



<https://doi.org/10.15407/scine22.04.139>

POKORNY, N. S. (<https://orcid.org/0009-0003-5316-0809>)

European University,
16 V, Vernadsky Blvd., Kyiv, 03115, Ukraine,
+380 44 334 5304, vup@e-u.edu.ua

DIGITAL UNIVERSITY AS AN INNOVATIVE SOCIO-TECHNICAL SYSTEM

Introduction. Digital technologies have been driving a radical transformation of higher education, leading universities to evolve into innovative ecosystems. The study of the digital university phenomenon has become particularly relevant in the context of the globalization of the educational landscape. The integration of digital technologies into educational processes has not only changed methods of learning and interaction but has also transformed the very nature of the university.

Problem Statement. Existing approaches to defining a digital university are diverse but do not fully capture its essence as a complex socio-technical system that integrates technological, pedagogical, and social components. The need to develop a unified conceptual framework that encompasses all dimensions of digital transformation in education has remained an urgent research challenge.

Purpose. The purpose of this study has been to develop a conceptualization of the digital university as an innovative socio-technical system that drives a fundamental transformation of the educational process and ensures its alignment with contemporary challenges and global trends.

Materials and Methods. The study has been based on systems analysis and synthesis of existing approaches to interpreting the digital university, as well as on structural modeling of its organization as a socio-technical system with the integrative role of a digital platform. In addition, generalization and comparative analysis of international practices in the digitalization of higher education have been conducted, with particular attention to cloud services, learning analytics, and the application of artificial intelligence.

Results. It has been established that a digital university functions as an integrated socio-technical system in which the technical subsystem (infrastructure, platforms, digital resources, and intelligent technologies) is combined with the social subsystem (participants, organizational practices, and competencies). It has been demonstrated that the effectiveness of digital transformation has been determined by the balanced development of technology, content, and human competencies, whereas imbalances have reduced innovation potential and overall performance. It has been substantiated that cloud solutions,

Citation: Pokorny, N. S. (2026). Digital University as an Innovative Socio-Technical System. *Sci. innov.*, 22(4), 139—152. <https://doi.org/10.15407/scine22.04.139>

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analytical platforms, and AI-based tools have supported the personalization of educational trajectories, increased accessibility of services, and enabled new models of interaction within educational and managerial processes.

Conclusions. The digital university has been conceptualized as a new paradigm for organizing educational and scientific space, providing platform-based integration of processes and enabling individualized learning through data-driven and intelligent technologies. Future research should focus on assessing the long-term impact of digital transformation on educational outcomes and the development of key student competencies, while also addressing risks related to ethics, data security, and academic integrity.

Keywords: digital university, sociotechnical system, digital transformation, innovative technologies, educational ecosystem.

Modern education as a component of the social sphere is undergoing profound transformations, driven primarily by the rapid development of digital technologies. These changes are prompting a re-evaluation of the traditional university model, which is progressively evolving into a digital institution. An urgent task for contemporary science is to explore the concept of the digital university, examining its essence and the specifics within the global educational context.

Existing scientific interpretations of the digital university are quite diverse. Some researchers view it as an innovative business model that enhances opportunities for learning and research [1, 2]. Other scholars emphasize its infrastructural dimension, defining a digital university as a set of digital tools and platforms that facilitate all aspects of the educational process, from administration to interaction among participants [3, 4].

In our view, a digital university should be understood as a multidimensional system that integrates both technological and pedagogical components, thereby establishing a new paradigm of education. Unlike traditional models that treat digitalization as a modernization of existing structures, a digital university offers a radical transformation of the educational process. Its essence lies in creating a dynamic learning environment that, through the application of artificial intelligence, data analysis, and other innovative technologies, adapts to the individual needs of each student. This approach not only broadens access to education but also ensures high-quality learning that addresses the contemporary challenges of modern society.

It is important to note that the digital transformation of the economy, marked by a shift from globalization to glocalization, creates new opportunities for personalizing the educational process. The advancement of digital platforms enables students to access educational programs anytime and anywhere. This shift significantly reduces logistical costs, as teaching materials are provided in electronic formats. In addition, the widespread adoption of distance learning technologies allows for the scaling up of educational services without substantial increases in costs, making education more accessible to a broader audience.

On the other hand, transitioning to the digital university model necessitates a radical transformation of the roles and competencies of all participants in the educational process, as the formation of a system of key competencies is crucial for maintaining the competitiveness of higher education institutions amid the fourth industrial revolution. To achieve this goal, it is essential to:

- ◆ continuous professional development for teachers in the field of information and communication technologies (hereinafter — ICT);
- ◆ development of effective motivation and support systems;
- ◆ reengineering of business processes;
- ◆ implementation of individualized educational trajectories.

Thus, the aim of our study is to develop a concept of the digital university as a complex sociotechnical system that incorporates these transformations.

Despite numerous studies on the digitalization of higher education, there is no holistic theoretical and methodological model of a digital univer-

sity as an integrated socio-technical system that combines technological, organizational, and competency transformations into a unified analytical framework, which necessitates this study.

The author proposes a comprehensive conceptualization of the digital university as a complex socio-technical system, within which digital platforms, analytical algorithms, management mechanisms, and staff competency models are viewed as interrelated elements of a unified structural-functional framework. Unlike existing approaches that focus either on the technological or infrastructural dimension of digitalization, the study substantiates an integrative model of a digital university as a system of co-evolution of technological and social changes that forms a new paradigm for organizing the educational process.

The scientific novelty lies in the following:

1. For the first time, a theoretical model of a digital university as a co-evolutionary socio-technical system has been substantiated, in which the technological infrastructure, organizational architecture, and competency profiles of the subjects of the educational process form a unified mechanism for creating educational and economic value.

2. It has been proven that a digital university is not a form of modernization of a traditional institution, but rather a new organizational paradigm based on personalized adaptability, algorithmic decision support, and platform logic for scaling educational services.

Within the scope of the study, the following tasks are formulated:

- ◆ conceptualize the digital university as a socio-technical ecosystem and clarify its difference from related models (in particular, University 4.0);
- ◆ identify the structural components of social and technical subsystems and the logic of their interaction;
- ◆ systematize the innovative technological components of digital architecture (platform solutions, data analytics, intelligent agents, generative AI) and characterize their functional roles within educational, research, and management frameworks;

- ◆ identify key implementation challenges (balance of technological change and human factors, digital inclusion, academic integrity, ethical and security risks) and determine the organizational characteristics that are subject to systems analysis and modeling in the transition to a digital university.

Additionally, emphasis is placed on the need to formalize the parameters for evaluating the effectiveness of digital transformation, in particular through the alignment of indicators of the quality of educational services, engagement, institutional capacity, and the sustainability of digital infrastructure.

The methodological basis of the study is the socio-technical approach, chosen as the foundational one due to its ability to simultaneously describe technological changes, organizational practices, and the transformation of the roles of actors in the educational process within a unified analytical framework. Its use is due to the fact that a digital university cannot be adequately interpreted either exclusively as a technological infrastructure or solely as an institutional or pedagogical model. It functions as an integrated socio-technical system in which digital platforms, algorithmic solutions, management mechanisms, and behavioral strategies of actors in the educational process are mutually determined. That is why reducing the analysis to a single dimension — technological, economic, or organizational — creates a methodological gap and does not allow us to explain the mechanisms of forming the sustainable competitiveness of a digital university.

The socio-technical approach provides an opportunity to view digital transformation as a process of co-evolution of technological solutions and social practices, enabling the identification of the patterns of the mutual influence of digital infrastructure, management strategies, and behavioral models of participants in the educational ecosystem. This approach is particularly relevant in the study of digital universities, where technological innovations (platforms, digital avatars, analytical models, HR systems) acquire economic va-

lue only when integrated into organizational structures, staff competency profiles, and regulatory data management regimes.

To reveal the content of key categories, conceptual and terminological analysis was used, which allows clarifying the characteristics of a digital university and structuring its components. To build the logic of subsystem interaction, a systemic approach and structural-functional analysis were used, which is methodologically appropriate for studying complex multilevel systems and ensures the identification of functions, relationships, and governance frameworks. Generalization and comparative analysis of scientific approaches were used to identify recurring invariants of digital transformation and to identify development imbalances (human competencies, content, technologies), while the modeling method was used to formalize a textual diagram of the structure of a digital university as a sociotechnical system and to substantiate management decisions within the proposed concept.

One of the most promising areas for the development of modern higher education is the creation of a digital university functioning as an integrated sociotechnical system. Such a university involves the development and implementation of various ICT platforms and analytical tools designed to enhance the cognitive development of all participants in the educational process. At the same time, a digital university is a complex system that encompasses at least three main components: anthropo-social, technological, and environmental, represented by a set of socio-cultural, socio-economic, historical, political, and other factors.

Obviously, the objective of a digital university is to harness human potential and employ smart modeling of scenarios of professional, creative, and personal biography of a person based on artificial intelligence, computer science, graphical analysis and forecasting, and noospheric development technologies [5]. Thus, digital applications (scripts) are fully tailored to individual needs, potentially replacing traditional educational programs and linear methods of information transfer. This advancement will enable students to engage in learn-

ing anytime and anywhere, irrespective of their age, social or professional status, and cultural, ethical, or ideological preferences.

Under these conditions, the traditional disciplinary core of modern education is significantly diminished, giving way to problem-oriented transdisciplinary learning that leverages project-based, learner-centered, and convergent educational technologies. At the same time, the key aspects of the digital university as an educational sociotechnical ecosystem include fostering individual creative potential as both author and creator and viewing innovation as a primary regulator of inter-institutional relationships.

Digitalization provides opportunities for sharing accumulated experience and knowledge, which allows people to learn more and make more informed decisions in their daily activities. In the current situation, there are obvious trends in the transformation of universities and higher education in general. These changes involve increased risks and experimentation in scientific activities, a shift from competition to collaboration, access to extensive databases (Big Data), the adoption of multi-format open educational resources (Open Online Resources), the integration of new and traditional training formats, and the redesigning of classrooms in the format of open spaces (Open Space). Technologies such as mobile device learning (Bring Your Own Devices), transition to Flipped Classrooms, creation of Makerspaces — high-tech platforms equipped with 3D printers, creation of mobile and adaptive learning technologies, development of adaptive learning through the introduction of digital platforms, and the spread of the Internet of Things are expanding in use. Other areas of digital technology application in education include the development of online digital libraries and digital university campuses, which have already been implemented by many universities in the United States, Europe, and Asia [6]. Among the noteworthy digital innovations is the rapid evolution of online learning, particularly through the adoption of blended learning models and the active development of Massive Open Online Courses (hereinafter referred to as MOOCs).

The upcoming digital era will necessitate the integration of efforts across universities, local communities, governments, international organizations, and multinational companies. In turn, in this new technological landscape, the role of continuous additional education for the older generation will become increasingly significant.

The field of education, along with several other sectors such as healthcare and telecommunications, is undergoing significant transformations due to the widespread adoption of digital technologies amid the trends of the fourth industrial revolution. As is often the case, the trends in the integration of digital technologies into educational and research activities are primarily driven by commercial organizations, including private universities, business schools, corporate universities, and state technical universities of leading countries.

The digitization of the university education system represents a form of implementation of the design and construction approach in the field of scenario management for future developments in the field of education [7]. Universities that seek to maintain their positions in the global education market face the task of entering the international scientific and educational space. Digital platforms, which are institutionally replacing traditional methods of storing, processing, and accessing information, along with “smart technologies,” digital applications, and educational resources such as MOOCs (Massive Open Online Courses) and SPOOCs (Self-Paced Online Courses), under conditions of irrational use act as disruptive forces in the global educational landscape. These technologies are gradually transforming educational methods and dismantling conventional organizational structures.

Thus, changes in the identity of higher education are increasingly irreversible, and the need to restructure its conceptual model is becoming more evident.

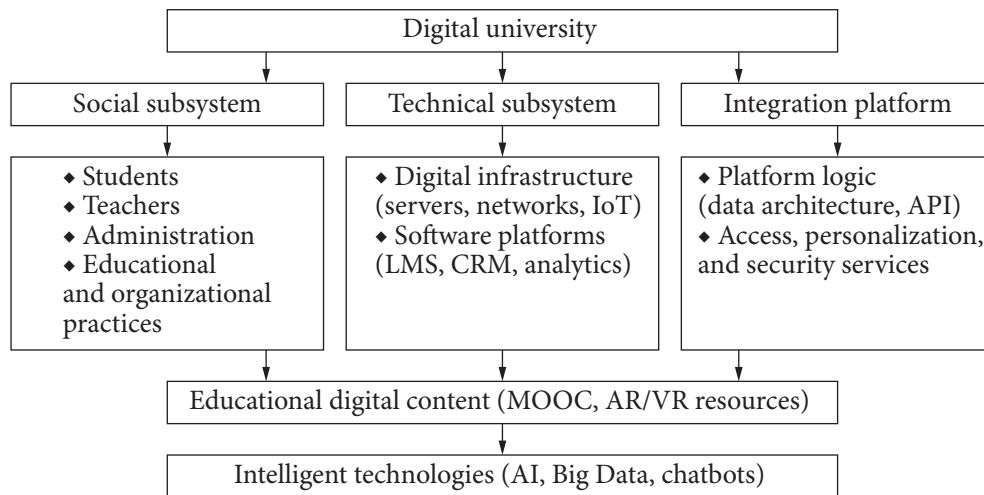
It should be noted that a digital university is defined as the latest model of higher education institution, shaped by the Fourth Industrial Revolution and the general digital transformation of society. The University 4.0 concept emphasizes the

expansion of the mission of universities: in addition to the traditional functions of teaching and research, modern universities should actively promote innovation and socio-economic development [1]. According to research by Vu Duc Le, Phan T. T., Vu T. N. Q., and Pham V. K., the University 4.0 model is based on four key components:

- ◆ the development of competencies in education, research, and innovation;
- ◆ innovative teaching methods adapted to the digital age;
- ◆ the use of information and communication technologies (including Industry 4.0 technologies);
- ◆ innovative infrastructure to support the educational process [1].

This approach reflects a transition to a paradigm in which students engage in lifelong learning, leveraging the benefits of digital technologies and networked interaction [8, 9]. The concept of a “digital university” is closely related to University 4.0, but emphasizes a comprehensive digital transformation of all aspects of university activity. In this context, the digital university is seen as an innovative sociotechnical system that integrates the human factor (students, teachers, administrators, and other stakeholders) with modern digital technologies and processes [10]. Thus, the digitalization of education is not simply the introduction of individual technical innovations, but a holistic socio-technological phenomenon that changes the architecture of educational and management processes [7]. Indeed, in the digital age, universities are becoming platforms that combine educational, scientific, and organizational functions with platform mechanisms for managing knowledge, data, and innovation [11]. In such a system, the technological and social components co-develop; the principle of joint optimization is applied, when both high technological efficiency and the quality of human performance within the system are achieved [5].

An analysis of recent studies shows that the digital transformation of higher education is viewed in a multidimensional context [9, 12, 13]. On the one hand, digital universities are key elements of



The structure of a digital university as an innovative sociotechnical system

Source: compiled by the author independently.

innovative ecosystems, combining knowledge, technology, and competencies to stimulate economic and social development [14]. On the other hand, it is noted that the effectiveness of the digitalization of education has not only economic but also social, cultural, and even environmental dimensions [15]. According to recent studies, digital educational technologies are a catalyst for the transformation of the learning process towards a personalized approach, which simultaneously stimulates the development of in-demand digital, intellectual, and creative competencies among students. As L. Ai, T. S. Hoon, Q. Wang, and S. N. Mohamad point out, these factors largely shape student satisfaction with the learning process [16].

Domestic and foreign studies indicate the need for the balanced development of all components of a digital university — technologies, content, and human competencies — to maximize the integral effect of digital transformation [17, 18]. Otherwise, disproportionate development may reduce the innovation potential and effectiveness of the system [19]. Thus, the concept of a digital university is substantiated as an innovative sociotechnical system that combines technological infrastructure with human capital and organizational structures to achieve a new quality of education [20, 21].

In scientific research, a digital university is described as a multilevel educational and economic system that integrates sociotechnical, organizational, and market mechanisms for creating value and developing human potential in the digital economy [22—24]. This means that a digital university simultaneously takes into account social aspects (people, culture, management structure) and technical aspects (technologies, platforms, data), building a close relationship between them [25]. Structurally, a digital university can be imagined as a system consisting of two interconnected subsystems — social and technical [26, 27]. The social subsystem includes participants in the educational process (students of various levels and forms of education, teachers, researchers, and administration) and organizational processes and practices that regulate their interaction [28]. The technical subsystem covers digital infrastructure (hardware, networks, data centers), software platforms (learning management systems, university information systems, cloud services), educational content in digital form, as well as intelligent technologies (artificial intelligence, data analytics, etc.) [10, 29].

Schematically, the structure of the innovative sociotechnical system of a digital university can be represented as follows (Figure).

It is important that both subsystems are closely integrated: technologies are developed and implemented taking into account the needs and characteristics of people, and people acquire new roles and competencies to work effectively in a digital environment [30]. The innovative components of the technical subsystem of a digital university include a range of modern technologies and solutions that distinguish it from a traditional university. In particular, researchers note the use of cloud platforms that provide scalable data storage and access to online educational resources [5], mobile applications for learning and communication, the introduction of virtual teachers and learning agents, as well as the deployment of comprehensive cybersecurity systems to protect data and privacy [31].

The digital university is also characterized by the personalization of students' educational trajectories, improved quality of education through artificial intelligence, and global accessibility of educational programs via the Internet [22, 23]. To realize these opportunities, a multilevel infrastructure is being formed, including distance learning platforms, video conferencing services, digital simulators, and virtual laboratories with elements of augmented and virtual reality (AR/VR), which provide an interactive and practice-oriented educational process [3, 4].

The key integration component of the structure is the university's digital platform. It connects the various elements of the system into a unified whole — educational content, tools and services, users and developers — ensuring the coordinated operation of all components.

O. V. Skliarenko et al. identify four interrelated elements of a digital university:

- ◆ digital format (new technologies and methods of presenting material, e.g., VR/AR for interactive learning);
- ◆ digital environment (combination of physical and virtual spaces for effective interaction between participants);
- ◆ digital resources (digital tools, materials, and data for learning and research);
- ◆ digital platform (a single mechanism that integrates all components into a functional system) [3].

This structural model allows the university to function as an integrated ecosystem. Innovative changes are also taking place within the social subsystem. The roles of teachers and students are transforming: teachers are increasingly acting as moderators and mentors, using learning analytics data to personalize teaching [11, 26], while students are becoming active co-creators of knowledge, using flexible learning formats [16]. The organizational structure of the university can take on the features of a platform, where, alongside traditional departments and divisions, there are centers for digital competencies, innovative learning laboratories, data and analytics offices, etc. [9, 14]. Human capital is complemented by the digital competencies of all participants in the educational process. Thus, the structure of a digital university as a sociotechnical system is multi-component and dynamic. Innovative technical components — from artificial intelligence to distributed registries for certifying learning outcomes — are combined with changes in learning culture and practices [10, 17]. Traditional university resources (human, financial, material) are integrated with digital assets (data, digital platforms, algorithms), forming a multilevel ecosystem of sustainability and competitiveness for the institution [18, 27].

Among the latest technological solutions integrated into the university's digital architecture, generative artificial intelligence and intelligent agents are highlighted as strategic resources for digital transformation and improving the functional efficiency of the academic environment. Generative AI models (such as GPT large language models, etc.) are capable of creating new content — text, images, program code — and thus open up new horizons for supporting learning, research, and university management [4, 25]. Within the digital university, generative AI can act as an “intellectual employee” or assistant for students, teachers, and staff. Such technologies are already being implemented at leading universities in Ukraine and Switzerland: in particular, at the European University (Kyiv), the integration of chatbots and AI assistants is seen as an element of the digitalization

of university services and improving the accessibility of advisory support for students and applicants within the platform model of the digital environment. In Switzerland, ETH Zürich has formalized an institutional approach to the use of generative AI in education through policies, instrumental recommendations, and the development of specialized solutions, including the virtual learning assistant (chatbot) Ethel, which supports students in working with course materials and routine learning tasks [32]. As noted by O. Gassmann et al., when integrated methodologically correctly, generative AI can enhance learning engagement and support better educational outcomes through personalized prompts, adaptive interaction, and timely formative feedback [31]. In this sense, generative AI in the architecture of a digital university performs not only a service function but also a didactic one, as it provides a new level of “intellectual accessibility” of educational materials, where content and explanations are tailored to the individual needs of the learner and their learning dynamics [10].

Digital teacher avatars are a separate form of intelligent agents designed to reproduce pedagogical scenarios and support educational interaction in standardized situations (instructions, explanations of typical topics, answers to frequently asked questions), with the ability to scale educational support without a proportional increase in the workload on the teacher [15, 21]. According to research, a digital teacher avatar provides interactive communication, visualization of educational content, personalization of learning, and flexible response to students' educational needs, shifting the focus from episodic consultations to continuous support of the learning process [11]. Such agents, built on generative models, are capable of scaling best pedagogical practices to a wider audience, combining standardization of explanation quality with adaptability of speech interaction, while preserving the role of the teacher as a subject of methodological design, quality control, and academic responsibility [15, 16].

At the same time, the integration of generative AI poses new challenges. These include issues of academic integrity (preventing unauthorized use

of AI for writing papers), ethical dilemmas (bias in algorithms, data privacy), and the need to improve users' digital literacy so that they can interact with AI critically and responsibly [16, 29]. As noted by A. Guadu, D. Dibekulu, and A. W. Menberu, the introduction of generative AI requires a culture of change and a willingness on the part of teachers and students to adapt pedagogy to collaboration with machines [20]. However, with proper change management, a university that actively uses generative AI gains a strategic advantage — it becomes more technologically mature and able to provide its graduates with the skills to work with cutting-edge technologies [2, 14].

Generative artificial intelligence and intelligent agents in the digital university model function as an organic element of the technical subsystem, significantly increasing its functional capacity and adaptability. Their application enhances the personalization and accessibility of educational services, optimizes the distribution of operational load between human and digital resources, and forms new models of interaction in the educational and management context. At the same time, adherence to the principle of human-centeredness remains a critical condition for institutional effectiveness: AI should complementarily enhance the activities of participants in the educational process without replacing pedagogical responsibility or conflicting with educational goals and standards of academic integrity [1, 17]. Under such conditions, the integration of generative AI supports the establishment of the university as an environment for the productive co-evolution of humans and digital systems in the field of education.

Based on the generalization and analysis of international experience in organizing and implementing various forms of educational activities in the field of continuing education, a conceptual model of a network educational platform for a digital university was developed, aimed at the multidimensional and multi-vector development of students' human potential.

At the same time, analytical applications and educational resources adapted to human needs and

capabilities are fundamentally changing the ways in which education is obtained, and therefore its architecture, principles, goals, and essential characteristics. The phenomenon of “Learning on Demand” arises when an educational product is designed for a specific subject.

Based on the generalization and analysis of international practices in organizing and implementing various forms of activity in additional education, a conceptual model of a networked educational platform of a digital university was designed, aimed at the multidimensional and multi-vector development of students’ human potential.

At the same time, analytical applications and educational resources tailored to individual needs and capabilities are fundamentally transforming the ways of obtaining education, and, therefore, its architecture, principles, goals, and essential characteristics. The phenomenon of “Learning on Demand” emerges, where educational products are designed for the individual learner.

Given the trends and challenges outlined above, it is proposed to view the digital university as a sociotechnical ecosystem designed to effectively address contemporary trends and challenges. According to this concept, in the context of global digitization of education and its individual negative consequences, the sociotechnical system of a digital university encompasses the integration of ICT services, digital educational resources, and a range of human potential factors, including academic, social and personal, professional and digital competencies. Within the framework of the proposed model, digital applications (scripts) are fully tailored to individual needs, replacing traditional educational programs and a linear method of information transmission. This allows students to study anytime and anywhere. In these conditions, a shift from disciplinary education to transdisciplinary education is anticipated, focusing on mastering thematic blocks followed by solving relevant practice-oriented complex problems.

The traditional physical presence of universities will gradually diminish as they expand their reach and influence within the virtual spaces of the digi-

tal universe of the Internet through cloud technologies. This includes the potential for network partnerships with distributed management. Transnational companies and public organizations will have the opportunity to engage in social procurement for the training of specialists with a given set of competencies.

In this context, a digital university can be viewed as a comprehensive educational service within the global information space. In the future, it may be positioned as a corporate subject in the knowledge economy, engaging in educational, research, innovation, and commercial activities. This role is particularly significant in the era of the “information explosion,” characterized by exponential growth in the volume, semantic complexity, and structural diversity of information flows.

Studying the management challenges of a digital university as a sociotechnical ecosystem, particularly in the transition to the sixth technological system, necessitates identifying key characteristics for its system analysis and modeling. These characteristics include:

- ◆ multi-functionality of the university’s educational activities, including the differentiation and diversification of students’ educational training;
- ◆ consulting activities and knowledge transfer;
- ◆ commercialization of innovative technologies;
- ◆ multilevel system of higher education;
- ◆ high-quality education for bachelor’s and master’s students, as well as highly qualified scientific personnel (candidates and doctors of science), which can be individually optimized through personalized educational trajectories;
- ◆ index indicators of the relative balance among education-seeking contingents at different levels of the university, including the ratio of master’s students to bachelor’s students, graduate students to master’s students, and doctoral students to graduate students; optimizing these ratios is crucial for the sustainable development of a digital university as an educational sociotechnical ecosystem;
- ◆ areas of educational activity aligned with innovative scientific, technological, and socio-huma-

nitarian directions, aimed at anticipatory development in the most competitive sectors of the national economy, which should be based on systematic forecasting of global and national trends in socio-economic and scientific-technological development;

- ◆ integration of administrative and management information flows through the use of cloud technologies and Big Data.

An important challenge in managing a digital university as a sociotechnical system is transitioning to a fundamentally new form of integration across all hierarchical levels and functions. This includes leveraging electronic didactic technologies to enhance the quality of the educational process and improve student academic success by optimizing individual educational trajectories.

It is important to note that when establishing a digital university, it is advisable to adhere to the five-vector model of digital transformation. According to this model, radical changes should occur in five areas of the university's operations, including:

- ◆ management systems utilizing “big data” analytics to develop an integrated innovation ecosystem within the university.
- ◆ digitization of educational and methodical support, including educational technologies and communication systems among participants in the educational process;
- ◆ formation and support of individual educational trajectories;
- ◆ development of digital technological and “cloud” infrastructure of the university;
- ◆ formation, development, and selection of human potential, supported by the continuous enhancement of digital competencies for all participants in the educational process in a digital university, including students, teachers, and administrators.

The practical implementation of this sociotechnical model requires a set of scientifically grounded management and technological solutions that synchronize the strategic goals of higher education institutions with the logic of platform-based process organization and the development of the

competence potential of the academic community. It is advisable to develop an integrated digital transformation strategy with a phased implementation plan covering the modernization of IT architecture, the development of digital skills among staff and students, updating educational programs with a focus on digital competencies, as well as institutional support for innovative initiatives and pilot projects (a unified university platform, educational analytics, online programs) with adequate resource support [3, 10].

The implementation of digital solutions should be based on a sociotechnical balance that involves parallel investments in technological components and the human factor: systematic personnel training, improving teachers' qualifications in digital learning methods, involving specialists in IT architecture, analysts of data and e-learning, as well as early involvement of users in the design and testing of services through pilot and experimental courses, which reduces resistance to change and increases the relevance of solutions [4, 11, 30]. Regulatory governance of data, platforms, and AI (security, ethics, responsibility, academic integrity) should be formalized in the form of internal policies and procedures, as it is regulatory certainty that strengthens trust in digital tools and ensures the sustainability of their use [24, 28].

The institutionalization of digital inclusion as a criterion for the quality of transformation is of particular importance, as it involves the introduction of a digital equality policy and measurable indicators of coverage and effectiveness for different groups of students and employees [26]. This includes providing basic access and support infrastructure (network coverage, digital workplaces, access to services for socially vulnerable groups), complying with digital product accessibility standards, creating counseling centers for learning digital tools, and regularly monitoring service usage and academic performance among target groups [11, 26].

The integration of generative AI is advisable as a phased practice focused on the most well-grounded scenarios (service chatbots, support for teachers in preparing materials, teaching assistants), accom-

panied by a code of academic use of AI and systemic measures to develop AI literacy, in order to combine increased efficiency with compliance with standards of integrity and quality of education [17, 19, 31].

The ecosystem logic of digital university development involves partnerships with IT companies, businesses, other universities, and public sector institutions for joint platform development, exchange of practices and data, participation in consortia, and co-creation of educational products, which accelerates innovation and optimizes the costs of digital modernization [19, 20]. Maintaining the continuity of transformation requires built-in monitoring and improvement mechanisms based on performance metrics (success, engagement, satisfaction with services, coverage of online components, automation effects), regular review of progress, and flexible adjustment of management decisions [7, 20].

The transition to a digital infrastructure of the sociotechnical ecosystem also includes the restructuring of business processes and the transformation of structural units based on ICT and a unified information and education system, and in the early stages can be reinforced by the paper-free principle, a business process monitoring module, a single window system, and a mobile ICT infrastructure, which reduces organizational barriers and increases management transparency [12, 26]. The real-time monitoring module, supported by Big Data technologies, allows for the collection and analysis of information about the activities of university departments, supports research processes, and integrates components of security and reliability of infrastructure functioning, including access control systems and cyber protection [21]. The single window system and mobile infrastructure of the digital university overcome internal bureaucratic barriers to communication between students, teachers, and administrative staff, reinforcing the service logic of interaction within a unified digital environment [15, 29].

The results of the analysis have allowed the digital university to be interpreted as a promising institutional model of higher education shaped

by the Fourth Industrial Revolution and aligned with the logic of “University 4.0,” in which the university expands its mission beyond the traditional functions of teaching and research toward the systematic stimulation of innovation and socio-economic development. The University 4.0 concept is structurally grounded in an interconnected system of competency development, updated teaching methodologies, the application of information and communication technologies, and innovative infrastructure as the institutional foundation for transforming the educational process. This paradigm has reinforced the importance of lifelong learning, network interaction, and platform-based mechanisms for organizing educational and managerial processes.

The digital university has been substantiated as an integrated socio-technical system in which technological solutions, organizational practices, and human capital co-evolve through joint optimization, thereby ensuring higher functional efficiency and improved quality of educational services. Such a system is not limited to the implementation of isolated digital tools; rather, it reflects a holistic transformation of the architectonics of educational and managerial processes, whereby the university acquires the characteristics of a platform integrating knowledge, data, and innovation management. Structurally, the digital university should be considered through the interaction of social and technical subsystems: the social subsystem encompasses the actors of the educational process and organizational practices, whereas the technical subsystem includes digital infrastructure, platforms, content, and intelligent technologies, including data analytics and artificial intelligence.

The effectiveness of digital transformation has been shown to depend on the balanced development of technologies, digital content, and the competency potential of participants in the educational process; imbalances among these components have reduced innovation capacity and limited the overall effect of digitalization. The digital transformation of higher education has generated multidimensional consequences by combining econo-

mic effects with social, cultural, and environmental dimensions, while simultaneously creating opportunities for personalized learning and the development of digital, intellectual, and creative competencies. In this context, digital platforms and learning analytics tools have supported the transformation of the roles of teachers and students: teachers have increasingly shifted toward the functions of moderation, mentoring, and instructional design, while students have strengthened their position as active co-creators of knowledge within flexible learning environments.

Particular importance has been attributed to the integration of generative artificial intelligence and intelligent agents, which have enhanced the functional capacity of the technical subsystem of the digital university. These technologies have expanded opportunities for supporting learning, research, and management through automated content generation, personalized assistance, the automation of routine functions, and the scaling of pedagogical practices. At the same time, their institutionally effective implementation has required a hu-

man-centered design approach, clear principles governing academic use, ethical and security governance, and the systematic development of digital and AI-related competencies among all participants in the educational process.

Managing the digital university as a socio-technical ecosystem has required a transition toward integrated models of coordination across hierarchical levels and functional domains, the deployment of cloud-based and data-driven infrastructure, the development of network partnerships, and the establishment of mechanisms for monitoring the effectiveness of digital services. The practical implementation of the socio-technical model has necessitated strategic planning of digital transformation, the institutionalization of digital inclusion as a criterion of transformation quality, the phased introduction of intelligent services accompanied by integrity and ethics policies, ecosystem-based interaction with external stakeholders, and continuous improvement based on transparent indicators of effectiveness, engagement, and educational quality.

REFERENCE

1. Vu Duc Le, V., Phan, T. T., Vu, T. N. Q., Pham, V. K. (2024). Developing a conceptual model for University 4.0 in the digital era. *Educational Administration: Theory and Practice*, 30(4), 5697—5705. <https://doi.org/10.53555/kuey.v30i4.1559>
2. Kolodinska, Y. O., Skliarenko, O. V., Nikolaievskiy, O. Y. (2022). Practical aspects of developing innovative business ideas using digital services. *Economics and Management*, 4, 53—60. <https://doi.org/10.36919/2312-7812.4.2022.53> [in Ukrainian].
3. Skliarenko, O. V., Yahodzinskyi, S. M., Nikolaievskiy, O. Y., Nevzorov, A. V. (2024). Digital interactive learning technologies as an integral component of the modern educational process. *Innovative Pedagogy*, 68(2), 51—55. <https://doi.org/10.32782/2663-6085/2024/68.2.51> [in Ukrainian].
4. Khomenko, O. O., Paustovska, M. V., Onyshchuk, I. A. (2024). Impact of interactive technologies on the learning process and development of higher education students. *Scientific Innovations and Advanced Technologies*, 5(33), 1222—1231. [https://doi.org/10.52058/2786-5274-2024-5\(33\)-1222-1231](https://doi.org/10.52058/2786-5274-2024-5(33)-1222-1231) [in Ukrainian].
5. Bobro, N. S. (2024). Digital platform as a modern organizational innovation. *Investments: Practice and Experience*, 1, 63—66. <https://doi.org/10.32702/2306-6814.2024.1.63> [in Ukrainian].
6. Huk, P. V., Skliarenko, O. V. (2022). Economic feasibility of enterprise modernization using automated systems. *Economics and Management*, 2, 103—112. <https://doi.org/10.36919/2312-7812.2.2022.103> [in Ukrainian].
7. Bobro, N. S. (2024). Digital transformation of educational systems [in Ukrainian]. *Efficient Economy*, 1, 36—41. <https://doi.org/10.32702/2307-2105.2024.1.36>
8. Kolodinska, Y. O., Hudakov, D. O. (2023). Stages of user interface design [in Ukrainian]. *Scientific Bulletin of the European University*, 1, 61—66. <https://doi.org/978-966-301-265-0/1.2023.61>

9. Liebowitz, J. (2022). Digital transformation for the university of the future: A perspective. *Computer*, 55(10), 66—69. <https://doi.org/10.1109/MC.2022.3178625>
10. Bobro, N. S. (2024). Digital transformation in education: Impact on learning processes. *Investments: Practice and Experience*, 2, 130—134. <https://doi.org/10.32702/2306-6814.2024.2.130>
11. Buawangpong, N., Pinyopornpanish, K., Aramrat, C., Nantsupawat, N., Pliannuom, S., Wiwatkunupakarn, N., McCoy, A., Angkurawaranon, C., Jiraporncharoen, W. (2026). Experiences of using the iCHANGE digital health application in the curriculum for medical students in Thailand. *BMC Medical Education*, 26(1), Article 32. <https://doi.org/10.1186/s12909-025-08287-0>
12. Krap, A., Bataiev, S., Bobro, N., Kozub, V., Hlevatska, N. (2024). Examination of digital advancements: Their influence on contemporary corporate management methods and approaches. *Multidisciplinary Reviews*, 7, Article 2024spe026. <https://doi.org/10.31893/multirev.2024spe026>
13. Tymoshenko, O. I., Yahodzinskyi, S. M. (2024). Digitalization of universities in the context of modern challenges. *Scientific Bulletin of the European University*, 6—9. <https://doi.org/978-966-301-266-7/1.2024.6>
14. Luque-Martínez, T., Faraoni, N., Doña-Toledo, L. (2026). Reflecting university image in the era of digitalization. *Social Sciences and Humanities Open*, 13, 102350. <https://doi.org/10.1016/j.ssaho.2025.102350>
15. Wang, S., Alam, G. M., Bashir, K., Lei, M. (2026). Reproducing inequality? Social capital, digital literacy, and SES in access to higher education. *Humanities and Social Sciences Communications*, 13(1), Article 42. <https://doi.org/10.1057/s41599-025-06264-y>
16. Ai, L., Hoon, T. S., Wang, Q., Mohamad, S. N. A. (2026). The relationship between digital literacy, perceived usefulness, and learning satisfaction among medical students in blended learning. *BMC Medical Education*, 26(1), Article 22. <https://doi.org/10.1186/s12909-025-08370-6>
17. Dülger, H., Ada, G., Dilcen, H. Y., Bilişli, Y. (2026). Social media's effect on sexual literacy and healthy life skills in young adults. *BMC Public Health*, 26(1), Article 72. <https://doi.org/10.1186/s12889-025-25651-3>
18. Ahmed, U., Ahmed, R., Hashim, S., Shakur, M. B. M. A., Ahmed, A. (2026). Assessing the impact of digital enablement on internal brand management in higher education institutions. *Discover Education*, 5(1), Article 1. <https://doi.org/10.1007/s44217-025-00940-6>
19. Gassmann, O., Frankenberger, K., Sauer, R., Blohm, I., Palmié, M. (2025). *Exploring the field of business innovation: New theoretical perspectives*. Springer Nature. <https://doi.org/10.1007/978-3-032-03104-4>
20. Guadu, A., Dibekulu, D., Menberu, A. W. (2026). Academic integrity in the age of AI: Challenges and strategies. *Discover Education*, 5(1), Article 21. <https://doi.org/10.1007/s44217-025-01031-2>
21. Lysenko, S., Bobro, N., Korsunova, K., Vasylyshyn, O., Tatarchenko, Y. (2024). The role of artificial intelligence in cybersecurity. *Economic Affairs*, 69 (Special Issue), 43—51. <https://doi.org/10.46852/0424-2513.1.2024.6>
22. Verina, N., Titko, J. (2019). Digital transformation: Conceptual framework. *Contemporary Issues in Business, Management and Economics Engineering*, 719—727. <https://doi.org/10.3846/cibmee.2019.073>
23. Monazam-Tabrizi, N., Kurt, Y., Kang, W. I.-K. (2026). Navigating learning disruptions. *Computers and Education*, 246, Article 105534. <https://doi.org/10.1016/j.compedu.2025.105534>
24. Chan, T. J., Zulkarnain, A. R. H., Zamsury, A. N., Ng, M. L., Setiawan, Y. B. (2026). The effect of self-disclosure behaviors in social media. *Studies in Media and Communication*, 14(2), 60—71. <https://doi.org/10.11114/smc.v14i2.7974>
25. Williamson, B., Eynon, R., Potter, J. (2020). Pandemic politics, pedagogies and practices. *Learning, Media and Technology*, 45(2), 107—114. <https://doi.org/10.1080/17439884.2020.1761641>
26. Kortemeyer, G., Dittmann-Domenichini, N., Merki, C. (2025). Attending lectures in person, hybrid or online. *Discover Education*, 4(1), Article 94. <https://doi.org/10.1007/s44217-025-00500-y>
27. Kubiv, S. I., Bobro, N. S., Lopushnyak, G. S., Lenher, Y. I., Kozhyna, A. (2020). Innovative potential in European countries. *International Journal of Economics and Business Administration*, 8(2), 250—264. <https://doi.org/10.35808/ijeba/457>
28. Minja, I. K., Sirili, N., Hamad, A. K., Tarimo, E., Mloka, D., et al. (2026). Readiness of medical universities for e-learning. *BMC Medical Education*, 26(1), Article 21. <https://doi.org/10.1186/s12909-025-08360-8>

29. Schaal, T. K., Marchwacka, M. A., Tolks, D., Kugler, J. (2026). Transforming educator expectations. *BMC Medical Education*, 26(1), Article 87. <https://doi.org/10.1186/s12909-025-08406-x>
30. Nnaji, I. L., Ayanwale, M. A., Ukeje, I. O., Ekwunife, R. A., Igwe, C. M., Okwor, E. O., Nwuzor, C. I. (2026). Enhancing governance and performance in higher education. *Social Sciences and Humanities Open*, Article 102348. <https://doi.org/10.1016/j.ssaho.2025.102348>
31. Gassmann, O., Wincent, J. (2025). The non-human enterprise: How AI agents reshape organizations. *California Management Review Insights*, 1—12.
32. ETH Zurich News / Künzler, R. (2022, January 25). *One step closer to lifelike avatars*. ETH Zurich. URL: <https://ethz.ch/en/news-and-events/eth-news/news/2022/01/one-step-closer-to-lifelike-avatars.html> (Last accessed: 29.04.2026).

Received 15.08.2024

Revised 18.02.2026

Accepted 23.02.2026

Н.С. Покорни (<https://orcid.org/0009-0003-5316-0809>)

ПВНЗ Європейський Університет,
бульвар Вернадського, 16 В, Київ, 03115, Україна,
+380 44 334 5304, vup@e-u.edu.ua

ЦИФРОВИЙ УНІВЕРСИТЕТ ЯК ІННОВАЦІЙНА СОЦІОТЕХНІЧНА СИСТЕМА

Вступ. Цифрові технології спричиняють радикальну трансформацію вищої освіти, перетворюючи університети на інноваційні екосистеми. Дослідження феномену цифрового університету набуває особливої актуальності у контексті глобалізації освітнього простору. Інтеграція цифрових технологій в освітній процес трансформує не лише методи навчання та взаємодії, а й саму сутність університету.

Проблематика. Підходи до визначення цифрового університету є різноманітними, проте не охоплюють повною мірою його сутність як складної соціотехнічної системи, що інтегрує технологічні, педагогічні та соціальні компоненти. Актуальною є проблема створення універсальної концепції, що враховує всі аспекти цифрової трансформації освіти.

Мета. Розробка концепції цифрового університету як інноваційної соціотехнічної системи, що сприяє радикальній трансформації освітнього процесу та забезпечує його відповідність сучасним викликам і тенденціям.

Матеріали й методи. Застосовано системний аналіз, синтез і моделювання структурних елементів цифрового університету, а також метод узагальнення міжнародного досвіду впровадження цифрових технологій у вищій освіті.

Результати. Встановлено, що цифровий університет функціонує як інтегрована соціотехнічна система, яка охоплює технологічну інфраструктуру, індивідуалізовані освітні траєкторії та адаптовані освітні ресурси. Застосування штучного інтелекту, аналітичних платформ і хмарних технологій дозволяє значно підвищити ефективність освітньої діяльності, забезпечуючи персоналізацію навчального процесу та зменшуючи витрати на матеріально-технічне забезпечення.

Висновки. Цифровий університет втілює в собі нову парадигму освіти з високим рівнем інтеграції технологій і можливістю створення персоналізованих освітніх траєкторій. Впровадження цієї концепції дозволяє розширити доступ до освітніх ресурсів та підвищити ефективність науково-дослідницької діяльності. Подальші дослідження варто спрямувати на аналіз довгострокових впливів цифрової трансформації на освітні результати та розвиток ключових компетенцій здобувачів освіти.

Ключові слова: цифровий університет, соціотехнічна система, цифрова трансформація, інноваційні технології, освітня екосистема.