

INFORMATION AND COMMUNICATION TECHNOLOGIES AS A TOOL OF STRATEGY FOR ENSURING THE HIGHER EDUCATION ADAPTABILITY TO THE DIGITAL ECONOMY CHALLENGES

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Summary

The intensification of the processes of the digital economy development is leading to the transformation of the higher education system. Universities are forced to digitalize their own educational, research, international, marketing, financial and economic activities in order to maintain a competitive position in the global market of educational services. The purpose of the article is to study the role of information and communication technologies in the development of the higher education system and to ensure its adaptability to modern challenges of digital economy. To achieve this goal, methods of content analysis, logical generalization, systematization and a structural-functional method are used. In the article, the authors substantiate the urgency of forming a holistic strategy to ensure the adaptability of higher education to the challenges of digital economy. In the structure of this strategy, the information-technological block is singled out and described. The authors specified a set of positive synergetic effects from the introduction of modern information and communication technologies in the activities of universities. The main information threats to the digitalization of higher education related to the protection of personal data and university systems from cyberattacks and fraudulent schemes are identified. In conclusion, the authors detail the measures for the strategy implementation to ensure the adaptability of higher education to digital economy.

Key words:

higher education; university; digital economy; information and communication technologies; digitalization; blockchain.

1. Introduction

The XXI century is marked by rapid transformation of all spheres of management and human life; the formation of a new type of economy – the so-called digital economy, takes place. Characteristic features of this type of economy are as follows: the growing contribution of information to socio-economic development, active introduction of information and communication technologies, the development of the global information space, the increase in demand and supply of information products, ensuring free access to information resources, building information infrastructure, intensifying information exchanges, as well as increasing the role of education in the social and economic development of the country. It should be emphasized that not only higher education and the results of its operation (highly qualified specialists for the labor market, scientific developments, inventions and technological innovations) affect the dynamics of digital economy, but digital economy itself significantly affects higher education (see Table 1).

Table 1: Main directions of the impact of digital economy on higher education

Feature of digital economy	Impact directions on modernization processes in the higher education system
The growing role of knowledge in the national economy development	Increasing the requirements for professional knowledge and competences of graduates of higher educational institutions; development of lifelong learning
The growing role of information in the national economy development	Intensification of the generation processes of knowledge, information, the improvements of channels of their transfer in economy
Active implementation of information technologies in the activity of economic entities	Dissemination of distant education; formation of skills of operative mastering and productive work with new information and communication technologies by future specialists
Formation of the global information space	Ensuring wide access for students to information technologies; information mobility and media literacy of the population; training of a new generation of entrepreneurs – capable of conducting the so-called virtual business; the development of the young people's readiness for

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	inter professional and inter territorial labor mobility
Growth of the share of information products in GDP	Orientation of higher education institutions to the specialists' training in new types of professions, the demand for which is formed by enterprises of new types of economic activity
Increase in the share of employees in the field of information technologies	Orientation of higher education institutions on the specialists' training to work with information and communication technologies (especially-narrow specialization); IT staffing
Informatization, computerization	Introduction of modern information and communication technologies in the educational process of universities; the formation of global competences by applicants for higher education; training the specialists capable of competing in the international labor market (given the expansion of employment opportunities abroad through the use of Internet resources)

Source: compiled by the authors

In 2020, the challenges of digital economy were exacerbated by the effects of the COVID-19 coronavirus pandemic. In response to these challenges, higher education institutions are forced to actively digitalize their own activities in order to remain competitive in the educational services market, to attract the best professors and more students from around the world. Moreover, it is not just about the technical side of the introduction of information and communication technologies in educational activities of universities. In the outlined context, the need to form a holistic strategy to ensure the adaptability of the higher education system to digital economy is highlighted.

2. Literature Review

The issue of the application of information and communication technologies in the educational activities of universities is quite widely reflected in scientific publications (Cosmulese et al., 2019; Djakona et al., 2020; Grigoraş-Ichim et al., 2019; Grosu et al., 2021; Kalenyuk et al., 2020). In the articles of Polishchuk et al. (2019), Shkarlet et al. (2016), Samoilovych et al. (2021) the possibility of applying institutional approaches to teaching and learning in the context of the higher education digitalization is investigated. Ugur (2020) reveals the potential of the qualitative approach to research of the higher education digitalization, in particular, on the level of the introduction of multi modal and digital technologies in the educational process for bachelor's degree.

A number of scientific publications are devoted to the disclosure of peculiarities of the modern technologies use by higher education institutions. For example, Santos et al. (2019) study how the use of information and communication technologies by students affect the digital transformation of higher education. Direct and indirect effects of the impact of information and communication technologies on the success of students of higher educational institutions are disclosed in the article of Ben et al. (2008). The Portuguese experience of using communication technologies at universities is studied by Batista et al. (2016); the Russian experience is researched by Koroleva (2020); the German experience is revealed in the article by Bond (2018), the Turkish experience is

analyzed by Bozanta (2017). Romanova et al. (2020) single out the issues of information inequality in the context of the higher education digitalization.

A team of scientists, experts and analysts in a joint article (Barzman, 2021) presented 4 scenarios of digital transformation in higher education and research. These scenarios take into consideration the commodification of knowledge, the dissemination of data, the restoration of multilateral relation between civil society and academia, and others parameters.

It should be noted that the scientific literature describes not only positive consequences of the introduction of information and communication technologies in the activities of higher education institutions. Rodrigues (2017) describes the main challenges and problems faced by universities in the process of digitalization. The scientists emphasizes the need to consider the existing problems of digitalization of higher education institutions in producing digital strategies for their development. Rodrigues (2017) notes that new technologies are the way to increase the efficiency and adaptability of higher education to information society. Despite the presence of a significant number of publications on the introduction of information and communication technologies in the activities of higher education institutions, the problem of ensuring the resilience and adaptability of higher education institutions to digital economy are still insufficiently studied.

The purpose of the article is to study the role of information and communication technologies in the development of higher education and ensuring its adaptability to current the challenges of digital economy.

3. Methods

To achieve the goal of the article, a set of general scientific methods of cognition is used. In particular, the method of content analysis was used to analyze the essence of digital economy and its main features. The method of logical generalization allowed to determine directions of the interaction between higher education and digital economy. Based on the application of the structural-functional method, the structure of the strategy ensuring the adaptability of the higher education system to

the conditions of digital economy is identified, and the exclusive role of the information-technological block of its implementation is substantiated. The systematization method was used to formulate scientific and practical proposals to increase the adaptability level of the higher education system to the conditions of digital economy, as well as to implement theoretical generalizations and conclusions.

4. Results

A prominent place in the strategy of ensuring the adaptability of the higher education system to the conditions of digital economy is occupied by the information technology unit, which is justified by several reasons: the need to create appropriate stimulus in order to introduce and operatively update information and communication technologies by universities to guarantee

the completeness and truthfulness of information resources; ensuring reliability and efficiency of communication channels between higher education institutions and stakeholders; expanding the possibility of free, fast and unimpeded information movement between stakeholders; the modernization of the information infrastructure in the country; the development of consolidated information database out of the transfer of knowledge, information and technologies. The scale and volume of information flows operated by higher education institutions, as well as the arrays of information they generate, are growing rapidly. In addition, there is a rapid update of information, its active dissemination through information networks and communication channels. The scheme of information flows between universities, state regulators, non-governmental education organizations and stakeholders from the business sector and the public is generalized and presented in Fig. 1.

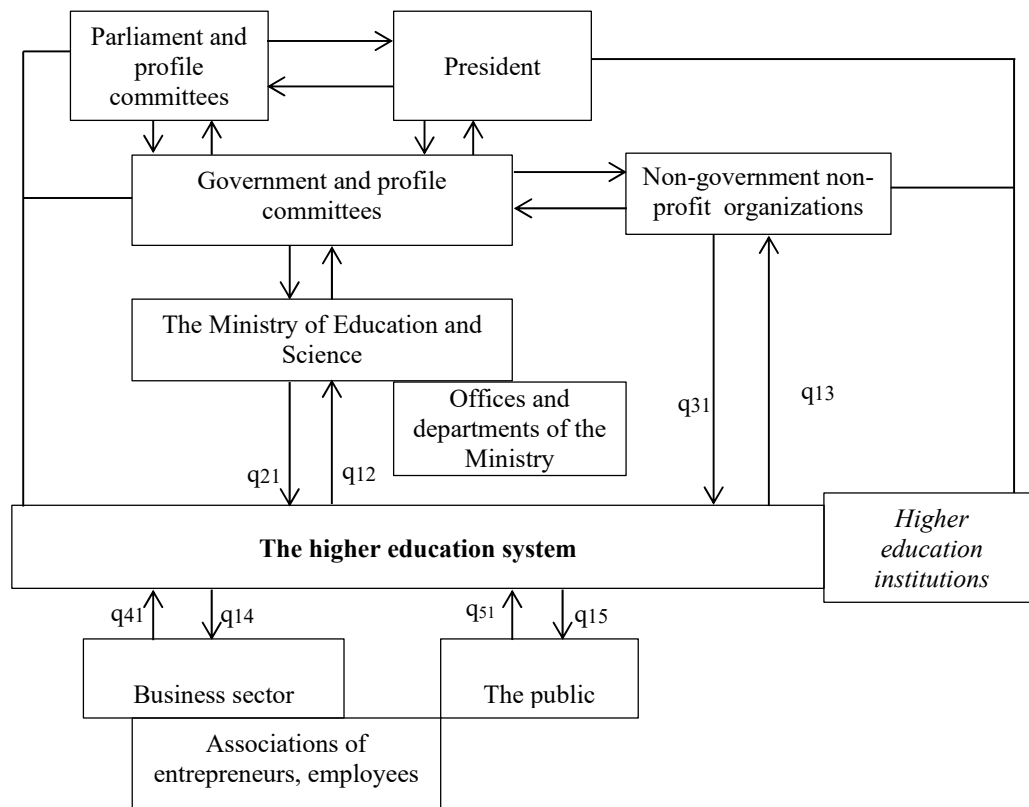


Figure 1. Structural scheme of information flows

Note:

q_{ij} – information flow;

i – element number with information output;

j – element number with information output.

Source: compiled by the authors

Based on the above, we consider it necessary to form a holistic strategy to ensure the adaptability of the higher education system to digital economy, which will be comprehensive and will allow the effective operation of large arrays of information sources that are constantly updated. In our opinion, the information technology block of the strategy should include comprehensive measures for the introduction of innovative information and communication technologies in education, research, management, marketing and other processes of the

functioning of higher education institutions. In addition, the strategy effectiveness depends on the ability to successfully implement it at the macro, meso and micro economic levels (Table 2). This complex approach to strategizing the development of the national higher education system will increase the level of its adaptability to the conditions of digital economy, will create preconditions for the formation of its resilience and flexibility to respond to the challenges of exogenous environment.

Table 2: Levels of the strategy implementation to ensure the adaptability of the higher education system to the conditions of digital economy

Level	Characterizes of the regulation directions	Possible consequences of the effective implementation of measures within the strategy
Macro level	Organization, regulation of modernization processes , the order of their implementation; resource provision, monitoring of the target nature and efficiency of the use of allocated resources	Formation of preconditions at the national level for the implementation of modernization changes in the higher education system; increasing the competitiveness of the national higher education system; synchronization of the subjects' development of higher education and business sectors
Meso level	Mobilization of resources and potentials of the subjects of modernization processes in the higher education system; attracting external resources for the implementation of modernization processes	Interests coordination of the subjects and stakeholders of modernization processes in the higher education system; ensuring the effective use of their potentials
Micro level	Encouraging higher education institutions, research and teaching staff to support modernization changes in the system	Increasing the flexibility of higher education institutions; development of their endogenous environment; increasing the international competitiveness of domestic universities

Source: compiled by the authors

In digital economy, the priority of the modernization of the higher education system is digitalization. This is based on high-speed Internet, HyperNet, 4G, LTE, IoT data acquisition sensors, Big Data storage systems, automated analytical systems and others. The need to find fundamentally new approaches to the educational services provision, the introduction of new educational technologies (advanced-learning-technologies, smart-technologies), focusing on designing individual educational routes, Big Data analysis, cloud computing, virtualization, gamification and the use of augmented reality technologies. Traditional technologies with multimedia formats of the presentation and analysis of information are outdated, as they do not allow to train a competitive specialist in the labor market. They have been replaced by networks and technologies with digital communication systems – based on the ISDN and xDSL technologies.

Moreover, today researchers and practitioners are talking not only about the introduction of mobile technologies, cloud technologies, grid technologies, but also about studying the potential of artificial intelligence technologies, the blockchain (Fig. 2). The creation of a single information scientific and educational space, the software and hardware integration of computer equipment, its maintenance and development of adequate infrastructure require significant financial investments.

This is due to the need to purchase and to install laptops, tablets, mobile devices, to ensure uninterrupted Internet access, the purchase of routes, services and special software products (AIDE, Cppdroid, Iassembly, Pascal N-IDE, Android Web Developer) (Skalatskyi, 2006; Zybareva, 2021); interactive whiteboards, projectors, printers, scanning devices, and etc.

To develop communication between the participants in the educational process and other stakeholders, a program for video conference (Skype), messengers of social networks (Facebook, Telegram, Viber), postal services (meta.ua; ukr.net; gmail.com) and others are often used. Mass scientific events can be conducted using the online service Pruffme, the BigBlueButton platform. With regard to information and communication technologies in educational activities, we can note the greatest prevalence of the distance learning systems, such as: LMS Moodle, eFront; testing programs Google Forms, MyTestX, Kahoot; specialized web-services Prezi, PowToone, Microsoft Sway (to create presentation). Products of the Microsoft Office 365 (Microsoft Exchange Online, Microsoft SharePoint Online, Microsoft Lync Online, Office Web Apps, Drive disk) are being actively promoted in Ukraine (Skalatskyi, 2006; Shkoda et al., 2020; Zatonatska et al., 2019; Shaposhnykov et al., 2021). Among the personalized learning platforms used to train highly qualified professionals at universities are Cortex (the

development Innovate EDU), Buzz (Agilix), Personalized Learning Platform (Summit Learning). Attention should be

also paid to mass open online courses (MOOC) – on the platforms Prometheus, edX, Coursera and others.

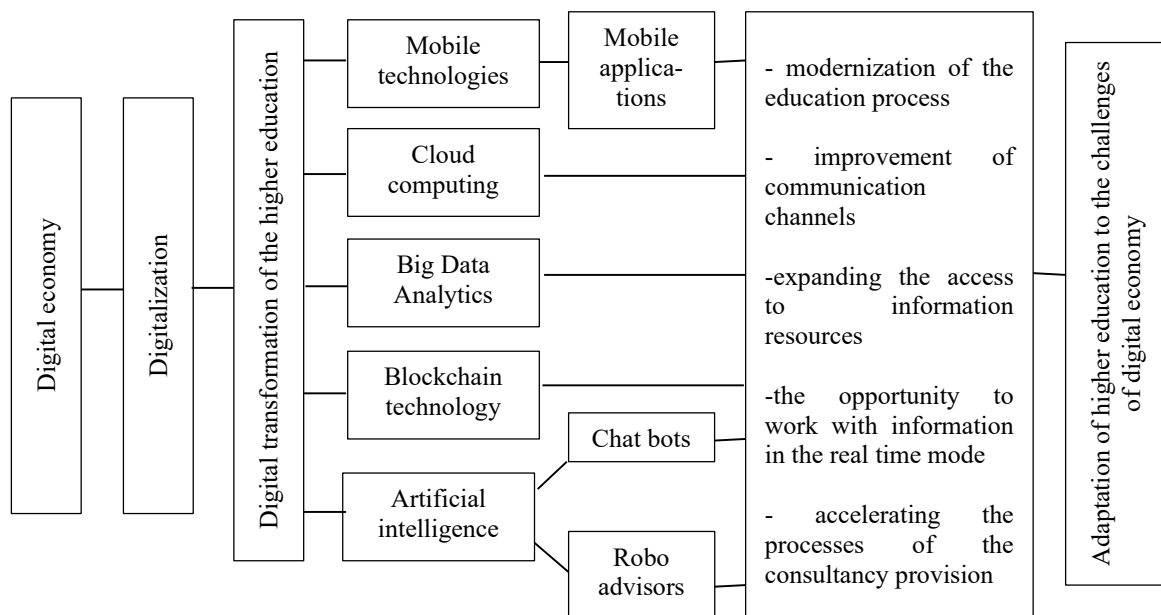


Fig.2. Information and communication technologies for the adaptability provision of higher education to the challenges of digital economy

Source: compiled by the authors

Let's systematize the effective synergetic effects from the effective implementation of the information technology block of the strategy to ensure the adaptability of the higher education system to digital economy:

1) educational activity:

- improving the quality of educational services and, as a result, the competitiveness of the national higher education system and university graduates in labor markets-due to higher motivation of young people to learn educational materials using modern information and communication technologies, i.e., e-skills (information skills);

- solving contextual systematic problems of the higher education development in digital economy;

- increasing information and media literacy of the population; the level of mastery and speed in the course of mastering by students of innovative technologies, which causes a reduction in the cost of enterprises on additional training of graduates providing them with their first job;

- modernization of the educational process, development of lifelong learning, forms of blended learning;

- facilitating “student-teacher” communication (for example, by launching a virtual teacher's office);

- expanding the access to qualitative educational services, attracting foreign students on account of the

development of distance learning, online courses; development of the inclusive environment of the Ukrainian higher education institutions;

2) research activity:

- actualization of researches of domestic scientists on account of the expansion and simplification of the access to the global information systems, repositories, scientific-metric and other researches databases;

- accelerating the communication between the executors of international research projects;

- speeding up the transfer of knowledge and information;

- increasing the efficiency of scientific research due the updating the material and technical basis of laboratories and elements of the innovative infrastructure at universities;

3) managerial activity:

- optimization of the paperwork processes (e-document management);

- minimizing the institutional trap of corruption by ensuring the transparency of the document flow based on the block chain technology;

- operative information flow on account of the creation of information platforms and networks for communication with specialists (by type “Dean Office” “Staff Office”, “E-University” and others);

- finding spare time of specialists to implement their professional obligations due to the introduction of telecommunication technologies, the automation of individual operations;

4) marketing activity:

- monitoring the youth's inquiries (including, in social networks) and the preparation on this basis marketing materials;

- promoting the brand of the Ukrainian higher education institutions on the international level on account of the effective promotion in the Internet network;

- increasing competitive positions of universities due to the qualified promotion of them on the Internet, regular monitoring of changes concerning their image;

- establishing active channels between universities and applicants for higher education;

- events popularization of universities among the members of society, the demonstration of their role in the development of society, city, and region.

Along with the above positive synergetic effects, it should be noted that the implementation of the strategy of the information-technology block to ensure the adaptability of higher education to digital economy should take into consideration negative effects of information threats. In particular, we are talking about the use of the unlicensed software by employees and students of higher education institutions (violation of property rights; vulnerability to cyber attacks, network or virus threats); non-compliance with the rules of the distribution of the licensed content, copyright (academic plagiarism, unauthorized copying of the technology; trust reduction between stakeholders). These threats may be accompanied by risks of outside interference in the system of testing the level of knowledge, students' assessment, databases for the preservation of educational documents, and so on. Failure to take into consideration the identified threats in the strategy can lead to losses for partner organizations, reduce the likelihood of implementing the unique start-up ideas (due to plagiarism and copyright protection) and reduce the level of higher education diplomas. A significant number of problems can be offset by the introduction of the block chain technology in the higher education system, which means a special digital register with a set of organized digital queries in the database. The advantages of this technology implementation are as follows:

- secure network (due to the inability to forge or destroy records in the database);

- legitimacy (due to the certification of transaction blocks with electronic signatures);

- the ability to connect a large number of participants (respectively, the formation of a widely available record of transactions in the database);

- fixing the moment of registration of each transaction; consistent interconnection of transaction blocks in the chain;

- the ability to reliably and relatively inexpensively store data in digital format (Skalatskyi, 2006; Tkalenko et al., 2017; Kosach et al., 2019; Fedyshyn et al., 2019; Koibichuk et al., 2021).

The introduction of the blockchain technology in management of universities will optimize the processes of the information flow management, translate documents flow into electronic format, including The Ministry of Education and Science and its departments. In educational activities, this technology will allow you to reliably record documents about education (diplomas, certificates), the results of testing the level of students' knowledge in certain disciplines, ensuring their safety and legitimacy. The same applies to all contractual relations between higher education institutions and stakeholders, namely: students, customers of research, enterprises, and government agencies. In this context, it is worth emphasizing the prospects of using the blockchain technology in the implementation of the research results commercialization of scientific universities – it will easily track, analyze and ensure the complete legality of their implementation (transparency in terms of volume and timeliness of revenues, their distribution, taxes, etc.).

In general, in our opinion, the development of a single information, scientific and educational space should be implemented on the basis of the blockchain technology introduction in higher education. Collectively, this will ensure greater adaptability of the national education system to the challenges of digital economy. The IT business, understanding these challenges, offers new software products in the market. For example, Sony has produced a special system on the basis of the IBM blockchain with an access to IBM Cloud, which integrates data of the system: IMS (an information and management system) – provides controlling of attending classes, the work of teachers; LMS (an educational system) – contains educational materials, topics, tasks, the results of the evaluation of the success of the applicants for higher education. Taking on the technical side of the System, Sony provides universities with a user-friendly interface. The operation of this system involves the use of the open source software, self-regulating data management solutions and open standards for information storage.

5. Discussion

In our research we support the position of Shkarlet et al. (2019), who identify and analyze the dynamics of educational, research and innovation components of digital economy. Moreover, we hold the view that there is a two-way interaction between higher education and digital economy. In other words, in our opinion, it is not only universities that influence the dynamics of digital economy in course of their educational research, innovation and

international activities. But, on the hand, digitalization of the national economy provides for digital transformation of higher education.

We fully agree with the study that proves the prospects for their use of a wide range of information and communication technologies in the activities of universities: from mobile technologies (Lim, 2017) to social media (Bozanta, 2017). We consider the opinion of Morento et al. (2017) on the importance of building e-learning platforms to simplify the work and to accelerate the students' access to e-learning tools being quite important. In our opinion, in today's digital economy, e-learning platforms of universities should be comprehensive (combining the full range of teaching materials and tools) and available seamlessly in real time. It is also appropriate to supplement these platforms with consulting services, which can be successfully implemented using artificial intelligence technologies (chat bots and/or robo-advisors).

In our firm belief, in the conditions of information society and digital economy, digitalization of higher education cannot be limited exclusively to the use of information and communication technologies in the process of student's learning. Powers of innovative technologies allow to use them successfully in researches of scientists, in carrying out financial calculations. We are impressed by the article of Levina et al. (2016), in which the information approach to management processes of higher education is substantiated. We consider especially valuable the study published in 2015 (Levina et al., 2015), within which the scientists have formulated adaptive mechanisms for managing the educational system development.

The COVID-19 pandemic and quarantine restrictions caused by it have put the problems of digitalization of higher education at the top of the agenda of world organizations. Toader et al. (2021) reveal the challenges faced by teachers and students at higher education institutions during the pandemic. However, this study focuses on some aspects of online learning. Instead, the issues of complex adaptation of universities to new socio-economic conditions of the exogenous environment have remained out of the focus of scientists' attention. Accordingly, it is this direction that we can see prospects for further research.

6. Conclusions

Digitalization is one of the most relevant trends of our time, affecting almost all areas of human activity. Higher education, which is being actively transformed under the impact of digital economy and the challenges of the COVID-19 pandemic, is no exception, in particular in the direction of digitalization of its activities. The adaptation

of the higher education system to the challenges of digital economy must be implemented comprehensively, systematically, and in orderly manner. It is possible to avoid chaos and inconsistency to this end by developing and implementing a holistic strategy that covers different economic levels and takes into consideration interests of different stakeholders. The main measures for the strategy implementation to ensure adaptability of higher education to the conditions of digital economy are as follows: the development of the legal framework for the higher education digitalization; training highly qualified personnel for the national economy which acquires the skills of working with information technologies, have broad information competences, and are able to work in the conditions of high unpredictability of economic environment; increasing the qualification of scientific and pedagogical workers in part of mastering innovative information and communication technologies; guaranteeing information safety of citizens and copyright protection of intellectual property; the creation of educational and research environment at higher education institutions, which should be based on the principles of personification, interactivity, flexibility, secure and unifications of the infrastructure (for example, the could service Nextcloud allows to carry out the synchronization of files, gives an opportunity of joint use of the content, provides confidentiality of the users' server).

Thus, the development of higher education in the conditions of the economy digitalization requires broad implementation of modern information and communication technologies in different directions of the universities' activity based on the elaboration of the integral strategy of ensuring the adaptability of the system to new challenges. Information and communications technologies can be considered in their nature as the advantages of higher education institutions, in 2020 they became an indivisible element and active tool of their development.

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