



## Stages of Digital Transformation of Educational Institutions in the System of Sustainable Development of the Region

Svitlana Kryshchanovych<sup>1\*</sup>, Galyna Liakhovych<sup>2</sup>, Oksana Dubrova<sup>3</sup>, Henrikh Kazarian<sup>4</sup>, Ganna Zhekalovych<sup>2</sup>

<sup>1</sup> Department of Pedagogy and Psychology, State University of Physical Culture, Lviv 79000, Ukraine

<sup>2</sup> Department of Management and Administration, West Ukrainian National University, Ternopil 46009, Ukraine

<sup>3</sup> Educational Institute of Management, Economy and Finance, Interregional Academy of Personnel Management, Kyiv 03039, Ukraine

<sup>4</sup> Department of Finance and Administration, Odessa Institute Private Joint-Stock Company "Higher Education Institution "Interregional Academy of Personnel Management", Odessa 65011, Ukraine

Corresponding Author Email: [svitlana.kryshchanovych@gmail.com](mailto:svitlana.kryshchanovych@gmail.com)

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### ABSTRACT

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The purpose of the article is to model the main stages of sustainable development through the digital transformation of educational institutions in the region. World trends in the development of society, education, science and economy are aimed at the transition to digital transformation. Successful digitalization is becoming a key condition for the successful functioning of both the region and the entire country. Accordingly, today the successful sustainable development of the region is impossible without effective digitalization of higher education. Based on the results of the study, paired models of sustainable development of the region were formed with the help of digital transformations, taking into account the characteristics of the educational environment. The study has a number of limitations related to the inability to cover more than one region. Subsequent research should be related to ensuring the sustainable development of the region through the digitalization of other areas of activity.

## 1. INTRODUCTION

Global trends in the development of both education and the management of educational institutions are aimed at the transition to digital transformation in order to achieve sustainable development in the region. This means that all educational, scientific, managerial, and other processes of higher education must be completely transferred to the digital environment. Without digital transformation, higher education cannot effectively organize a high-quality educational process and remote work of its departments with documents, and cannot function normally in a competitive environment, which negatively affects students, teachers, and employees. Traditional approaches to automating the activities of higher education institutions have lost their effectiveness and can no longer meet modern requirements. Automated systems of training, management, and accounting not only do not solve all the problems of higher education, but they also divide the information space into separate "cells", in accordance with those functional tasks for which this or that information is needed. Usually, these are disparate tools that are not combined into a single system for solving the functional problems of higher educational institutions. And, of course, this approach does not allow the effective implementation of digitalization projects and does not allow the creation of a unified system for building digitalization in the context of sustainable development of the region. We need new approaches and new concepts of digital transformation of higher education in the system of

sustainable development of the region. Approaches that allow you to combine all the processes of creating and using software and information tools to build digital universities. Therefore, an urgent scientific task arises, which is to develop methods and models for the digitalization of higher education based on the integration of all functions, procedures, and information bases into single concentric information technology for the digital transformation of educational activities for the sustainable development of a particular region.

The purpose of the article is to model the main stages of sustainable development through the digital transformation of educational institutions in the region. The innovativeness of our study lies in the fact that in this study the authors tried to depict the complex and complex process of digital transformation of educational institutions in the system of sustainable development of the region, in the form of systematized models, which greatly simplifies its understanding and implementation.

The background to the development of this model took place on the basis of the formation of a certain concept of how to solve the problem of digital transformation of educational institutions in the system of sustainable development of the region. We came to the conclusion that the best methodological approach would include elements of modeling and systematization, as this is a complex and complex process.

The structure of the article involves the analysis of the literature, the formation of the methodology, and the

determination of the research results and conclusions.

## 2. LITERATURE REVIEW

In general, scientists and practitioners [1, 2] focus on data-related aspects of digital transformation, implying that data itself is an asset if the problem of turning this data into value is solved. The main goal of the digital transformation process in higher education is the rethinking of the level of education and the processing of operational processes in organizations.

A certain group of scientists [3, 4] notes the technical aspects of digital transformation. The corporate IT architecture of universities is indicated as one of the key factors in the digital transformation of the entire higher education system. It has been determined that among the main problems of the digital transformation of the education system, the difficulties of combining different technical solutions, that is, the integration of different computer systems, stand out. While our study offers a solution through the creation of a single information space for the digital interaction of educational institutions based on the cloud platform of the entire education system. However, we plan to focus on the mundane stages of digital transformation, taking into account the region's sustainable development strategy.

So, Shriberg [5] in his work explored the features of the modern functioning of educational institutions and the mechanisms for using digital technologies for the development of the education system. In our opinion, their research is useful, but all proposals are complex and unsystematic. Therefore, in our opinion, the use of model systems is a key element in the implementation of an effective digital transformation of the higher education system.

As noted by Muzanni et al. [6] and Aliksieienko et al. [7], the central element of informatization of education is the information and communication environment, which is a more technological system. It is based on the widespread introduction of methods and means of information and communication technologies into the education system and the creation of a computer-oriented information and communication environment based on it. This environment is filled with electronic scientific, educational, and management information resources with the provision of opportunities for participants in the educational process to access the resources of the environment, and use tools, and services in solving various problems.

In a number of studies [8, 9], the focus is on the concept of the information and educational environment of an educational institution, which, based on a systematic approach, is considered as a complex socio-technological and information-control system, which, on the one hand, includes people (subjects of management and participants in the educational process), and on the other hand, technical and technological objects, primarily information systems, different in purpose and structural features. In addition, some researchers Chu [10] and Kryshtanovych et al. [11] approached this issue in more detail and substantiated the use of specific models for the implementation of the process of digitalization of the higher education system. Thus, Cortes's study [12] used conceptual approaches to the construction of a "SMART model of an educational institution and a SMART university", which are based on technologies and principles, among which the leading role is played by a

comprehensive solution to the problem of designing an information and educational environment, taking into account creation of a unified information system of an educational institution. But SMART modeling is a special technology that is very popular in the specialization of the region. However, the digital transformation of the education system is a more local solution for sustainable development.

Considering the results of the analysis of scientific and practical literature on this topic, it should be noted that today most regions of the world are still experiencing problems with digitalization as an important element in the sustainable development of the region. Here and there we can meet more and more new ideas on proposals for the sustainable development of a particular region, that the world includes a significant number of regions and each region is a separate complex structure, the socio-economic system in which the educational system is not the last.

According to the analysis of the literature, we have identified topical issues and problems: sustainable development of the region, digitalization of regional policy, digital transformations in education.

## 3. METHODOLOGY

When it comes to the stages of digital transformation, it is important to use the right modeling methodology. The best options are those that have a graphical modeling language. It is difficult to demonstrate in a textual or tabular format a model of a phased digital transformation. The tabular and text format helps to clarify the initial stages of the simulation, but the main model must be written in a graphical language.

In this case, the best option would be to use a popular graphical system description language (in our case, a digital transformation system for the sustainable development of the region), which, based on structural analysis and design, can form a set of interconnected functional blocks. In a wide scientific and practical circle, it is called the modeling of the functional elements of a process.

The first stage of the methodology is the definition of the very functional blocks that will be our stages of digital transformation of educational institutions in the system of sustainable development of the region.

All stages should be marked in order to reduce their representation during modeling. To do this, we use the method of symbolic mathematical notation, which involves simple actions when a certain word is denoted as a letter or number.

The first goal concerns the improvement of technologies for the introduction of the educational process in the system of sustainable development of the region. Let's denote it as T-1. Without it, the so-called T-2 is not achieved - Effective digitalization of education in the region (1):

$$T-2 \in T-1 \quad (1)$$

It should be noted that for both T-1 and T-2 there are a number of stages that contribute to this achievement (2):

$$T-i = [T-i_1; T-i_2; T-i_3; T-i_4] \quad (2)$$

In Table 1, we have presented all the goals and the stages to achieve them for better understanding and depiction.

**Table 1.** The main functional blocks of the stages of digital transformation

<b>T-1</b> <b>Improvement of technologies for the introduction of the educational process in the system of sustainable development of the region</b>	<b>T-2</b> <b>Effective digitalization of education in the region</b>
T-11. Implementation of digital functional information bases	T-21. Change of technological equipment
T-12. Implementation of digital technologies for solving functional problems	T-22. Implementation of remote methods of work and study
T-13. Introduction of digital information management technologies in educational institutions	T-23. Formation of an electronic cabinet for employees and students
T-14. Implementation of digital technologies for ensuring the activities of higher education	T-24. Free digital access to educational resources

The second stage is already direct modeling, which will be in the form of two paired models, the second of which will be a consequence of the first. We get not only certain stages, but the models themselves will be by themselves two large stages to achieve the main goal.

A particular region, its sustainable development policy, and the relevant educational institution should be chosen as an example - Masovian Voivodeship Region and Warsaw University of Technology as a key institution for its sustainable development. The reason for choosing this educational institution is that after a full analysis and communication with the leadership of educational institutions, we found that they have significant problems and shortcomings in the issue of digitalization of their own activities.

#### 4. RESULTS OF RESEARCH

To begin with, it is necessary to build a diagram of the transition from stage T-1 to T-2 for our object of study in the framework of ensuring the sustainable development of the region in which it is located directly (Figure 1).

So, as we can see in Figure 1. the process of reaching the T-1 and T-2 stages is systematically depicted in the context of discovering a set of necessary resources, determining inputs and outputs.

The model of stage T-1 "Improvement of technologies for the introduction of the educational process in the system of sustainable development of the region" for the sustainable development of the Masovian Voivodeship Region is presented in Figure 2. As you can see in Figure 2. a detailed model for achieving the T-1 stage is shown, indicating the system for implementing its main elements, their place and mechanisms for their provision. For a better understanding of this model, we will consider each element in more detail.

T-11. Implementation of digital functional information bases. These are technologies that are used to solve functional problems, or which are a product (solution) of these problems. In particular, it is information accompanying students' activities, in particular information about grades, thanks and reprimands, living in dormitories, participation in competitions, Olympiads, artistic activities, sports events, academic mobility, student self-government; technologies of the educational process: examination, assessment, and other information, attendance logs; educational and work curricula: disciplines, types of classes, the scope of work.

T-12. Implementation of digital technologies for solving functional problems. Digital information technology for

solving functional problems uses the information resource located in the databases of normative and reference information and information on functional problems. Traditionally, the information base of functional problems is divided into databases of various tasks, to which integration tools are applied to create a single information environment. Tools of this technology, as well as in traditional information systems, in the field of educational activity solve problems: processing educational and work curricula; calculation of the educational load; organization of distance learning and electronic testing; formation of the class schedule; conducting business operations for sustainable development.

T-13. Introduction of digital information management technologies in educational institutions. The task of creating a digital space should be separated from functional tasks that are subject to automation and should act as an independent system-forming component of digital development. For this, it is necessary to create an end-to-end (relative to functional tasks) information management technology for a higher education institution. In the presence of such information technology, the issue of solving functional problems is also simplified. First of all, because a number of information processing functions are transferred to information management technology. Secondly, the means of solving functional tasks will operate with information that is publicly available and that is formed collectively by all tools of digital development, and does not belong only to this task and is formed by its tools.

It is important to isolate, retrieve and store information used in different functional tasks in a centralized information environment independent of these tasks. For its formation, it is necessary to create information management technology. Using the information management system, it is easier to create information technology for solving functional problems. The algorithm for creating an information management system consists in choosing functions that are implemented when solving many problems and combining them into a single system of preparing an information resource for the means of solving these problems.

T-14. Implementation of digital technologies for ensuring the activities of higher education. This technology is based on tools aimed at achieving the goal of digital transformation - maximum provision of information needs of higher education institutions. To achieve this goal, it is necessary to direct the tools of digital transformation described above to solving the problems of information support for the activities of the institution of higher education and sustainable development. Essentially, the tools for managing information and solving functional

problems should not only fill information bases with data that are input or output for these technologies, but also with information that is a resource for employees in production or management activities. This is an additional task of digital transformation, which relies on information technology to support activities.

The model of stage T-2 “Effective digitalization of education in the region” for the sustainable development of the Masovian Voivodeship Region is presented in Figure 3. As you can see in Figure 3, a detailed model for achieving the T-2 stage is shown, indicating the system for implementing its main elements, their place and mechanisms for their provision. For a better understanding of this model, we will consider each element in more detail.

T-21. Change of technological equipment. Sustainable development implies constant progress and for this, there must be effective technological equipment. Without putting the existing technological equipment in order, it is impossible to talk about sustainable development. In general, the renewal of technological equipment is mandatory for any object of sustainable development.

T-22. Implementation of remote methods of work and study. Thanks to digital technologies, remote working

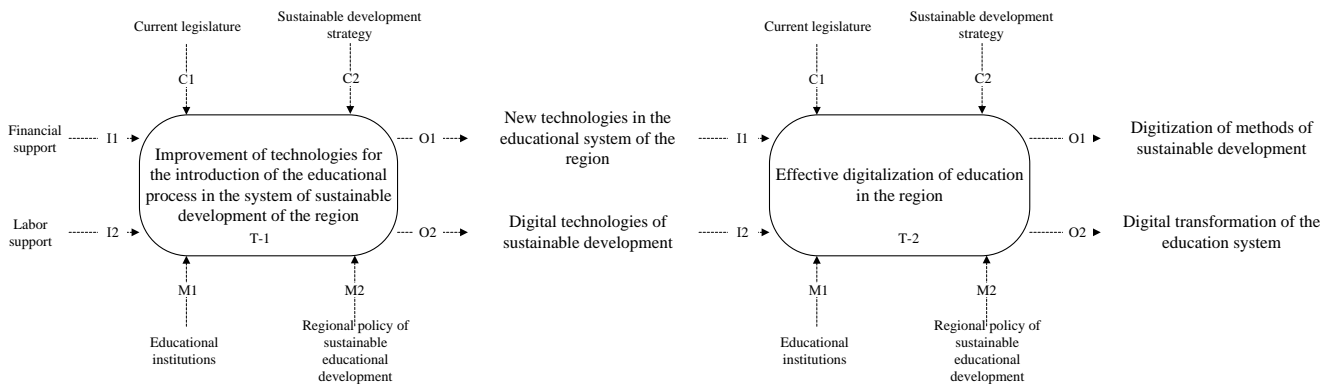
methods can be introduced on an ongoing basis. Remote work will bring foreign specialists for sustainable development.

T-23. Formation of an electronic cabinet for employees and students. Sustainable development through the digital transformation of education is possible only when the basic data can be digitized and form electronic classrooms that become an element of Industry 4.0.

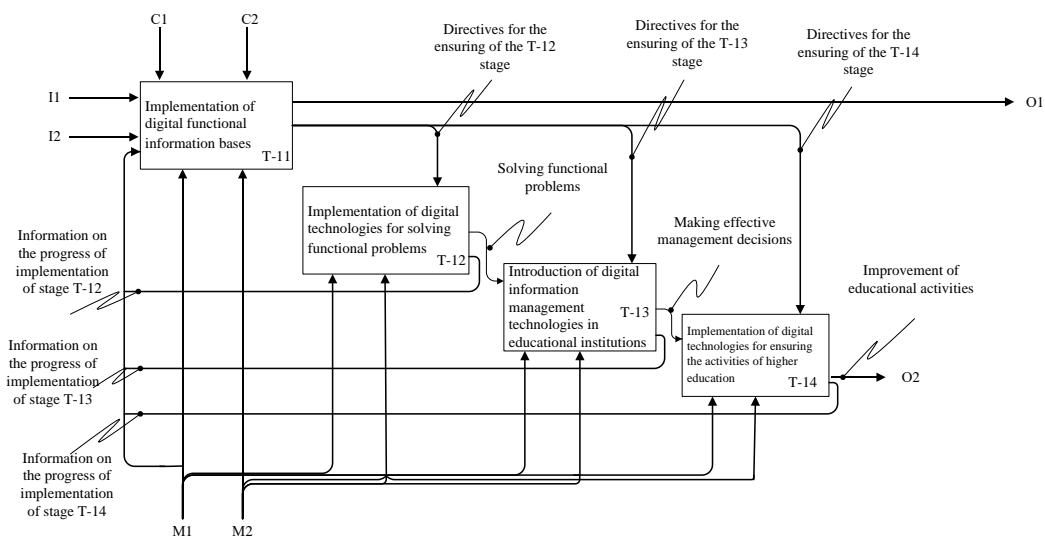
T-24. Free digital access to educational resources. Thanks to digital transformation, quick access to various categories of resources, including educational ones, is possible. Free access to resources significantly contributes to the sustainable development of the region.

As already noted, we tried to implement the stages of digital transformation proposed above in the text at the Warsaw University of Technology in the context of the sustainable development of the region. The result shows that, on average, up to 1 month was allocated for the implementation of each of the stages of T-1 (Figure 4).

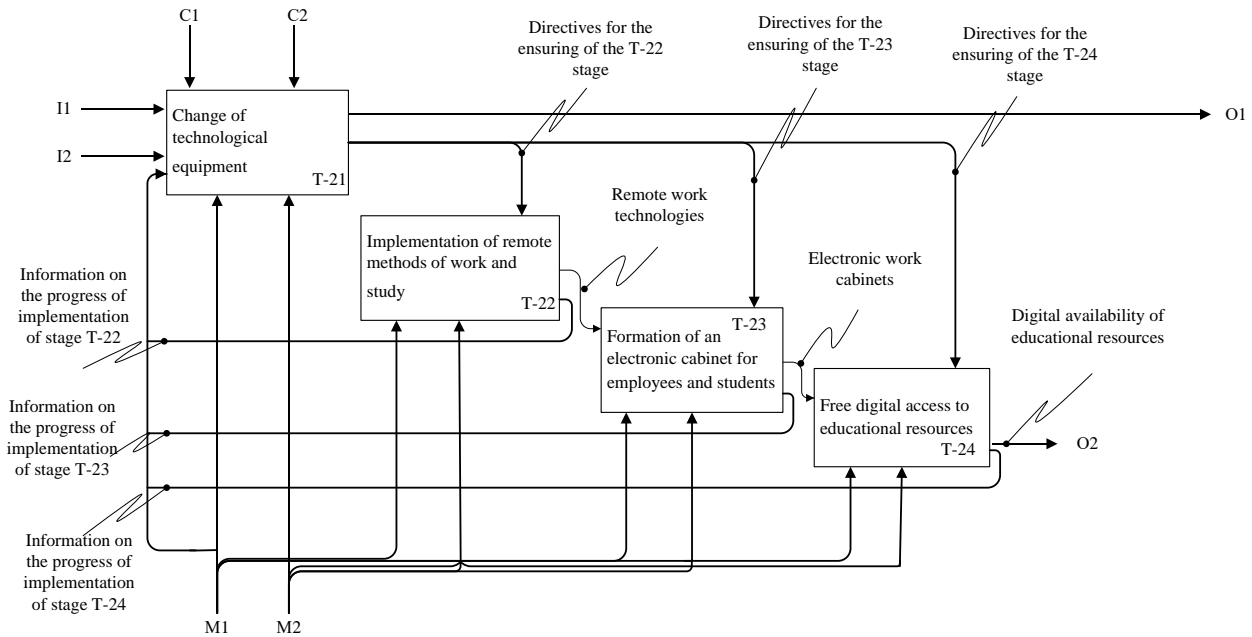
In general, this is only the beginning of the practical application, and a significant amount of time is still needed to speak with confidence about the effectiveness of the practical value of the research results.



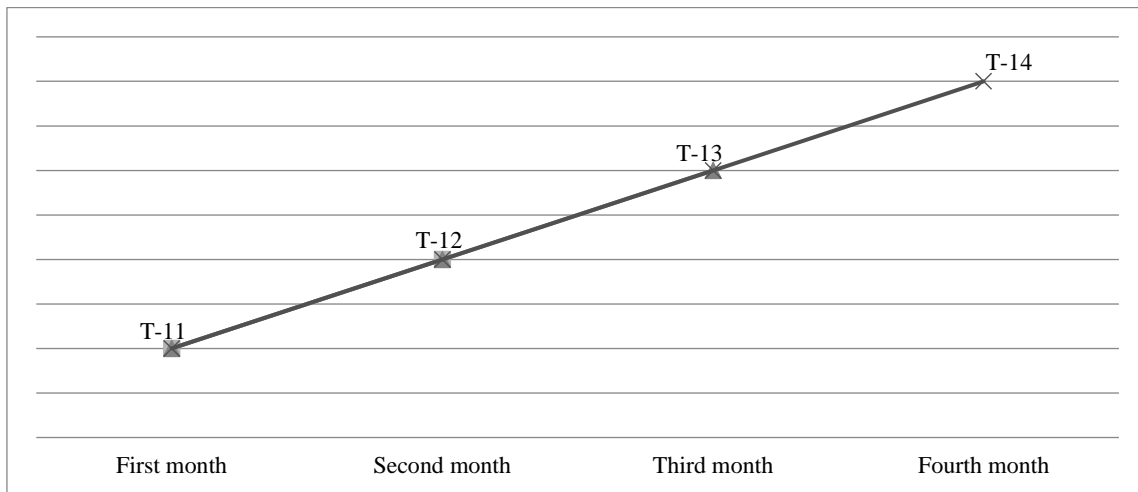
**Figure 1.** Diagram of the transition from stage T-1 to T-2 for our object of study in the framework of ensuring sustainable development (developed by the authors)



**Figure 2.** The model of stage T-1 “Improvement of technologies for the introduction of the educational process in the system of sustainable development of the region” (developed by the authors)



**Figure 3.** The model of stage T-2 “Effective digitalization of education in the region” (developed by the authors)



**Figure 4.** Dynamics of the implementation of the proposed stages of digital transformation T-1 in practice of the Warsaw University of Technology (developed by the authors)

## 5. DISCUSSIONS

Discussing the results of the study, it should be noted what similar scientific results are in other works. For example, most authors [13, 14] agree that digital transformation in the system of sustainable development of the region is, first of all, organizational changes implemented with the help of digital technologies and digital business models in order to improve organizational efficiency. The categories of organizational change that a business may experience include: business models, organizational structure, and people, business processes, technologies used to collect and manage information, product or service mix, and customer and supplier interaction patterns. In our opinion, digital transformation should occur gradually and begin with education. That is why our study focuses on the system of higher education and its impact on the sustainable development of the region.

In addition, in the study of Iatsyshyn et al. [15], the issue

of using specific digitalization systems was investigated, which were supposed to intensify the activities of students. In our opinion, the use of such systems is expedient, but first of all, the basic step should be the introduction of a system of general digitalization. Thus, in our study, the formed model demonstrates the unified steps of the digital transformation of educational institutions in the system of sustainable development of the region.

Most of these works Chen et al. [16, 17] provide a more detailed description of the components of a single information space: the digital environment, the tools for its formation, the tools for using the digital environment, the organizational foundations of digital transformation, and the methodology for managing digitalization projects. The article by Tang et al. [18] focuses on the importance of developing a methodological concept for managing projects for the transformation of higher education institutions into digital universities as part of complete digital transformation technology. However, we do not strive to

cover all the principles of the educational process in the system of sustainable development of the region as much as possible. Such a unification of the model that we have developed allows us to adapt it to the realities of the existence of various educational institutions.

In other works [19, 20], a conclusion is made about the importance of the scientific and practical significance of the system-technical approach to the digital transformation of higher education. A system-technical concept of digitalization of higher education institutions is proposed, which integrates the methodological concept of managing digital transformation projects of higher education described above with a system and process approach. This approach combines the definition of the processes of higher education institutions, their effective management in the digital environment, and the use of this environment for the automated solution of the functional tasks of higher education.

However, it should be noted that when discussing our research results, we had only a demonstration of the process of modeling the stages of digital transformation of educational institutions in the system of sustainable development of the region. This is only the beginning but allows us to talk about the first results.

## 6. CONCLUSIONS

Summing up and drawing certain conclusions, it should be noted that the ideas of implementing the principles of digital transformation have been developing for several decades. They have gone from automating routine operations with information to the fundamental influence of information technology on organizational processes in enterprises and institutions. In recent years, digital transformation has appeared among the priorities of the state policy of sustainable development in many countries of the world. The introduction of information systems at enterprises and organizations usually occurs gradually and fragmentarily, as a result of which a typical informatization scheme is the presence of several systems developed at different times, on different platforms in accordance with a different understanding of the subject industry. That is, there are separate technological "islands", often not interconnected, in which there can be a lot of duplication of data and duplication of procedures for working with data.

Now the digitalization of education is a mandatory and priority part of reforming the education sector in the system of sustainable development. In the last decade, the focus of informatization has shifted more and more from automation to a transformational paradigm. The issue of informatization of education is considered more systematically.

Our studies bring a certain element of scientific novelty. Based on the results of the study, paired models of sustainable development of the region through digital transformations were formed, taking into account the characteristics of the educational environment. According to the authors, the model we have developed will make it possible to significantly simplify the complex process of digital transformation of educational institutions in the system of sustainable development of the region. The use of this model can serve as the basis for the formation of unique for each system mechanisms and measures for the digital transformation of educational institutions in the system of

sustainable development of the region. In addition, with the help of the models we have formed, the management of the educational institution will be able to form the main stages of the implementation of this process.

The study has a number of limitations related to the inability to cover more than one region. In the future, the authors plan to use this model in higher education systems in other regions, adapt it and make it more universal. Further research should be related to ensuring the sustainable development of the region through the digitalization of other areas of activity.

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