive architectural forms using algorithms. Kas Oosterhuis explored "living" architecture by creating dynamic buildings that can respond to the environment using embedded digital systems. In his research on digital architecture, he focused on the use of digital technologies to create dynamic, adaptable buildings. In his landmark

publication "Hyperbodies: Towards an E-motive Architecture", he presents the concept of "e-motive architecture", designating architectural objects capable of adapting and responding to various external stimuli, thereby creating an interactive and "living" architectural space. Mark Burry promotes research in the field of digital fabrication, allowing architects to design buildings that can then be quickly and accurately translated into 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 his work on the Sagrada Familia project, where 3D modeling was used to interpret and implement the ideas of Antoni Gaudi. Mario Carpo discusses the transition from manual to computer-aided design, analyzing how digital technologies are changing the very essence of the architectural process. The researcher emphasizes the transformation of traditional architectural design methods under the influence of computer technology. He examines how digital tools have influenced the conceptual foundations of design and brought changes to the practice of architectural creativity. In this context, Carpo points to the need for professionals to adapt to new technological realities, where building design is the result of a fusion of traditional architecture and digital innovation.

Greg Lynn used computer modeling tools to develop nonlinear and organic forms in architecture. The architect emphasizes the importance of "smooth" and "continuous" forms in modern architecture, achieved through digital modeling, in contrast to the traditional "sharp" and "broken" 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. His philosophy is based on the belief - in digital technologies - the potential to create environmentally sustainable and adaptive architectural structures. Achim Menges has developed methods for integrating materials science into digital design, creating adaptive and sustainable architectural solutions. The scientist examines how computers and digital technologies can work with natural materials and biological rules. In his opinion, such a collaborative approach helps to create buildings that fit well into the environment. Sina Mostafavi explores the application of artificial intelligence in architectural design, automating and optimizing the creation process.

L. N. Avdotyin made a breakthrough by offering the first textbook of its kind, which highlights the use of computer technology in architectural and urban planning design. In this book, he summarizes and systematizes the knowledge and experience of computer applications that were previously scattered in the practice of leading design organizations, thereby emphasizing the transformation of traditional design methods under the influence of computer technology. The author focuses on the importance of urban planning in the context of architectural specialization, raising the topic of wider implementation of mathematical methods and computers in this area. He argues that for the full implementation of these innovations, appropriate training of specialists and modernization of educational programs are necessary, although he retains the architect's creative uniqueness and intuitive vision. Also,

according to his concepts, it can be understood that the inclusion of more illustrative material will help to better convey to students the value of computer modeling in architecture.

The issues of studying the phenomenon of digital culture as a factor of socio-cultural growth, in the context of the prerequisites for digitalization and the development of artificial intelligence in architectural shaping were considered in the works of the authors: Ruzavin G. I., Krauss R., Averkin AN., Altunyan A.O., 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., Jenks C., Dobritsyna I.A., Dolgova A., Yemelyanova O.I., Ivanov V.F., Ivanova A.S., Igumnova A.S., Isabaev G.A., Izodzhanova G.R., Kavtaradze S., Kalinina E.E., Kalnitskaya E., Kobzeva I.A., Kolodiy V.V., Ramilo Ru., Kondratiev E.A., Korsuntsev I.G., Krylov D.A., Lapshina E.G., Lomholt I., Lurie D. A., Luchkova V.I., Meerovich M.G., Mokshantseva O.A., Nadyrshin N.M., Novikova A.N., Nosov N. A., Orzunova O.E., Pomorov S.B., Repkin D., Rochegova N.A., Ryabova O.V., Savelyeva L.V., Salekh M.S., Samoilov K. I., Saprykina N.A., Somov G.Yu., Stepanov A.V., Sterlikova A.I., Talapov V.V., Taratuta E. E., Takhirov B. N., Trambovetsky V., Khutoroi S.N., Chernichenko E.A., Agkathidis Ast., Aiello C., Andadari S. Tri, Angulo A., Ascott R., Baitenov E., Bhooshan S., Chaillou S., Daniela B., Duffy Alex H.B., Efanova T.A., Engelbart D., Esaulov G.V., Feist S.T., Barchugova E.V., Gero J.S., Garcia M., Hansmeyer M., Grisaleña Ar. Jon., Hauwa O.Y., Kaiyang W., Knish V.I., Kolarevic B., Krawczyk R. J., Lee J., Leach Ne., Maver T., Malakhov S.A., Carlos L. Marcos., Werner Liss C., Terzidis Ko., Mikhailov S.M., Mokeeva O.D., Morel P., Moussavi F., Iwamoto Li., Milgram P., Raina A., Roussou M., Stsesel S., Uhrík M., Whyte J., Volynskov V.E., Asanovich A., Abdrasilova G.S., Prokhorov S.A., Mammadov S.E. and also in the works of 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 studied material on the topic of the dissertation - with the development of digitalization in architecture, and their impact on the shaping process has been the subject of many studies. However, how these technologies interact with broader aspects of digital culture, such as openness, collaboration, and networking, require further study. In addition, 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, as well as along with the downside of the problem - the dependence of architecture on modern technologies remain open for further research.

The scientific novelty lies in the development of models of interaction between digital culture and architectural shaping, which will significantly expand the possibilities of creating modern innovative architecture in Kazakhstan.

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

The methodological basis of the research is:

- analysis of examples of architecture with a digital component;
- consideration of the evolution of architectural shaping in the context of digital culture;
- analysis of existing approaches to the impact of digital technologies on architectural shaping;
- Conducting an in-depth opinion poll of architects, theorists, researchers of digitalization, as well as experts using digital tools in their work;
- Understanding how digital culture is changing approaches to architectural shaping and how this can affect 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 scope and structure of the research: the dissertation consists of an introduction, five sections, a conclusion, a list of sources used – 318 titles and 5 appendices. The total volume of the dissertation is 193 pages, the main text is 148 pages.

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

THE MAIN CONTENT OF THE WORK

In the first section of the dissertation, the concept of digital culture is given, its influence on architectural shaping is considered. It describes the main characteristics of digital culture, such as historical background and the use of computer technology, the Internet, social networks, etc. It analyzes how these technologies affect the design and 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 creating an architectural image from a historical perspective. The transition from the simplest tools to modern software and its influence on architectural form-making is clearly visible on the timeline. Thus, each stage of technological progress influenced architectural forms, which reflected, among others, the technological changes of the era.

2. The concept of "digital culture" is defined in the context of

architectural shaping. The prerequisites of digital culture in architecture have been traced from the time of Pythagoras to the present. The key points of the beginning of the use of computer technologies in architecture, the birth and development of computer-aided design (CAD) systems are outlined. In this context, the history of the development of digital culture in architecture shows how technological progress affects this area and how architecture, in turn, affects the development of technology.

3. The prerequisites and factors contributing to the

integration of digital culture into architectural shaping. The changes in the design in the context of the use of digital culture, especially in the aspect of technological innovations, are noted.

The second section examines the "embedding" of digital culture in architectural shaping, the factors and mechanisms of this process that contribute to the creation of sustainable architecture.

Conclusions on the second section

1. The study identified key mechanisms and factors,

influencing the integration of digital technologies in architecture. Special attention was paid to socio-economic, cultural and technological aspects. This allows us to understand exactly how the development of technology, changes in public perception and economic factors contribute to the adoption and adaptation of digital approaches in architecture.

2. Having studied the data obtained, it can be argued that the theoretical

The models that have been developed effectively describe the mechanisms of digital shaping in architecture. These models are based on modern methods such as algorithmic, parametric and generative design, and help to understand how digital tools and algorithms can contribute to the creation of innovative architectural forms.

3. The study showed that such factors as functional

opportunities, methods and processes in digital architecture play a key role in shaping the modern architectural landscape. Parametric modeling, algorithmic design and BIM allow architects to work more efficiently, creating projects at a qualitatively higher level, which meets modern requirements of sustainability and innovation.

The third section examines the influence of digital culture on architectural shaping, as well as analyzes the main trends and directions of development of this process.

Conclusions on the third section

1. A detailed analysis of the impact of digital technologies on modern trends in architectural shaping, including a detailed study of specific examples of buildings, showed that digitalization opens up new horizons in the design and planning of architectural spaces. The use of an innovative arsenal of 3D modeling and virtual reality allows you to create more complex and at the same time functional forms, which greatly enriches the architectural landscape.

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

3. The study showed that the developed model describing the factors and mechanisms of digital culture in the context of architecture effectively illustrates the relationship between technological innovations and the evolution of architectural forms. This demonstrates how the integration of digital technologies contributes to the adaptation and growth of architectural art.

4. The created model, illustrating the influence of digital technologies on stylistic and formal aspects in 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 above, the study of the problems and negative consequences associated with the use of digital technologies in architecture reveals important aspects related to sustainability, ethics and accessibility of technologies. This highlights the need for a balance between innovation and the preservation of traditional architectural values, as well as focuses on the potential risks and difficulties that the architectural field may face.

The fourth section examines the possibilities of BIM and VR technologies, with the help of which experimental projects are created in virtual digital cyberspace, which in one way or another affects the aesthetic worldview of architects and the design process itself as a whole. One of the main achievements is the ability to anticipate the results in the process of generating an architectural form. Since the methods of algorithmization and parametrics in architectural shaping are the main ones in form generation, they are the factors of the emergence, including new aesthetic properties.

Conclusions on the fourth section

1. The relevance and importance of the use of computer programs in architectural design, including for the creation of complex architectural forms, is revealed. Programs such as Autodesk Revit, Rhino and SketchUp allow architects to experiment with non-standard shapes and structures, opening up new horizons in architectural design.

2. Based on the analysis of the collected data, it has to be stated that the systematized main directions of digitalization in architecture and their impact on the shaping process enrich the design practice with new methods and techniques. Special attention is paid to algorithmic and generative design, which make it possible to create innovative and functional architectural objects.

3. The developed software product concept for architects reflects the requirements and needs of modern architectural practice. This software product offers tools for optimizing design, project management and customer interaction, which contributes to improving the efficiency and quality of architectural projects.

4. The study showed that the developed model describing the problems of implementing BIM technology in the industry highlights both its opportunities and challenges. BIM technology provides improved collaboration between project participants, but at the same time presents challenges in the form of the need for training and adaptation of work processes.

5. The created model demonstrates the areas of application of VR technologies in architectural design, reveals their role in improving the 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 information provided, the developed model identifies the key difficulties and limitations associated with the use of virtual reality (VR) technologies. These difficulties include the need for significant investments and resources to develop and implement VR projects. In addition, potential problems related to the user interface and perception of the virtual environment have been identified, which may make it difficult to use these technologies effectively.

7. The conducted practical experiments using the Autodesk Revit program for the study of shaping, including work with students on the example of objects such as Khan Shatyr and EXPO-2017, demonstrate the practical application of theoretical knowledge in the field of architecture. These experiments have shown how digital technologies can be integrated into the learning process, providing students with valuable experience working with modern architectural tools.

In the fifth section, the possibilities of new digital approaches in design are considered, which gives rise to new style directions. In this regard, the prospects of artificial intelligence and the specifics of its implementation in architecture at all levels are extremely important. Challenges of this order, at the same time, and the lurking danger of negative ones, including in architecture, imply the need to find flexible solutions, which is the vector of architecture development in new conditions. Research in this field inevitably leads to the synthesis of "culture" and "technology" as a symbiosis capable of giving new value orientations. This is particularly relevant in the conditions of modern Kazakhstan.

Conclusions on the fifth section

1. A model of Industry 4.0 capabilities in architecture has been created, which highlights 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 diagram demonstrates how the use of artificial intelligence can contribute to the creation of innovative architectural forms and structures.

3. The study showed that experiments conducted to create architectural forms and layouts using neural networks demonstrate their capabilities in creating design. These experiments allowed us to see 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 emphasizes the need for a balanced approach to the integration of this technology. The main difficulties include difficulties in interpreting the results, high hardware and software costs, and the potential threat of job cuts in the industry.

5. Based on the above, the analysis of the development of digital culture in the architecture of Kazakhstan has identified key aspects and directions. The study highlights the importance of integrating new technologies to create a 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 the needs of the future in different regions of Kazakhstan.

7. The model "Future Architecture of Kazakhstan" reveals the directions of integration of advanced technologies into architectural design, taking into account the climatic, socio-economic, cultural and historical features in the regions of Kazakhstan.

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

Conclusion

In the course of studying the phenomenon of digital culture in architectural shaping, the following results were obtained:

1. The phenomenon of "digital culture" in architecture and the stages of its development are analyzed. The reasons and factors that allowed digital culture to integrate into architectural shaping, which led to changes in approaches to design, materials and interaction with the environment, are considered.

2. The main factors influencing the use of digital technologies in the creation of architectural forms have been identified, based on this analysis, a model has been created that shows how digital technologies affect the design process in architecture. The interrelationships between digital culture and architecture are investigated based on their specifics. The article analyzes how digital technologies influence design

methods and change traditional approaches. A model has been created that describes the interaction of digital technologies with the process of creating architectural forms. The changes in the principles of design and approaches to the creation of architectural forms are investigated.

3. The influence of digital culture on architectural shaping is considered, as well as the reverse effect of architecture on the development of digital practices, and a model of this interaction is created. Experiments on architectural shaping have been carried out using the example of well-known objects in the Revit program.

4. Based on the results of an extensive Internet survey among active users of computer architectural programs, a diagram has been created that allows you to evaluate the capabilities of these programs in creating complex architectural forms. Experiments with shaping in the Autodesk Revit program, including with the participation of students, demonstrated its importance for architectural practice.

5. The modern trends of digital shaping are systematized, the influence of advanced technologies, including artificial intelligence on architecture, is analyzed. Based on a sociological survey, the attitude in the professional environment to the influence of digital culture on architectural shaping is presented. 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 peculiarities. The findings of the study can be useful for architects, teachers and students working in the field of modern architecture.

List of publications

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