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## ONLINE EDUCATION AS A DRIVER OF DIGITAL TRANSFORMATION AND ECONOMIC SUSTAINABILITY OF UNIVERSITIES

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*The article examines online education as a key driver of digital transformation in universities and a factor in strengthening their economic sustainability. It analyzes current trends in the global education services market, the impact of online learning formats on the financial stability of higher education institutions, and the specifics of integrating EdTech technologies, educational data analytics, and artificial intelligence into the structure of university management. The role of impact investing, social investment bonds, and “university-business-state” partnership ecosystems in the formation of sustainable financial models for digital universities is revealed. The main directions of online education development have been identified: micro- and macro-education, blended learning formats, corporate educational practices, and personalized learning trajectories. As a result of the study, it has been determined that the combination of technological, organizational, and financial solutions in a single digital ecosystem ensures the transition from partial digitalization to a fully digital university model, where data becomes a strategic resource and AI solutions become the core of personalization, cost optimization, and improvement of education quality. Further work should focus on developing procedures for assessing the value of digital educational assets, designing impact financing models for online programs, and refining ethical standards for the use of AI in personalized learning.*

*Keywords: online education; digital university; economic sustainability; EdTech; learning analytics; artificial intelligence; digitalization; blended learning.*

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### PROBLEM STATEMENT AND ITS RELEVANCE TO KEY SCIENTIFIC AND PRACTICAL OBJECTIVES

At the turn of the 20th and 21st centuries, the preconditions for radical changes in the global economy, politics, culture, and the structure of the world economy began to take shape. In these conditions, education is becoming one of the most dynamic sectors of the global services market, forming an entire branch of the global economy – the global market for educational services. Population growth, increased life expectancy, and an increase in the proportion of working-age citizens have led to a global trend toward lifelong learning, which requires new approaches to the organization of the educational process and the digital transformation of universities. According to forecasts by the Wittgenstein Centre for Demography and Global Human Capital, by 2050, the number of graduates at all levels of education worldwide will increase by more than 2 billion people, which will significantly affect the demand for educational services and the workload of educational systems in general [1]. In such conditions, the traditional university model is no longer able to meet the needs of the global market, and online education is becoming the leading tool for expanding access, improving quality, and ensuring the economic sustainability of educational institutions.

The development of the global economy is accompanied by processes of deindustrialization in developed countries and the relocation of production to developing countries, where new education markets with high growth potential are forming. Education is becoming a key factor in the competitiveness of nations and regions, and knowledge is turning into a specific economic resource and commodity that determines the stability and development dynamics of modern economic systems. In this context, the study of online education as a driver of digital transformation of universities is becoming particularly relevant, as it not only ensures the technological modernization of the educational process but also creates the conditions for financial stability, expansion of partnership ecosystems, and integration into the global educational and economic space.

### ANALYSIS OF RECENT RESEARCH OR PUBLICATIONS THAT HAVE INITIATED THE SOLUTION OF THIS PROBLEM AND ON WHICH THE AUTHOR RELIES

The issues of digital transformation of universities and the development of online education are widely covered in contemporary scientific research. The works of G. Kortemeyer, N. Dittmann-Domenichini, and C. Merki [2] examine changes in students' choice of learning formats (full-time, hybrid,

and distance learning) after the pandemic and determine their impact on educational outcomes. A. Krap et al. [3] investigated the impact of digital technologies on modern approaches to corporate governance, emphasizing the role of digital solutions in improving the efficiency of educational institutions. The work of S. Kubiv et al. [4] substantiates the importance of innovation potential and digitalization for improving the competitiveness of education systems. H. Lan, Y. Zhang, and W. Liu [5] emphasize the assessment of teachers' digital competence as a key factor for the successful implementation of online learning. L. Leiva, M. Matera, and J. Schöning [6] identified the importance of user experience and digital interfaces in ensuring effective interaction in an online environment. The work of M. Kaku [7] examines the impact of robotization and artificial intelligence on the transformation of labor and education, which leads to new requirements for the training of specialists. S. Lysenko et al. [8;9] investigated the role of artificial intelligence in the automation of cybersecurity processes, which is a necessary condition for the safe functioning of digital universities. The study by O. Tymoshenko and S. Yahodzynskyi [10] reveals the peculiarities of the digitalization of universities in the context of modern challenges and prospects for integration into the global educational space.

#### **IDENTIFICATION OF PREVIOUSLY UNRESOLVED PARTS OF THE GENERAL PROBLEM ADDRESSED IN THIS ARTICLE**

Despite the active introduction of digital technologies in education, the issues of determining the economic effects of online education, assessing its role in shaping the financial stability of universities, and mechanisms for combining innovative educational models with economic instruments such as impact investing, digital educational assets, and partnership platforms remain insufficiently studied. The transition from partial digitalization to the creation of a fully digital university, in which online education is the basic driver of the transformation of managerial, scientific, and educational activities, has not been adequately scientifically substantiated.

#### **FORMULATION OF THE ARTICLE'S OBJECTIVES (TASK STATEMENT)**

The aim of the article is to provide a theoretical and analytical substantiation of the role of online education as a key driver of the digital transformation of universities and a factor in strengthening their economic sustainability.

#### **PRESENTATION OF THE MAIN RESEARCH MATERIAL WITH FULL SUBSTANTIATION OF THE SCIENTIFIC RESULTS OBTAINED**

The global COVID-19 pandemic has been a catalyst for unprecedented changes in the education system, causing more than 1.5 billion students to switch to online learning by the end of March 2020, which accounted for about 87% of the total student population worldwide. According to UNESCO, the transition to distance learning has affected educational institutions in more than 170 countries, transforming the usual forms of organizing the educational process and managing educational systems [11]. The forced digitalization of education has directed the activities of governments and educational institutions towards solving priority tasks related to ensuring technical accessibility, continuity of the educational process, training teachers to work in a virtual environment, and psychological adaptation of participants in the educational process to new formats of interaction.

The EdTech industry proved to be the most prepared segment of the education market for the sharp increase in demand for distance learning formats, as it has the necessary resources – online educational platforms, cloud services, intelligent content management systems, and analytical tools for assessing educational outcomes. It is these technological solutions that have proven their effectiveness, become a strategic tool for maintaining the continuity of the educational process, and have been officially recommended by state education authorities in most countries around the world.

Before the pandemic, the potential of the EdTech industry was limited primarily by long investment cycles. While the most successful companies operated for an average of 6-8 years, the payback period for capital investments was at least 10 years. However, in 2020-2023, the situation changed dramatically: global demand for online education grew exponentially, shortening the return on investment period and stimulating capital inflows into the educational technology sector. Leading companies, including Pearson, have seen a fourfold increase in user activity on their digital platforms. Other major players, such as Vedantu, Udemy, and UpGrade, have reported the creation of new jobs and the expansion of their range of educational products, indicating the formation of a new model of digital employment in the education sector.

Pandemic restrictions have also initiated a trend toward democratizing access to knowledge. Free educational courses, launched during the quarantine period, have become an impetus for the development of self-education and professional development. Massive online schools have begun to use the model of free introductory courses as a means of attracting new audiences. However, due to increased competition, this strategy has transformed into a more radical one, making educational materials completely open to students. For example, the Coursera platform, in partnership with universities around the world, has provided free access to 3,800 courses in more than 400 specializations, and European educational services have provided access to a thousand short-term professional development programs [12].

One of the notable trends in the development of the global online education market in the post-pandemic period has been the growth in the number of new players, primarily educational content aggregator platforms such as GetCourse, Eduardo, Gurucan, and others. Such systems specialize in hosting author courses, interactive learning materials, and digital simulations, as well as providing real-time monitoring of students' performance and progress. This format has become extremely popular among teachers, entrepreneurs, and educational startups, who now have the opportunity to create their own educational products without the need for complex technical infrastructure.

Despite the instability of the global economic situation, the EdTech market is showing a trend toward institutional growth, as educational technologies have proven their viability in crisis conditions. The entry of new players into the market has contributed to increased competition and diversification of educational offerings. The success of these platforms is largely ensured by the prior training of entrepreneurs through open courses on building online schools and educational businesses, which spread across the global network in 2020-2022. This has formed a new educational and entrepreneurial segment that combines pedagogical innovation, marketing strategy, and digital competence.

The further development of the global online education market directly depends on the degree of digitalization of education systems. Leading researchers and education experts emphasize that the question is no longer whether digital technologies can change education, but how profound and lasting this impact will be [2;5;6;8]. Key aspects of the transformation are being discussed: whether students will be able to perceive distance learning as a full-fledged alternative to classroom-based forms; whether it will be possible to train a sufficient number of teachers who are ready for a complete transition to online learning; how the balance between traditional and digital forms of education will change; whether the mass introduction of innovative methods will lead to a real improvement in the quality of education [3].

According to forecasts by the World Economic Forum, the future of the global online education market will be determined by stronger partnerships between public and private educational institutions, which will work together to expand access to digital technologies and create sustainable educational ecosystems [13]. At the same time, researchers note that digital inequality will remain one of the key global problems – the gap in access to technology between countries, regions, and social groups will continue to grow [8;9].

Despite the economic recession of 2020, the pace of online education development has not only slowed down, but has accelerated. As noted by S. Lysenko et al., the online segment is becoming a strategic priority for most universities and educational organizations, as it provides scalability of educational services and reduces transaction costs. This allows universities to maintain economic stability even in the face of external shocks and unpredictable crises [8, p. 47].

According to researchers, the key directions in the development of online education in the coming years are:

- the creation of distance learning courses for academic staff;
- converting most university lectures into a digital format using interactive tools;
- the transformation of traditional classrooms into laboratories for practical experiments and project work;
- the development of blended learning models that combine online and offline components [2;8].

At the same time, the role of the private sector in financing the digitalization of education is strengthening. Leading global IT companies are actively investing in the development of educational ecosystems. In particular, Apple supports more than 400 educational institutions in various countries, promoting the introduction of digital technologies in education. An example of institutional integration is the so-called Steve Jobs Schools in the Netherlands, which combine the individualization of the educational process with technological learning tools. The main teaching tool in such schools is the iPad, which enables the implementation of flexible learning scenarios, the creation of personalized programs, and the development of digital skills in children from the primary education level [14].

Along with this, the scientific community is increasingly considering the prospect of forming a fully digital university – an institutional model in which all educational, scientific, managerial, and communication processes are carried out in a single digital ecosystem [8;9]. Such a university will operate on the basis of integrated distance learning platforms, knowledge management systems, big data analytics, artificial intelligence, digital avatars of teachers and students, blockchain identification, and electronic document management.

The concept of a fully digital university involves a transition from partial to full digitalization of the organizational architecture, where data is a strategic resource and digital services are a key means of creating added value. This ensures transparency in management, personalization of learning, flexibility of academic programs, effective interaction with business and scientific partners, and increases the economic sustainability of the institution through cost optimization and the creation of new sources of income.

Thus, the current stage of development of the global online education market is characterized by the integration of financial, technological, and social innovations that create new architectonics of interaction between the state, business, and educational institutions. One of the key instruments for financing digital transformation is social investment bonds, which are aimed at attracting private capital to implement educational and socially significant initiatives [10, p. 7]. The essence of the mechanism is that the state reimburses investors for their investments only if certain social and educational results are achieved, such as an increase in the academic performance of students by a certain percentage or an increase in the proportion of graduates who have successfully found employment.

This format of impact investing opens up new opportunities for the development of online education, as it provides mutually beneficial synergy between the private sector and educational institutions. For businesses, this means lower costs for retraining employees: many companies are forced to invest in additional training for young specialists due to the mismatch between university programs and the real demands of the market. According to experts, the average adaptation cycle for a graduate to the conditions of a company lasts about a year, while cooperation between universities and businesses within online programs allows this period to be reduced by integrating students into project-based activities and internships at companies [1].

For educational institutions, such partnerships create conditions for sustainable human resource development: universities receive resource support to modernize their learning platforms, open digital laboratories, and develop hybrid learning programs. At the same time, businesses receive trained specialists who are familiar with the company's internal processes, which minimizes the risks of incorrect personnel selection. This approach is particularly effective for regional universities, which can attract applicants and strengthen their competitiveness through partnership digital programs [13].

Analyzing market development trends, researchers identify several structural trends that are shaping a new paradigm of online education and directly affecting the economic sustainability of digital universities:

- the growth of the education market, increased sales of educational services, and the mobility of students and teachers;
- the internationalization of programs and the development of cross-border learning formats;
- the increased competition and regular emergence of new platforms and content aggregators;
- the enhancement of educational institutions, which are moving from fragmented digitalization to the construction of integrated ecosystems;
- the revision of state policies in the field of export and import of educational services;
- the creation of regional education markets and the formation of digital learning clusters;
- the development of network structures for cooperation between universities, startups, and corporations;
- the transition from mass education to personalized education focused on the unique competencies of learners [2;3;5].

The key drivers of market growth are the introduction of blended learning formats, the development of artificial intelligence technologies, the individualization of educational trajectories, and the growing demand for qualified personnel in the digital economy. Recent events have shown that completely replacing classroom learning with an online format is not yet feasible, but it is the synthesis of offline and online components that is proving to be the most effective transitional stage to a new university model [7;8]. This format ensures the gradual introduction of artificial intelligence technologies, educational data

analytics, and integrated digital platforms that allow tracking the dynamics of material assimilation, identifying students' strengths and weaknesses, forming individual recommendations, and supporting the adaptability of the educational process. In this context, universities are systematically moving towards the creation of a fully digital educational environment in which digital tools do not replace traditional education but expand its capabilities, ensuring flexibility, personalization, and sustainability of the educational system.

Indeed, artificial intelligence and educational analytics are at the core of the new generation of universities, ensuring content adaptability, assessment automation, formative testing, and academic performance prediction. Universities that actively integrate AI solutions demonstrate not only an improvement in the quality of the educational process but also greater economic stability due to reduced costs and increased scalability of educational services [2;3].

A significant factor in the development of online education is the rise in the cost of traditional education, which exceeds inflation rates. In these conditions, online education programs are a more affordable alternative, providing an equivalent level of qualification at a lower cost. The advantages of distance learning formats are complemented by the flexibility of learning: students can choose their own pace, combine learning with work, and employers can obtain certified specialists without interrupting production.

Among the new pedagogical formats, hybrid learning, microlearning, and macrolearning are becoming increasingly popular []. Microlearning is focused on the rapid acquisition of applied competencies and is gaining popularity due to short modules on platforms such as YouTube, Pathgather, Axonify, EdCast, and Grovo. Macrolearning covers systematic professional training, represented on platforms such as Coursera, EdX, General Assembly, Udacity, Udemy, SkillSoft, and others. Universities that integrate both approaches provide flexibility and continuity of learning, forming an ecosystem of lifelong learning.

Another trend is corporate storytelling training, which is based on the use of real company cases and implemented through cloud platforms. Such solutions allow the learning process to be combined with business practices, promote the formation of professional thinking, and create new economic value for knowledge.

Taken together, these trends reflect the evolution of the educational ecosystem from traditional institutions to a fully digital university model, where online education is the basic driver of innovation and sustainable development. It is the integration of EdTech technologies, AI analytics, and impact investing instruments that is shaping a new type of university – one that is economically sustainable, open, personalized, and competitive in the global digital space.

#### **CONCLUSIONS FROM THIS STUDY AND PROSPECTS FOR FURTHER RESEARCH IN THIS AREA**

To sum up, it should be noted that online education is a systemic driver of the digital transformation of universities and, at the same time, a mechanism for strengthening their economic sustainability. The combined effect of market trends (the scaling of EdTech, the emergence of content aggregators, the transition to micro/macro education), impact investing instruments, and data-centric learning process management logic creates the institutional prerequisites for a fully digital university model. In this model, data becomes a strategic resource, and AI solutions and learning analytics become the core of personalization, effective cost allocation, and scaling of educational services without compromising quality. At the same time, the importance of the ethical dimension and risk management is growing: overcoming digital inequality, ensuring academic integrity, transparency of algorithms, and privacy protection.

It has been proven that coordinating technological, organizational, and financial decisions within a single ecosystem transforms a university from fragmented to managed digitalization with measurable effects – improved educational outcomes, cost optimization, and revenue diversification. Further research should focus on developing models for assessing the value of digital educational assets, designing impact financing mechanisms for online programs, and validating ethical standards for the use of AI in personalized education. This will ensure the methodological completeness of the transition to a fully digital university and support its economic sustainability in a dynamic global environment.

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## ОНЛАЙН-ОСВІТА ЯК ДРАЙВЕР ЦИФРОВОЇ ТРАНСФОРМАЦІЇ УНІВЕРСИТЕТІВ І ФОРМУВАННЯ ЇХ ЕКОНОМІЧНОЇ СТІЙКОСТІ

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У статті теоретично й аналітично обґрунтовано онлайн-освіту як системний драйвер цифрової трансформації університетів і водночас механізм зміцнення їх економічної стійкості. Мета дослідження – показати, яким чином поєднання EdTech-платформ, аналітики освітніх даних і ШІ, змішаних форматів навчання, а також інструментів імпаکت-фінансування та партнерських екосистем переводить ЗВО від фрагментарної цифровізації до моделі повністю цифрового університету. Методологія спирається на міждисциплінарний підхід: систематизацію сучасних наукових джерел і практик, порівняльний інституційний аналіз форматів онлайн/змішаного навчання, економічну інтерпретацію ефектів масштабування, а також концептуальне моделювання архітектури цифрового університету.

Отримані результати демонструють, що онлайн-освіта формує нову логіку створення вартості у вищій освіті: забезпечує персоналізацію та адаптивність навчання завдяки ШІ-рішенням і навчальній аналітиці; підвищує керованість і прозорість через даноцентричні процеси; створює умови для масштабування освітніх послуг без втрати якості; активує ринкові механізми (мікро-/макроосвіта, агрегатори контенту, корпоративні кейси) й відкриває канали імпаکت-інвестування (зокрема соціальні інвестиційні облігації) для фінансування цифрової інфраструктури та програм підвищення якості. Показано, що синтез онлайн-компонентів із офлайн-практиками є оптимальним перехідним етапом, який підвищує стійкість ЗВО до зовнішніх шоків, прискорює оновлення програм і скорочує цикл адаптації випускників до вимог ринку праці. Окреслено ключові структурні тренди ринку (інтернаціоналізація, кластери цифрового навчання, мережеві ефекти платформ) і регуляторно-етичні умови результативності (подолання цифрової нерівності, академічна доброчесність, прозорість алгоритмів і захист приватності).

Новизна полягає у цілісному обґрунтуванні онлайн-освіти як системного драйвера переходу університетів від фрагментарної цифровізації до моделі повністю цифрового університету, де дані виступають стратегічним ресурсом. У рамках статті інтегровано педагогічну площину (змішані формати, мікро-/макроосвіта, персоналізація на основі навчальної аналітики та ШІ) з економічною (ефекти масштабу, зниження транзакційних витрат, диверсифікація доходів, імпакт-фінансування через соціальні інвестиційні облігації). Запропонована логіка «платформи – дані – сервіси – управління» показує, як EdTech та AI формують нову архітектуру створення освітньої вартості й підсилюють економічну стійкість ЗВО. Подальшу роботу доцільно спрямувати на розроблення процедур оцінювання вартості цифрових освітніх активів, проектування моделей імпакт-фінансування онлайн-програм (зокрема з використанням соціальних інвестиційних облігацій) та їх валідацію на практиці, а також уточнення етичних стандартів і критеріїв прозорості застосування ШІ в персоналізованому навчанні з урахуванням академічної доброчесності й захисту приватності.

Ключові слова: онлайн-освіта; цифровий університет; економічна стійкість; EdTech; навчальна аналітика; штучний інтелект; діджиталізація; змішане навчання.