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DIGITAL TRANSFORMATION OF UNIVERSITY EDUCATION IN UKRAINE: TRAJECTORIES OF DEVELOPMENT IN THE CONDITIONS OF NEW TECHNOLOGICAL AND ECONOMIC ORDER

Abstract. The article substantiates the role of the digital transformation of higher education in Ukraine in the era of the fourth industrial revolution. There was proven the need to develop the strategy of the university education digital transformation, as well as the formation of new information and communication competencies. According to the authors, the strategy of digital transformation of the university education system has to include the modernization of corporate IT architecture management, which should be implemented as a cloud-based platform. The authors analysed the main possible directions of the educational services transformation and the accompanying business processes. The use of blockchain technology for the educational content management module construction is proposed. The integration of the educational content management modules of different Ukrainian universities should become the basis for creating a global cloud-based platform for higher education.

Keywords: information technologies; cloud computing; digital transformation; higher education; corporate architecture; blockchain; digital economy; innovative development.

1. INTRODUCTION

Problem statement. Over the past several years, digital transformation has become one of the main trends, both in industry and in the public sector of many countries. Digital transformation determines the transition to a massive use of digital technologies in the variety of sectors of the economy and society, which improve or replace traditional products and services. According to the World Economic Forum [1], digital transformation offers enormous potential for innovation at a rate of several trillion dollars and applies to many industries (e.g., logistics, healthcare, automotive industry) and social trends (e.g., science, government, etc.). The digital transformation of society not only significantly alters industrial and economic structures, but also introduces new essences in civil, business, state and interstate turnover.

Ukraine's Digital Agenda 2020 states that the rapid and profound consequences of the transition to a "digital" will only be possible if digital transformation becomes the basis for the life of Ukrainian society, business and government institutions, the commonplace and

everyday phenomenon, our DNA, our key goal on the path to prosperity, the basis of prosperity of Ukraine [2].

One of the areas that have enormous potential for digital transformation is the higher education system, especially the system of university education. University education requires the development of a strategy for digital transformation, and the formation of new information and communication competencies. However, the use of digital technologies in the Ukrainian universities is often limited to the creation of multimedia content for lectures and the opening of the access to distance education platforms deployed on the Internet. We believe that the strategy of digital transformation of the university education system should have a broader focus and has to include the modernization of corporate IT architecture management, which could provide an important contribution to structuring the efforts of innovation in education. Cloud-based university platforms can play an important role in the implementation of the Ukrainian education digital transformation and the modernization of traditional educational services. Everything mentioned above indicates the relevance of the chosen topic and outlines the range of issues that require a thorough scientific research.

Analysis of recent research and publications. The theoretical and practical aspects of the digital transformation of society and the system of higher education, in particular, are covered in the works of such authors as S. Berman, R. Bell [3], M. Wißotzki, K. Sandkuhl [4], A. Kuntzman [5], N. Rozanova, A. Yushyn [6], G. Karcheva [7], S. Veretiuk [8] etc.

The main directions of the influence of digital transformation on the evolution of social and economic systems are:

- increasing mobility in satisfying the needs of consumers, allowing to overcome the territorial restrictions and dependence on the location of service providers [5];
- obtaining the possibility of collecting, storing and processing large volumes of information, which leads to a reduction of transaction costs in decision-making and concluding transactions;
- proliferation of network effects [6], that change the chains of generating profits and underlie new business models;
- changing the system of relations between consumers and service providers towards the involvement of consumers in the process of creating a new consumer value, for example, under the concept of "open innovation" [6].

However, existing studies do not fully take into account the peculiarities of the creation and modernization of corporate IT architecture of universities, as well as the emergence and development of cloud-based university platforms that can play an important role in the process of digital transformation of Ukrainian education and modernization of the traditional system of educational services of universities.

The purpose of the article is to study the features and define the main criteria for the university education system digital transformation in the context of transition of the domestic socio-economic system to the innovative nature of development.

2. RESEARCH METHODOLOGY

The research is based on the use of general scientific and theoretical methods: analysis and synthesis of scientific, technical and pedagogical literature concerning the digital transformation of society and its impact on the system of higher education; the combination of theories and conclusions from various fields of research. The paper uses argumentative-deductive, inductive and systematic approaches.

3. RESEARCH RESULTS

According to the World Bank, the digital economy is a system of economic, social and cultural relations based on the use of digital information and communication technologies. The widespread proliferation of digital technologies, their penetration into basically all spheres of human life and society is reflected in the concept of digital transformation. In the era of the fourth industrial revolution, the most important factor – the factor of access to advanced technologies – was added to traditional advantages in the form of inclusive institutions and strong leaders. The technological explosion leads to qualitative changes in business and management [6].

In many industries, products and services are traditionally supplied on the basis of physical infrastructure (for example, shops, banking offices, service centres, universities) or individuals (for example, dealers, brokers, academics, lecturers). Often, products or services are also physically displayed, and operational processes use physical support. In this context, digital transformation determines the transition from traditional creation and sales of services to clients, including related operational procedures, to the use of digital technologies to enhance or replace traditional services with digital ones.

The basis of modern digital enterprises will be the technology of the so-called third platform: cloud computing, mobile services, "brainfacturing", i.e., intellectual production, big data, the concept of IoT (Internet of Things) and social networks.

For the further analysis of the directions of digital transformation, authors used the structural approach proposed in the study [4]. This approach addresses two aspects of digital transformation: the transformation of products and services offered by organizations and the transformation of business processes for the provision of these products, in both aspects, they are distinguished by three stages. In the aspect of transformation of products and services, the following stages are distinguished: improvement (adding additional services), expansion (adding new features of existing products or services through digital components), and redefining (creating new products or services that replace the previous ones). In the aspect of business processes, the stages are as follows: creation (the emergence of new business processes on the basis of IT), leverage (the emergence of new opportunities to achieve greater efficiency of business processes) and integration (the combination of new and traditional business processes into a single infrastructure).

Assuming that the overall goal of digital transformations in the system of higher education is the transformation of educational services and the accompanying business processes, there are three different possible directions that need to be analysed:

- transformation and redefinition of educational services to match the changes in the system of business processes of the university;
- transformation of business processes aimed at creating new and improving the existing IT-based business processes as the basis for further analysis and transformation of educational services;
- combining the first and second directions in order to integrate the simultaneous transformation in both directions.

The first direction mainly requires digitization of all major and most of the auxiliary educational services. Creating profits in higher education institutions is primarily related to the educational process and students (i.e. university admission, the choice of curricula and courses, the results of examinations, etc.), as well as the development of curricula and programs and ensuring their quality. Supporting educational services include: financial management, training planning, academic training scheduling and many other functions. In general, this normally requires creation or implementation of an integrated management

system for higher education, including support for mobile workers and asset management of the organization.

The University, as a provider of educational services, should first focus on creating new services and converting existing services into digital ones. An integral part of this process is the opening of implemented curricula for access outside the higher education institution at the national and international levels. Usually, this involves the creation of digital educational content and the provision of digital interaction and collaboration between students and faculty as well as students between themselves. Internationalization of services also requires adaptation while using the different languages. In addition, most traditional educational programs should be distributed to lower-level programmes, for example, instead of four-year curricula for shorter individual certification programs, or instead of six ECTS training modules, smaller, but combined modules. Such a division will allow the sale of services to a wider audience and increase their flexibility.

In the case of a combination of two directions, their systematic interconnection is established. For example, it may be the creation of a new group at the university to conduct research on a grant, in a combination with the digital transformation of business processes related to a new direction or field of research and the financing of its work. The results of the analysis of competitive advantages and means of digital transformation implementation in the system of university education, carried out by the authors, are shown in Fig. 1.

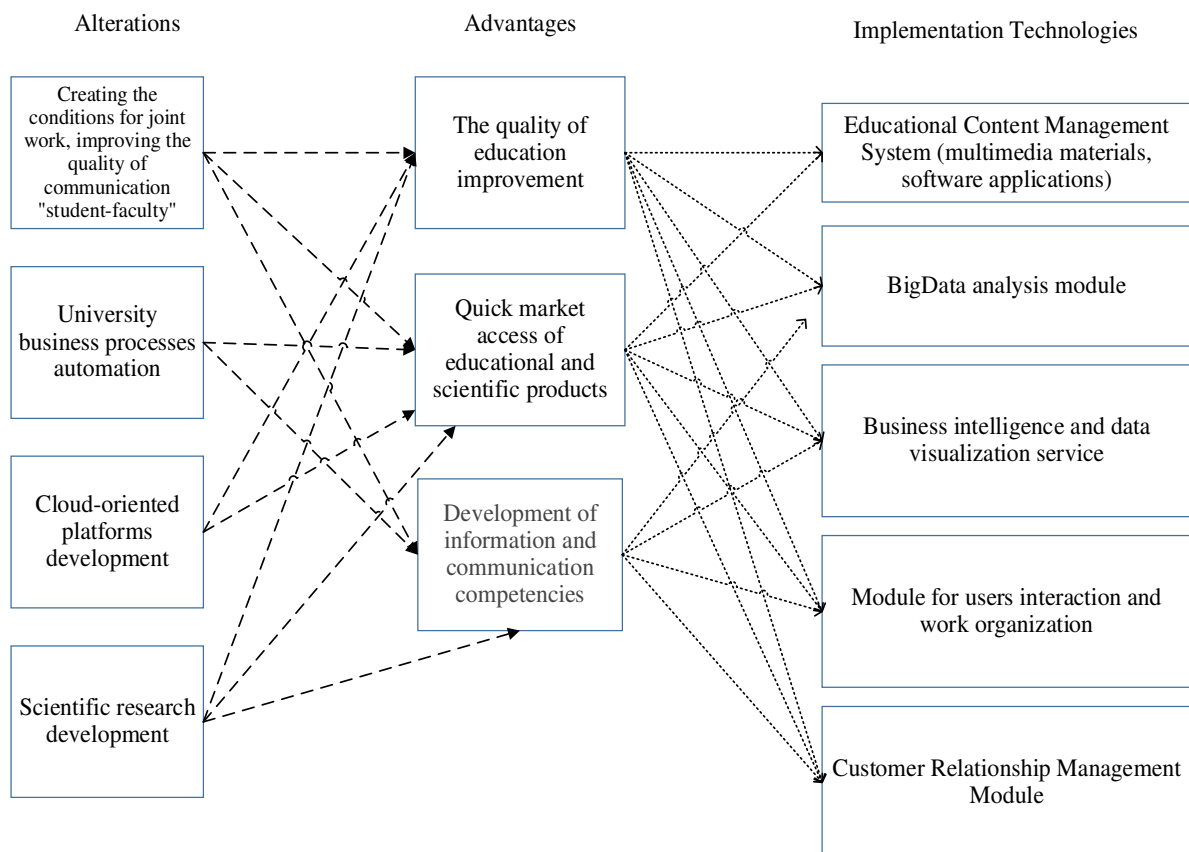


Fig. 1. Implementation of digital transformation in higher education institutions

An analysis of the impact of digital transformation on the University's IT architecture makes it possible to draw the following conclusions:

- The university business process system requires the creation of a directory of administrative services for the training process and internal research, personnel management, infrastructure management and other support services. Also, it is necessary to take into

account all stages of the student's life cycle in the system of business processes (from admission to university to graduation).

- The software application architecture requires the creation of an integrated student life cycle management system, the integration of administrative information systems with systems of planning and management of curricula and modules, databases of scientific data and library repositories. The best way to implement such a system is to create a cloud-based platform for the university.
- The data architecture requires the creation of a publicly available data model with the opportunities for exchange between the universities (for example, for managing the student life cycle, for administrative purposes, for content of lectures, etc.). In modern conditions, educational materials are already created in the form of multimedia, digital content, but often are not integrated with administrative data.
- Technology architecture in the context of digital transformation requires the creation of a centralized IT infrastructure of the university established on a cloud-based platform with additional separate platforms for technology parks and research units [10].

The largest change is needed in the architecture of software applications, which should be implemented as a new cloud-based platform for the delivery of innovative scientific products and educational services. This can be implemented through collaborative cloud-based support in the divided student groups that cannot attend classes in university buildings and are geographically distributed. The digital transformation process will also be affected by the business processes: for example, the formalization of the online exams procedure and the development of modified work processes for issuing the diplomas, certificates, etc. However, most of the traditional university management functions should remain stable. In the data architecture, one of the important transformations will be the more intensive use of digital content and the integration of different types of data with administrative databases and student registers.

The digital transformation process focuses on the digitization of all revenue-generating processes and supporting business processes that affect the business from the point of view of IT architecture of the university. For a business process system, the implementation of digital processes and their optimization is just one of the issues that needs to be addressed. Adaptation of the university organizational structure to change in the business processes, creation of new organizational units for online educational programs or conducting the certified courses are equally important.

For the combined directions of digital transformation, the alteration of services and business processes is initially performed on the basis of separate units or clearly defined individual institutions. An example is the beginning of a digital transformation of only the Master's training system or the modification of internationally oriented training programmes. There is also the possibility of new training formats, such as short curricula (up to one semester) for mixed target groups, in the form of a combination of traditional study and online learning.

Based on the results of the analysis, we can conclude that the educational content management system can serve as an integration point for the implementation of the digital transformation strategy. New target groups of students and educational services formats require adapted support for learning management systems in comparison with the traditional student groups, since the teaching and tuition concepts and materials will be different from the traditional ones. The authors believe that, in order to facilitate this adaptation, the University's educational content management system should be flexibly adapted to the student's individual needs, and integrate existing and future learning process essentials and

tools that support different phases of learning. Such a module for managing the educational content of the university platform is presented in Fig. 2.:

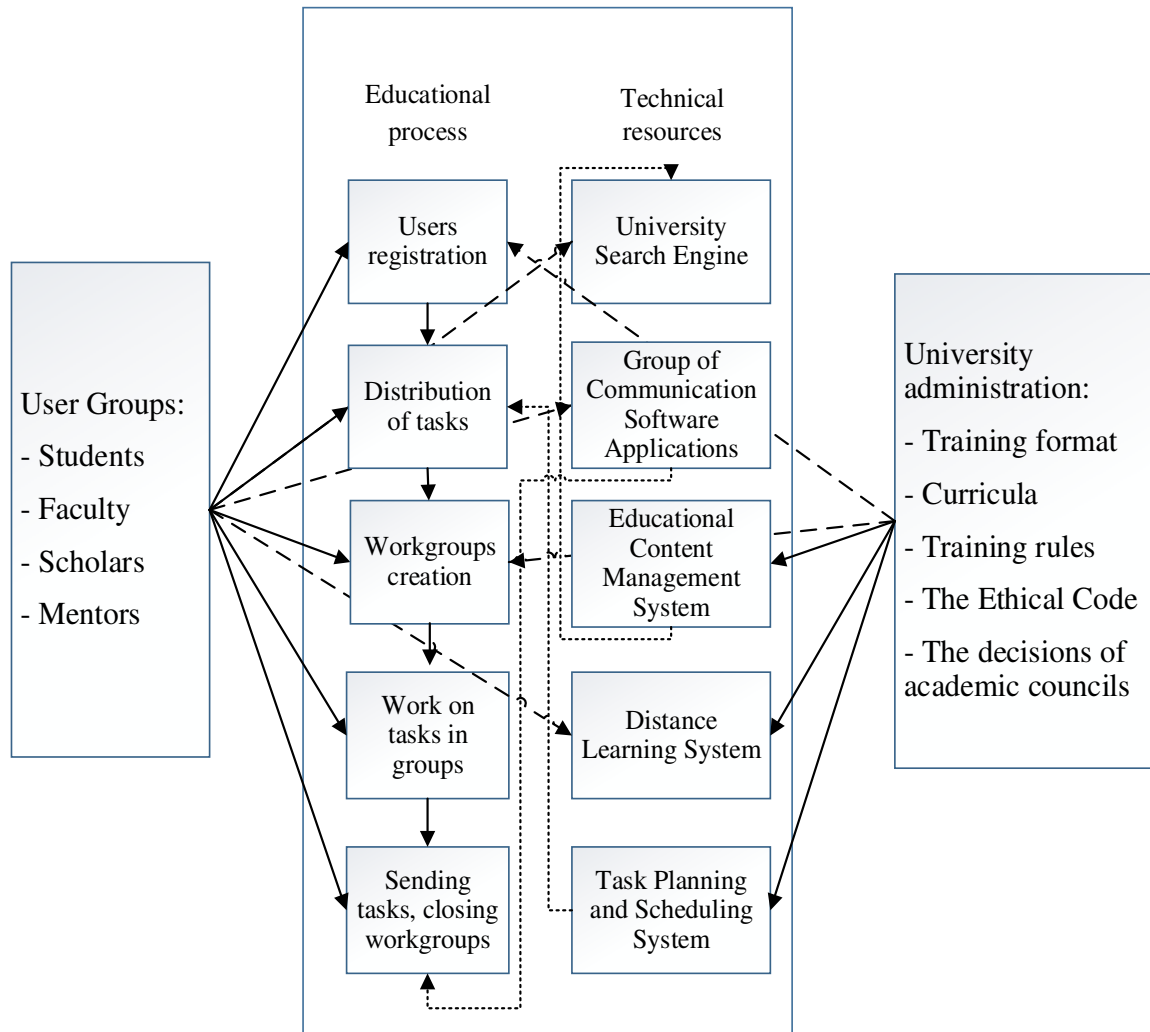


Fig. 2. The block diagram of the educational content management module of the university

The module combines various functions and cloud services in a single UI, and consists of the following set of services:

- University Search Engine - provides a unified user interface for searching all training databases, repositories and databases of research platforms of technology parks using ontologies and related technologies of Semantic Web. Based on the student's profile (that is, on the basis of their training format, integration into working groups and personal data), the priorities of search in databases, which are considered by the system to be most important for the accomplished tasks, are determined.
- Task Planning and Scheduling System: includes training support systems at various courses, audience distribution and e-scheduling, educational planning and provision of individual information. These systems are integrated into one interface and combined by a single data flow.
- a Group of Communication Software Applications includes synchronous (i.e. Skype) and asynchronous communication, document sharing, collaborative document editing and group task explanation.

- Educational Content Management System integrates curriculum managers and training courses (video collections, digital manuals, guides, media content etc.).

The above list shows that the educational content management module facilitates the integration of various cloud services, which, in turn, are the part of the digital transformation of university education. Moreover, the implementation of this module facilitates the synchronization of information flows and the integration of business processes.

The script for using this module starts with the student's login to the system. The student is provided with a personalized web page with relevant materials and courses for his or her tutoring process. After completing the training stages, performing various modules as part of the training format, the student starts downloading a specific module that reflects the current state of their training. When receiving the latest results, the student is faced with various tasks that need to be performed within the module, but they have the option of a free choice of tasks to perform. The module includes an informational analysis of the student's work, providing relevant multimedia materials for research, including the access to a big data analysis system. Also, the tasks involve communication with other students if they are assigned to a workgroup or joint research. All student activities must be documented and carried out within individual schedules and working hours, as well as meet specific interests and responsibilities within the scope of the task. Any transaction completed by a student is recorded in a public accounting book and is the subject to verification and on-going analysis. For the construction of an educational content management module, we propose to use the blockchain technology. The blockchain technology is implemented in the form of a distributed database, which stores data packed in special cryptographically separated blocks in chronological order. New blocks are added to the end of the database, and each new block contains a link (the so-called hash value) to the contents of the previous one. [11]. The block content can be predefined or randomly generated by users of the module. The public key data encryption method is used to ensure the security and reliability of the content of the distributed database.

The blockchain technology, by integrating the educational content management modules of different Ukrainian universities, will ensure the creation of a unified, safe and transparent platform for developing a global cloud-based platform for higher education systems. We can distinguish three main advantages of such project:

- First, it is the content exchange. Academic staff and scholars share ideas and upload their tutoring materials to the cloud so others can use them freely;
- Secondly, it is the emergence of content-based innovation, where tutors co-operate on interdisciplinary and inter-university projects to jointly create new teaching materials using global databases and other tools;
- Thirdly, universities and colleges become part of a global network of lecturers, students and educational institutions learning together in the framework of a general cloud-based platform, nevertheless retaining their identity, financial policy and brand.

The integration of the academic and technological environment, emergence of new mixed forms of learning, early career guidance in the latest industries are only a part of the trends determining the future of education. Much of the breakthrough decisions in this area are realized not by traditional academic institutions, but rather by new players in the education market: financial and technological companies, academic associations, and bright private initiatives. A new transnational market is emerging and it can quickly become a major competitor against the traditional educational institutions, reformat the educational markets and set new rules for them.

4. CONCLUSIONS AND PROSPECTS FOR FURTHER STUDIES

The conducted investigation of society digital transformation in the context of the university education system digitalization, as well as the analysis of the ways for the general transformation and modification of university IT infrastructures brings us to a conclusion that corporate IT architecture of higher educational establishments is the basis for the digital transformation of the entire higher education system of Ukraine.

The basic components of the digital economy, which are developing through its digitization, currently include: infrastructure, electronic business operations and e-commerce. Digital transformation is the significant factor in technological evolution, which allows service providers to overcome the territorial constraints, reduce transaction costs for decision making and bargaining, and develop new business models based on networking effects.

The analysis of the digital transformation impact on the university IT architecture showed that digital technologies enhance the tendency of education system service delivery, creating the preconditions for the development of new business models of educational services. The IT architecture of a modern university should be implemented as a new cloud-based platform delivering the innovative science products and educational services, including digital competence portfolios and educational navigators. The platform will also provide personalized additional training using mobile tracking devices.

The main problems of the education system digital transformation are associated with the difficulties of merging the various technical solutions, the need for security in terms of the confidential information disposition, as well as the risk of imposing poor-quality educational content. In order to solve the above problems, the authors propose to create a single information space for the digital interaction of universities on the basis of a convergent cloud-oriented platform of the entire education system of Ukraine.

We propose the concept of the educational content management module construction for the university platform based on the blockchain technology, which promotes the integration of various cloud educational services, and its creation is the part of the digital transformation of university education.

Further research should include a step-by-step analysis of transformational measures and analysis of all layers of IT architecture of higher education institutions, including the calculation of the economic effect of digital transformation at all its levels. It is also necessary to investigate the digital transformation of other organizations of secondary and vocational education in order to involve them in the construction of a single meta-university platform. Over the next two decades, new technologies and digitalisation processes will generally change the approach to education, and we need to take measures today to prepare for these changes.

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ЦИФРОВА ТРАНСФОРМАЦІЯ УНІВЕРСИТЕТСЬКОЇ ОСВІТИ В УКРАЇНІ: ТРАЄКТОРІЇ РОЗВИТКУ В УМОВАХ НОВІТНЬОГО ТЕХНІКО- ЕКОНОМІЧНОГО УКЛАДУ

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Анотація. У статті обґрунтовано роль цифрової трансформації вищої освіти в Україні в епоху четвертої індустріальної революції. Доведено потребу розробки стратегії цифрової трансформації університетської освіти та формування нових інформаційно-комунікаційних компетентностей. На думку авторів, стратегія цифрової трансформації системи університетської освіти повинна включати в себе модернізацію управління корпоративною ІТ-архітектурою університетів на основі хмаро орієнтованих платформ. Авторами проаналізовано основні можливі напрямки трансформації освітніх послуг і супроводжуючих їх бізнес-процесів. Запропоновано використання блокчейн технології для побудови модуля управління освітнім контентом, а також інтеграція таких модулів різних

університетів України, що має стати підґрунтям для створення глобальної хмаро орієнтованої платформи системи вищої освіти.

Ключові слова: інформаційні технології; хмарні обчислення; цифрова трансформація; вища освіта; корпоративна архітектура; блокчейн; цифрова економіка; інноваційний розвиток.

ЦИФРОВАЯ ТРАНСФОРМАЦИЯ УНИВЕРСИТЕТСКОГО ОБРАЗОВАНИЯ В УКРАИНЕ: ТРАЕКТОРИИ РАЗВИТИЯ В УСЛОВИЯХ НОВЕЙШЕГО ТЕХНИКО-ЭКОНОМИЧЕСКОГО УКЛАДА

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Аннотация. В статье обоснована роль цифровой трансформации высшего образования в Украине в эпоху четвертой индустриальной революции. Доказана необходимость разработки стратегии цифровой трансформации университетского образования и формирования новых информационно-коммуникационных компетентностей. По мнению авторов, стратегия цифровой трансформации системы университетского образования должна включать в себя модернизацию управления корпоративной IT-архитектурой университетов на базе облачно ориентированных платформ. Авторами проанализированы основные возможные направления трансформации образовательных услуг и сопровождающих их бизнес-процессов. Предложено использование блокчейн технологии для построения модуля управления образовательным контентом, а также, интеграция таких модулей различных университетов Украины, которая должна стать основой для создания глобальной облачно ориентированной платформы системы высшего образования.

Ключевые слова: информационные технологии; облачные вычисления; цифровая трансформация; высшее образование; корпоративная архитектура; блокчейн; цифровая экономика; инновационное развитие.



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