Basis of the digital economy: use of information and communication technologies in higher education

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Abstract. 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.

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.

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

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<tr>
<th>Feature of digital economy</th>
<th>Impact directions on modernization processes in the higher education system</th>
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<tr>
<td>The growing role of knowledge in the national economy development</td>
<td>Increasing the requirements for professional knowledge and competences of graduates of higher educational institutions; development of lifelong learning</td>
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<tr>
<td>The growing role of information in the national economy development</td>
<td>Intensification of the generation processes of knowledge, information, the improvements of channels of their transfer in economy</td>
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<tr>
<td>Active implementation of information technologies in the activity of economic entities</td>
<td>Dissemination of distant education; formation of skills of operative mastering and productive work with new information and communication technologies by future specialists</td>
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<td>Formation of the global information space</td>
<td>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</td>
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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.

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; Grigoraș-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.

**2 Research 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.

**3 Results and Discussion**

A prominent place in the strategy of ensuing 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.

![Fig. 1. Structural scheme of information flows](image)

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 |
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, smarttechnologies), 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 (Figure 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 uninterruptable Internet access, the purchase of routes, services and special software products (AIDE, Cppdroid, iassembly, Pascal NIDE, 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.

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

<table>
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<tr>
<th>Level</th>
<th>Characterizes of the regulation directions</th>
<th>Possible consequences of the effective implementation of measures within the strategy</th>
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<tr>
<td>Macro</td>
<td>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</td>
<td>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</td>
</tr>
<tr>
<td>Meso</td>
<td>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</td>
<td>Interests coordination of the subjects and stakeholders of modernization processes in the higher education system; ensuring the effective use of their potentials</td>
</tr>
<tr>
<td>Micro</td>
<td>Encouraging higher education institutions, research and teaching staff to support modernization changes in the system</td>
<td>Increasing the flexibility of higher education institutions; development of their endogenous environment; increasing the international competitiveness of domestic universities</td>
</tr>
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</table>
2) research activity
3) managerial activity
4) marketing activity

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:

4 Conclusion

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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