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Modeling the Effective Digitalization of the Education Management System in the Context of Sustainable Development

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ABSTRACT

The main purpose of the article is to form a methodological approach to the digitalization of the education management system in the context of ensuring the sustainable development of a single socio-economic system. The relevance of the topic of the article is due to the active development of modern digital technologies and the advancement of requirements for the digitalization of education for sustainable development. The object of the study is a single educational institution and its system for ensuring sustainable development. The basic modeling technique represents the main research methodology. The main articles propose new models for the effective digitalization of the education management system in order to ensure its sustainable development, taken specifically as an institution of higher education. As a result, we have described a new methodological approach to improve the integration of all aspects of digitalization into the education management system in the context of sustainable development.

1. INTRODUCTION

At the beginning of the 21st century, the main strategic task of the entire world community is to ensure the stable and efficient existence of modern civilization based on the integrity of the natural environment, economic viability and social justice for current and future generations. The solution of these issues became possible with the introduction of the sustainable development strategy into the content of social and educational policy.

The formation of advanced education for sustainable development requires a new pedagogical culture and thinking, new pedagogical models, new pedagogical content. The modern school is designed to ensure the achievement of such educational results that would meet the goals of personal development and the modern requirements of society. The most important among them is the formation of established models of human behavior, the change of its value priorities towards socially responsible, environmentally and humanistically oriented forms of interaction with the natural and social environment.

At the end of the 20th century, the growth of the economic component of human life was a destructive force for the biosphere and man. The need to form a balanced model for the development of civilization, which would be safe for the environment, turned out to be obvious. An attempt to implement such ideas is the strategy of sustainable development, which is today the leading strategy for the socio-

economic development of mankind as a whole. Today, a sustainable development strategy cannot be implemented without taking into account modern digital technologies. This is due to the fact that today humanity is actively functioning in the era of Industry 4.0, which leads to the spread of digital technologies in all spheres of society: from everyday construction to the functioning and development of state and regional structures of the country. The formation and implementation of sustainable development strategies based on various types and active use of digital technologies is no exception.

For several years now, the economic, political and cultural modernization of most countries of the world in the conditions of the "digital" world has been mainly determined and identified with the digitalization of all aspects of the life of its citizens. Of the many areas in which, thanks to "digitalization", fundamental changes are taking place, leading to an improvement in the quality of human life, the industry is significantly different, the vector of progress of which is directed mainly to the future. We are talking about the educational environment, the digitalization of which is designed to change the fate of not only current, but also future generations, creating new capital based on the development of human creativity and intellectual potential as fundamental components of the human personality.

The undoubted advantage of the "digitalization" of learning and teaching is that higher education becomes available to those students who, for certain reasons, are unable to attend

classes or exams. It should also be noted that the digitalization of the educational process does not exclude the traditional classroom work of individual groups of students. The successful combination of extracurricular, distance learning with lectures and practical exercises "live" proves the complementarity of these forms, and therefore, with digitalization, it will allow them to be combined more and more organically and effectively, diversifying the educational process. As the demand for lifelong learning grows from a lifelong learning perspective, the creation of new digital learning resources and the development of innovative digital learning models are of particular relevance. But, despite all the benefits that global digitalization brings, it contains a certain danger: to a certain extent, a person is threatened with the loss of personal data and valuable digital information. After all, even now, so to speak, at the initial stage of the global "digitalization", an unprecedented level of feeling of confusion, embarrassment, helplessness and reluctance is recorded. That is why it is difficult to overestimate the role of a balanced and gradual digitalization of the educational environment management system, which should become a place for the identification, disclosure and careful cultivation of purely human abilities and talents. It is quite possible that it is precisely in the open spaces of education modernized in this way that a new round of sapientation will be outlined and implemented.

The main purpose of the article is to form a methodological approach to the digitalization of the education management system in the context of ensuring the sustainable development of a single socio-economic system.

The study consists of the following structural parts: introduction, review of specialized scientific literature, description of the methodology, description of the results, discussion of the results and final conclusions.

2. LITERATURE REVIEW

In general, as noted by Prystupa et al. [1] and Kebritchi et al. [2], the idea of sustainable development is based on the understanding of such a complex phenomenon as constancy, which implies the ability of the system to maintain long-term equilibrium in the presence of external influences. The system is in a state of long-term equilibrium, when all influences on it are compensated by others. Such an equilibrium is also called homeostasis, i.e. the process of self-regulation, the ability of an open system to maintain the balance of its internal state through coordinated reactions aimed at maintaining dynamic balance.

The globalization of the world economy, politics and culture became the main issue of the development of world civilization at the beginning of the new millennium. The processes of globalization also actively influence the sphere of modern education, bringing positive and negative consequences to it. So, for example, the modern educational process is fully filled with a variety of scientific sources, and the recipients of education have a high level of academic mobility as never before, but at the same time, overcrowding of information creates the so-called "information noise", which makes it impossible to find the most effective learning techniques and scientific sources. And according to Cortese [3] and Berzosa et al. [4], this cannot be ignored when ensuring sustainable development.

As Alshuwaikhat and Abubakar [5] and Kryshtanovych et al. [6] note, global education is becoming an important element of the globalization of modern education, that is, a set of certain forms and technologies of education aimed at spreading aspects of globalization in all spheres of public life. Its components are environmental education and upbringing, the development of tolerance and multiculturalism in the field of social science education, and the increase in the informatization of education. Education for sustainable development in a certain sense is a form of global education.

Most scientists note that a feature of education for sustainable development is that it covers the environmental, economic and social issues of education and upbringing in terms of the formation of a new system of value orientations and behaviors of the younger generation and society as a whole [7-10]. It significantly complements and expands the scope of environmental education, and allows all aspects of educational activities to be developed in the context of sustainable development, the diversity of topics of which requires the use of complex processing and allows you to create a systemic mechanism for transforming meaningful life priorities at the individual level, and therefore ensure the leading function of education in modeling social processes Particular attention should be paid to the practical implementation of sustainable development models, the formation of appropriate norms of behavior and lifestyles, an active public position on the implementation of the idea of constancy in the everyday experience of children and adults.

We agree with the opinion of scientists and practitioners that sustainable development requires the concept of education aimed at an integrated and dynamic approach that takes into account the importance of critical thinking, social learning and participation in society [11, 12]. That is why education for sustainable development intertwines economic, social and environmental aspects.

But, paying tribute to the scientific achievement of leading scientists and practitioners, today there are still a significant number of educational institutions in many regions that cannot ensure proper sustainable development due to the lack of effective digital technologies.

3. METHODOLOGY

Despite the use of basic theoretical methods for analyzing information and literature, the main method is the method of structural modeling. The reason for choosing the method of structural modeling is the fact that the integration of any elements into any socio-economic system is a step-by-step process and needs proper structuring.

The method of structural modeling is often used to study socio-economic systems and their management processes to ensure sustainable development [5-10]. More often, the method of structural modeling is used to decompose the management system, while the issues of the features of modeling the processes of integrating digitalization into the education management system in the context of sustainable development remain practically unexplored. At the same time, the complexity and versatility of processes in the educational sphere determine the high level of adaptation of systems to the use of structural modeling methods.

In the studies of socio-economic systems, the SADT methodology has gained the greatest popularity. Its provisions are effectively used for the knowledge of complex systems, the functioning of which is associated with a specific subject area

and implies the presence of a control loop. The key difference between the SADT methodology lies in the application of the concept of system modeling and the formalized description of complex systems using structural models. The SADT model accurately, fully and adequately reflects the complex system under study with its clearly defined purpose and purpose of functioning. To model educational systems, notations of the SADT methodology were used, namely: IDEF0, which provides an effective organization of the collection of requirements for the development of a project to integrate digitalization elements and reengineer existing ones in order to ensure sustainable development.

The IDEF0 functional model is used to formalize and describe processes through graphical diagrams. A feature of this model is the reflection in it of the subordination of objects of a complex system to each other. Among the advantages of the IDEF0 methodology for modeling, the following should be highlighted: 1) a high degree of visibility of the constructed functional models, which makes it possible to identify and eliminate bottlenecks; 2) unambiguous interpretation of the elements of the model by specialists from different industries and areas; 3) the simplicity of the process of building a model by a system analyst of the company, increasing the productivity of his work; 4) the presence of strict rules for building a model, which practically eliminates the possibility of errors or violations of the standard [13].

It is necessary to set the main goals of modeling, which we denote as A0 (Integration of digitalization elements into the sustainable development management system of an educational institution) and B0 (Integration of digitalization elements into the educational process).

Reaching A0 and B0 is possible due to the following condition (1):

$$A0\text{-}B0 = \{A1+A2+A3+A4\} + \{B1+B2+B3+B4\} \qquad (1)$$

It is necessary to choose a socio-economic system for which structural modeling will be carried out. Of course, due to the evaluation of various options, it is possible to choose the optimal one, but if we are talking about the sustainable development of higher education, we will choose the

institution where all the authors who know all its problematic aspects work. Such an institution will be the State University of Physical Culture in the Lviv region. It has significant problems with digitalization, which hinders its sustainable development.

4. RESULTS OF RESEARCH

In order to generally clarify the structure of achieving the goals set, it is first necessary to outline the key elements for ensuring this process. This can be shown in the form of a diagram of the structural elements of providing A0 - Integration of digitalization elements in sustainable development management system of an educational institution (Figure 1).

First of all, it is necessary to graphically present the scheme for achieving A0 in accordance with the fulfillment of requirement (1). This scheme will lay the foundation for further structural modeling (Figure 2).

Let's form a structural model of the graphical scheme of achieving A0 - Integration of digitalization elements into the sustainable development management system of an educational institution (Figure 3).

Let us characterize the key stages of the structural graphic scheme for achieving A0:

A1. Formation of investment attractiveness. Much of the funding for digitalization initiatives comes from external investment in projects. Such a large percentage of external financing implies not only advantages, but also certain risks if investors are primarily pursuing external goals. This creates sporadic projects that are not built in or do not contribute to the sustainable development of higher education. This development is a matter of concern, especially in light of stagnant core funding and increased outside funding for universities. Therefore, it is important to establish financial incentives for the sustainable and structural-strategic creation of digital teaching and learning formats in universities, for example, by connecting digitalization projects to reliable funding structures in targeted agreements.
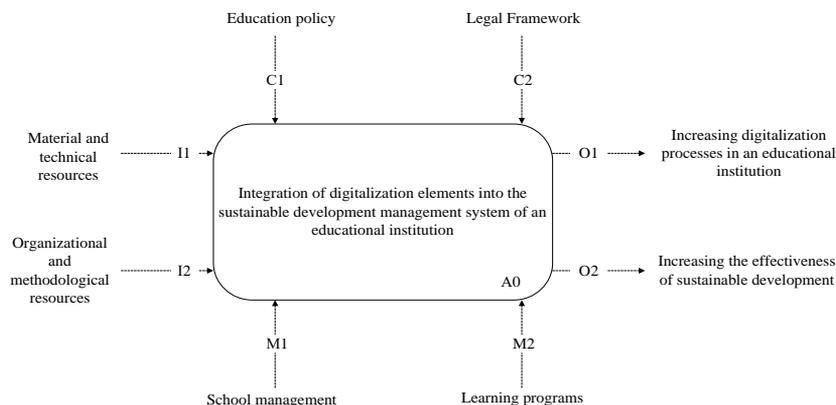
Figure 1. Diagram of the structural elements of providing A0 - Integration of digitalization elements into the sustainable development management system of an educational institution
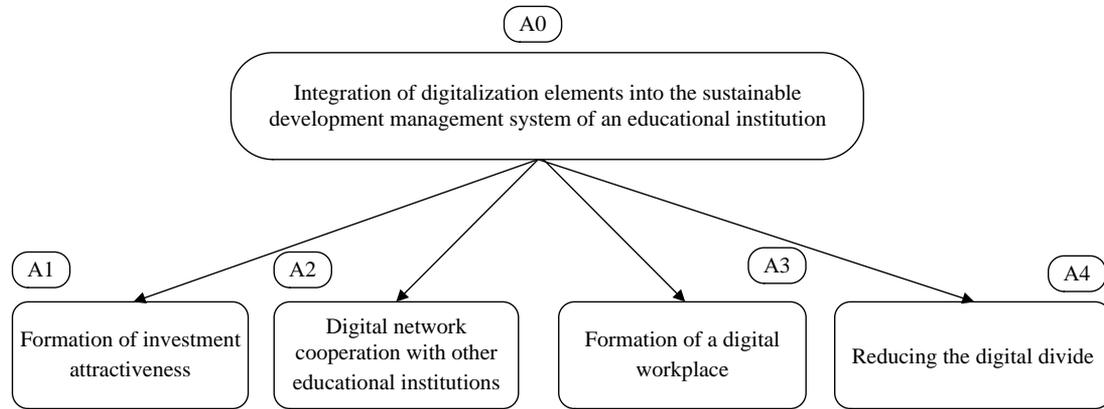
Figure 2. Graphic achievement scheme A0 (Integration of digitalization elements in the sustainable development management system of an educational institution)
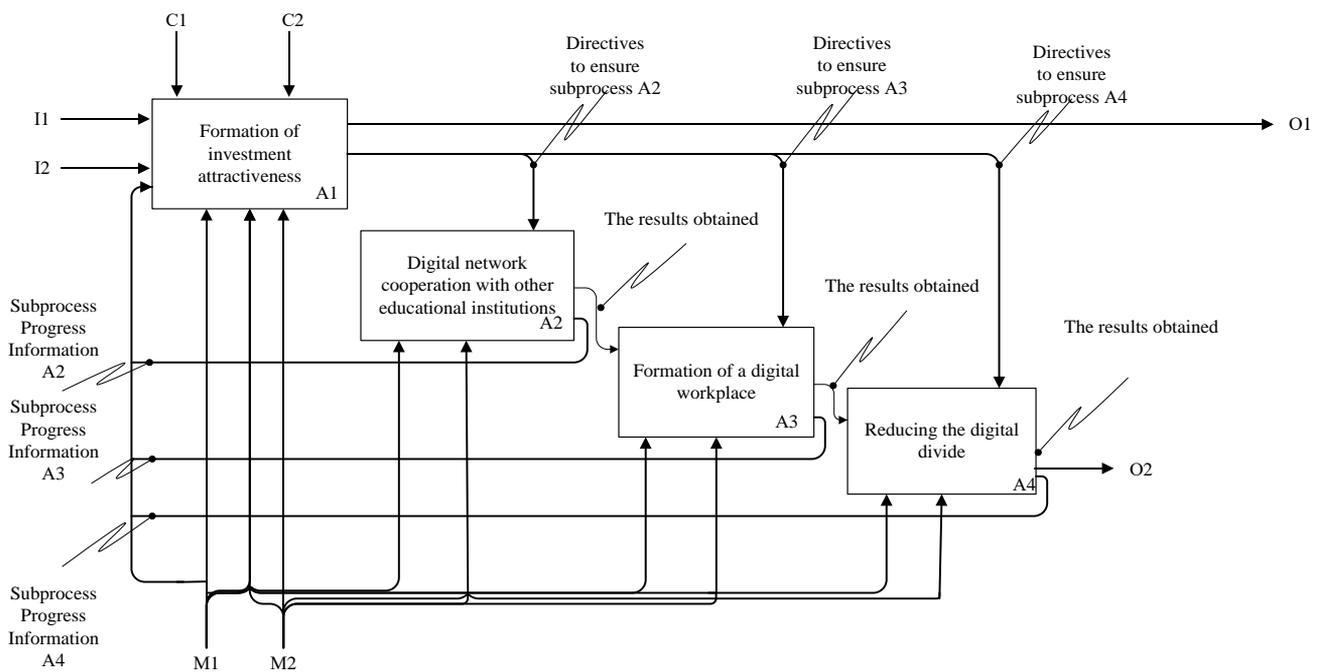
Figure 3. Structural model of the graphical scheme of achieving A0 - Integration of digitalization elements into the sustainable development management system of an educational institution

A2. Digital network cooperation with other educational institutions. By joining consortiums, institutions demonstrate leadership positions in innovation and sustainability in a particular area. It should be noted that networks and partnerships as resources and digital network management as a process underlie further strategic sustainable development. Institutional policy can be used to guide a strategic approach to network management. This will address the issue of data privacy, respect and good ethics in the use of academic analytics and other large amounts of collected and accumulated data, as well as exchanged by institutions. With regard to open educational resources, in the higher education sector, the share of the use of foreign educational resources and the unhindered exchange of knowledge without borders is minuscule through institutional autonomy. Therefore, institutional leadership should strengthen the use of open content.

A3. Formation of a digital workplace. In the conditions of the digital economy, new ways of solving the problem of employment are opening up, because the workplace is no longer identical to a fixed physical object. From the employer's point of view, the undoubted advantage of the digital workplace is that the cost of equipment and office space is reduced. It can be virtual and mobile, which allows the staff not to be at a particular workplace during the whole working day, but to work remotely at home or while traveling, in any geographic location where there is Internet access. The digital workplace often leads to flexible working hours, which attracts an increasing number of workers. Such working conditions, under which one can independently choose the technology for completing the task, and cooperation and mutual assistance become desirable, have a positive impact on the productivity of public service workers, while at the same time solving the problems of sustainable development of decentralized and mobile ecosystems.

A4. Reducing the digital divide. To date, there are reasonable concerns about the exacerbation of the problem of digital inequality with the excessive use of technologies for providing and receiving higher education. The more classes are digitalized, the more behind are those students who cannot afford to buy modern equipment. This problem is most noticeable in developing countries where the

availability of Internet resources is limited. The policy of the educational industry should be based on principles that make it impossible to further the digital divide and contribute to the involvement of all segments of the population in the process of obtaining higher education.

Similarly, we present the diagram of the structural elements of providing B0 - Integration of digitalization elements into the educational process (Figure 4).

First of all, it is necessary to graphically present the scheme for achieving B0 in accordance with the fulfillment of requirement (1). This scheme will lay the foundation for further structural modeling (Figure 5).

Let's form a structural model of the graphical scheme of achieving B0 - Integration of digitalization elements into the educational process (Figure 6).

Let us characterize the key stages of the structural graphic scheme for achieving B0:

B1. Constant use of digital media. The use of digital media makes teaching interactive and more student-centered, which in turn expands the range of assessment scenarios. Using digital learning resources, students can learn at their own pace and decide which learning media or platforms to use in the process. In this way, both the program and the teaching materials are easier to adapt to the needs of each student, as well as to changes in professional and academic requirements.

B2. Formation of digital academic analytics. Digital technologies make it possible to collect and statistically evaluate student learning outcomes and data on teaching success, which can be conditionally called academic analytics. It creates new opportunities that go beyond traditional learning, as well as links between higher education institutions and educational authorities. The systematic collection and analysis of accumulated data makes higher education more transparent. Further, use of sophisticated data analysis can provide a dynamic and instantaneous assessment of the level of training success, which will allow you to quickly respond to problems. So, for example, in a situation where the majority of students experience difficulties in a certain subject or individual students cannot complete a course, the use of academic analytics can help to better understand the causes of learning failure and counteract the failure to achieve learning goals. This analytics can become a kind of feedback for teachers and, perhaps, to a large extent complement the subjective assessments of learning.
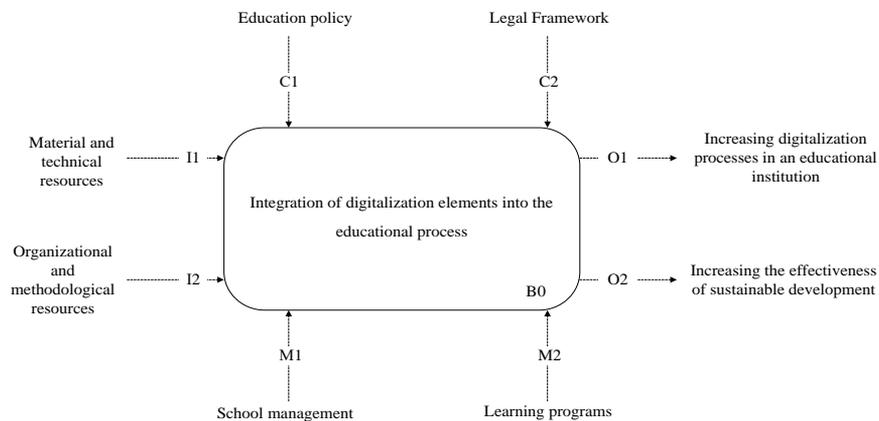
Figure 4. Diagram of the structural elements of providing B0 - Integration of digitalization elements into the educational process
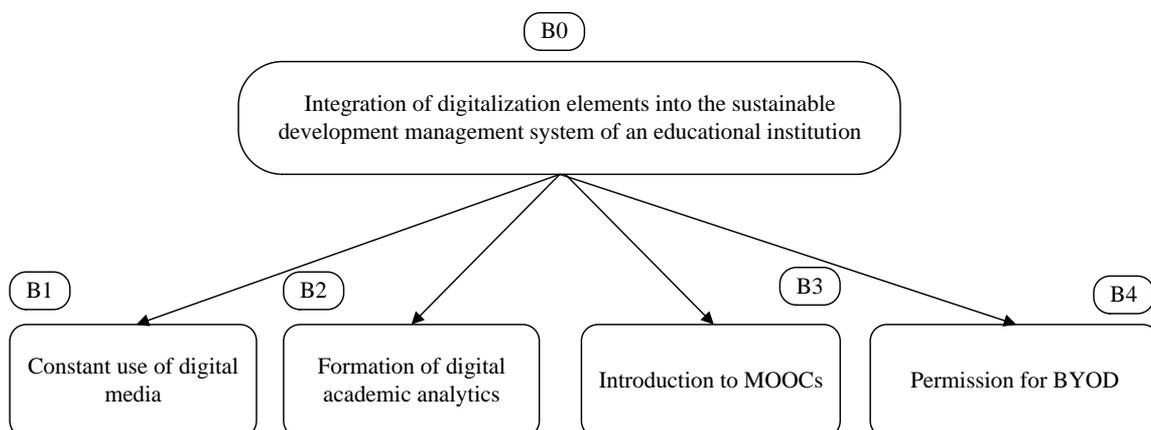
Figure 5. Graphic achievement scheme B0 (Integration of digitalization elements into the educational process)
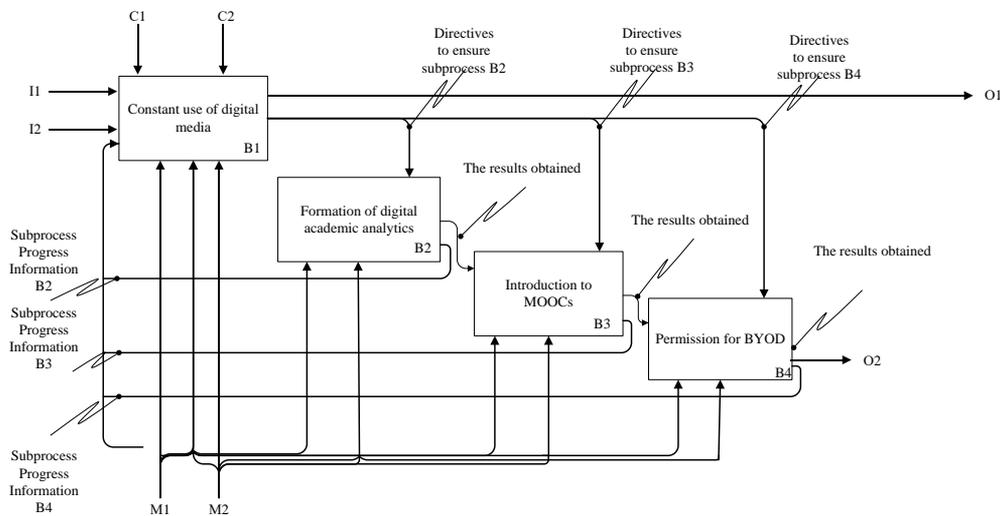
Figure 6. Structural model of the graphical scheme of achieving B0 - Integration of digitalization elements into the educational process
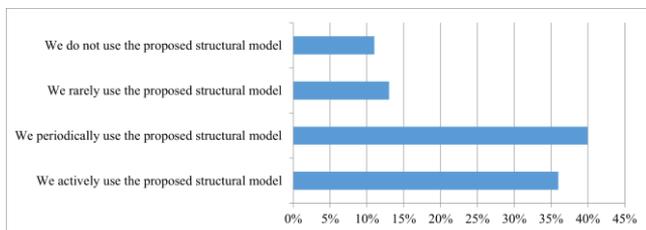
Figure 7. Evaluation of feedback after using the proposed structural models in State University of Physical Culture in the Lviv region

B3. Introduction to MOOCs. Another vector for the development of the digitalization of education, which is gaining popularity among the world's leading universities, is the so-called MOOCs - short for Massive Open Online Courses. The advantage of these projects is the expansion of personalized learning opportunities at any age. However, at the same time, many students state that studying at MOOCs is more difficult than at a regular university: the tasks require deep immersion in the topic, so it takes a lot of time to study the materials and study them on their own. Final exams are usually paid and are taken at regional test centers or directly at home, using special user identification devices. Until the end of the online course, no more than 10% of participants pass.

B4. Permission for BYOD. Learning technologies, facilities, process and assessment are considered as components of the integrated development of the learning environment. Mastering this cyberspace and controlling the processes taking place within it should be done from a pedagogical perspective, subject to the cooperation of experts from different fields. Bring your own device (BYOD) student use and new classroom designs will become more common, leading to more online and mobile learning. BYOD is an organizational policy that allows individuals to use their own devices in the workplace and provide them with access to all critical resources and services through their own mobile devices such as laptops, tablets and smartphones. Near-term prospects include the introduction of the BYOD method and the expansion of new approaches to online learning.

Since the entire team of authors of this article works in an educational institution that requires the integration of digitalization elements to improve its own sustainable development, we had the opportunity to offer the presented models to separate structural units of the State University of Physical Culture in the Lviv region (Figure 7).

It should be noted that the survey and practical application of the model was carried out exclusively by internal forces at the State University of Physical Culture in the Lviv region and more time is needed to identify signs of improvement in their sustainable development.

5. DISCUSSIONS

When discussing the results of our study, we should compare them with similar ones. For example, Kryshtanovych et al. [13] and Qi et al. [14] studied the specifics of the impact of digitalization on ensuring sustainable development. The phenomenon of digitization of education is interconnected with the characteristics of the modern generation, which is rapidly integrating into the global educational space. The active inclusion of personalized services in the lives of young people exacerbates the problem of finding new educational technologies, updating the content of education to meet individual educational needs, personal and professional self-determination in the context of their life and career growth. Digitization of the educational environment for sustainable development expands the boundaries of communication possibilities, which changes the social situation, transforms the motivational and value sphere, affects the personal and professional self-determination of students and students as a digital generation immersed in the digital environment and digital communications, the bearer of values formed under the influence computers, mobile devices, the Internet, social networks.

However, we focus on the digitalization of the educational process and the use of modern technologies that will allow us to achieve sustainable development today. That is, the emphasis is mixed on other aspects.

Another group of scientists considered the digitalization of the sustainable development of education through ready-

made software products. But the use of ready-made software products available on the market represents the implementation of individual fragmented solutions and does not correspond to the philosophy of digital transformation [15-17]. Since many universities use systems from different developers, it is necessary to integrate them, or at least the integration of various databases that will use information from other systems.

Other scientists considered ensuring sustainable development through the formation of an IT architecture for educational institutions [18-20]. 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 is determined that among the main problems of the digital transformation of the education system there are difficulties in combining various technical solutions, that is, the integration of various computer systems. The authors propose solutions through the creation of a single information space for the digital interaction of universities based on a cloud-based platform for the entire education system.

However, our research results have their own elements of scientific novelty and differ from similar ones. We propose an innovative methodological approach to better integrating digital technologies into the education management system in order to ensure its sustainable development for a specific socio-economic system.

6. CONCLUSIONS

Summing up, it should be noted and generalized the information received that the global trends in the development of society, education, science, and the economy are aimed at the transition to digital transformation. In essence, this means that all processes of social, educational, scientific, entrepreneurial and other types of activity are completely transferred to the digital environment for sustainable development. For this, first of all, the digitalization of higher education is required. It is necessary to create digital institutions. This is due to the need for information support, monitoring and control of the process of providing educational, scientific, scientific and technical services, which contributes to raising the level of educational and scientific activities of the university, improving the coordination of the activities of all its structural divisions, transparency of management processes and increasing the productivity of the staff of the institution of higher education. Traditional approaches to automating the activities of higher education no longer meet the requirements of the time. Automated systems of training, management, accounting not only do not solve all the problems of an institution of higher education, 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 education. And of course, this approach does not allow for the effective implementation of digitalization projects, does not allow the creation of a unified system for building digital universities. We need new approaches, new concepts of digital transformation of higher education. Approaches are needed to combine all the processes of creating and using processes for the digitalization of the education management system.

A similar methodological approach was presented in our article. We propose new models for the effective digitalization of the education management system in order to ensure its sustainable development, specifically higher education.

The study has its limitations. Considering that we formed these models for a specific higher education, some structural and content features of the model that we developed were adapted to the realities of the chosen higher education. But it should be noted that the main constructions of the model have remained unified and can be used for other socio-economic systems. Considering that the next stage of our research is the adaptation and use of this model for other institutions of higher education.

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