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ARTIFICIAL INTELLIGENCE IN OPEN UNIVERSITY ECOSYSTEM CONTEXT

Abstract. Artificial intelligence (AI) is one of the most prevalent topics in modern science. It is also reflected in the higher education sphere. Implementation of AI in university activities requires prior analysis of spheres where artificial intelligence can be used to provide responsible and smart use of AI. Based on the survey of educational process participants, the authors analysed the level of readiness of respondents to AI utilisation, their apprehension of AI's role in different spheres of university activities. The results of the survey have shown that most educational process participants either do not use artificial intelligence or use a very limited number of resources. Still the respondents estimated the possible impact of AI on different spheres of university activities as moderate or high. The spheres of open university ecosystem where AI can be used, were singled out and presented as a structural model. Among the spheres of university activities where AI can be implemented there are infrastructure, security, management and administration, research, ratings, sustainable development, learning personalisation, and e-learning. The selection of artificial intelligence tools for each sphere was performed and presented. Challenges of AI implementation are discussed, among which there are data security, privacy, ethical and legal issues, bias of AI, requirements to technical knowledge of university staff and university infrastructure, teachers' resistance, depersonalization of education, risks of education quality decrease. The advantages of AI implementation in each of the defined spheres are described. The need to document the rules of AI utilization at HEIs is stressed. The results of the research can be used for planning AI implementation in higher education institutions and AI policy formation.

Keywords: artificial intelligence (AI); open university ecosystem; spheres of university activity.

1. INTRODUCTION

The problem statement. Artificial intelligence has been in focus in different fields of human activities for the last decade. According to Scopus search result analysis the interest in the topic has been significant since the beginning of the 2000s with 4 to 16 thousand publications per year. Since the second half of the 2010s, this number has started to increase even more rapidly, reaching its peak in 2023 with 69 332 documents in Scopus. The global tendency inevitably had to influence the education sphere including higher education. This is proven by publication statistics in Scopus, where the number of documents with keywords "artificial intelligence" and "higher education" increased from 65 in 2017 to 709 in 2023. 2024 EDUCAUSE Horizon Report [1] includes generative artificial intelligence as one of the chief opportunities and challenges in higher education. For the first time in the history of Horizon research one trend - AI-related - was included in all five categories: social, technological, economic, environmental, and political. It proves that although the researchers concentrate mainly on the impact of AI on the teaching-learning process, the problems and possibilities connected to it, utilisation of artificial intelligence in higher education institutions (HEIs) is not limited to educational components only. There must be a complex approach to the integration of artificial intelligence into all spheres of higher education institution activity.

In the higher education sphere, AI is used to develop individual approaches to learning, assessment of knowledge, design of interactive platforms, etc. [2]. As a technology that can be used in various ways, artificial intelligence requires attention from all higher education institutions' stakeholders. Institutions must determine the boundaries and appropriate ways of AI utilisation, respond to technological, ethical and legal challenges, support and promote responsible AI application and provide training on it for educational process participants. The starting point for it is defining the components of an open university ecosystem (further in the text - university ecosystem) in which artificial intelligence can be applied. Considering multi-faceted campus needs, the following spheres of AI utilisation can be singled out: administration and management, research, infrastructure and security, teaching and learning (including e-learning), personalisation of learning paths for all education process participants. The level of a university's readiness for AI implementation must be determined. Thus, the topic of the place of artificial intelligence in a university ecosystem is highly relevant and requires a systematic overview of spheres of application to provide a vision for further AI policy formation at a higher education institution.

Analysis of recent publications. Artificial intelligence in higher education is addressed by many researchers. Scientists address both benefits and challenges of using AI for various purposes within higher education institutions. W. Huang and Y. Guo [3] highlight the current stage and problems of applying innovative technologies in education management, paying particular attention to teaching management. According to the researchers, implementation of such technologies as big data, artificial intelligence is now insufficient and is directed locally to solve some minor tasks. Among the reasons are low managers' awareness of the technologies opportunities, low orientation to the needs of teachers and students, insufficient data protection and security management. D. Huang [4] argues that education institutions should take advantage of artificial intelligence to create an intelligent education system that will meet diversified student needs. An AI-driven smart education system is explored as one of the solutions that can assist educational resources management, educational process participants interaction and learning personalisation. S. Mahariya et al. [5] introduce Smart Campus 4.0 where AI is seen as one of the tools to perform several managerial and administrative functions such as physical campus space utilisation and utilities management based on the attendance analysis, performance of repetitive tasks etc. In the context of universities' sustainable development artificial intelligence is addressed by W. Leal Filho et al. [6]. The study illustrates

it by such examples as campus management, community engagement, university management, teaching and learning management. AI-driven solutions for administrative and academic management at HEIs are discussed in the research by Y. Stukalina and O. Zervina [7].

Utilisation of artificial intelligence in academic research is one of the most controversial topics because of ethical reasons and research quality issues. The future of research is discussed in scientific publications by R. Peres, M. Schreier, D. Schweidel, A. Sorescu [8], S. A. Bin-Nashwan, M. Sadallah, M. Bouteraa [9], A. M. Jarrah, Y. Wardat, P. Fidalgo [10], G. J. Hwang, N. S. Chen [11] and others. The main questions raised by the research are the risk of plagiarism and AI-cheating, AI policy in the academic environment and editorial policy on AI. At the same time artificial intelligence can be a time-saving tool providing help with ideas generation, search, summarising and analysing literature, research structure shaping, translation and writing improvement [9, 12]. F. Miljković, J. L. Medina-Franco [13] discuss the benefits of AI utilisation in open science, in particular for research, science dissemination. It is expected that artificial intelligence and open science synergy will widen data availability especially for beginner level specialists who have limited access to free or formal education. However, high-quality data is required to train AI models. C.R. Kirkpatrick, K. Coakley, J. Christopher, I. Dutra [14] introduced the FAIR+ Implementation Survey Tool which takes into account AI in the adoption of FAIR principles and open science concepts.

The question of a university's digital and physical infrastructure and the role of AI in it in particular is raised by O. Duda, O. Karnaukhov, S. Martsenko, V. Yatsyshyn [15]. Artificial intelligence is seen as one of the tools beneficial for different spheres of university activities to optimise operations, consider the needs of educational process participants, and infrastructure efficiency. However, utilisation of artificial intelligence causes security awareness at the same time. I.H. Sarker [16], I. Jada, T. O. Mayayise [17], W.S. Ismail [18] explore potential risks of using AI including security and privacy issues, (un)faithfulness of information, lack of transparency, low digital literacy of users that leads to information leakage and technology misuse, etc. At the same time, artificial intelligence can be used in the cybersecurity sector for big data analysis, vulnerabilities detection, and countering cyber attacks.

Under the conditions of digital transformation of education, e-learning systems play a crucial role in the university ecosystem. One of the most popular learning management systems (LMS) used for e-learning implementation at HEIs is Moodle. AI-based chat-bots for different teaching and learning purposes is one of the most popular AI-solutions for Moodle. W. Kaiss, K. Mansouri, F. Poirier [19, 20] address chat-bots as a tool for building up adaptive learning recommendations based on the level of knowledge and learning style. Y.-A. Bachiri, H. Mouncif, B. Bouikhalene [21] explored the impact of automatically generated questions using an AI-driven plugin with gamification on students' motivation. Gamified assessment has shown a significant improvement in students' results compared to the traditional assessment. Students' satisfaction was also in focus in the research by R.R. Saqr, S.A. Al-Somali, M.Y. Sarhan [22]. The scientists studied the use of AI-driven learning platforms in correlation with self-directed e-learning readiness. Integration of AI is expected to provide vast possibilities for personalised learning in e-learning environments. Integration of AI into e-learning can personalise learning experience by two models - predictive and diagnostic [23]. In particular, predictive model can be used to find out students' learning styles and customise learning materials, and process accordingly [24]. Personalised feedback created by AI tools is another option to provide an individual learning trajectory for students. I. Naz, R. Robertson [25] explored the possibilities of ChatGPT3 for personalised learning feedback and the algorithms to make it meaningful and reliable. To be able to use artificial intelligence, educational process participants have to master utilisation of AI, understand its limitations, possibilities, and risks. That is why artificial intelligence has become a part of digital competence. M. Folmeg, I. Fekete, R. Koris [26] discuss what should be included in students' AI literacy. The researchers

agree that understanding AI algorithms is essential for the technology utilisation. Teachers must guide AI use in the educational process, which leads to the need for requirements for teachers' level of AI literacy as well. The connection between teachers' digital competence and AI adoption readiness is addressed by H. Galindo-Domínguez, N. Delgado, L. Campo, D. Losada [27], M. Lucas, Y. Zhang, P. Bem-haja, P. Vicente [28] and other researchers.

The analysis of recent publications has shown that AI penetrated into all spheres of HEIs activity. Still, most directions require further research and the overall picture of the role of AI in the open university ecosystem must be built.

The research goal. The purpose of the research is to analyse the expected role of artificial intelligence in different spheres of an open university ecosystem and build up a structural model of a university ecosystem with integrated AI. The main research question is: Do universities need AI? The follow-up research questions are: What spheres of a university activity can AI be integrated into? Are educational process participants ready for the implementation of AI into the university ecosystem? According to the purpose of the research and research questions, the following tasks were defined: to survey the attitudes of educational process participants towards AI in university ecosystem, to study AI options for different spheres of a university activity, to systematise the directions of AI utilisation in university ecosystem into a structural model, and to provide examples of AI tools for different spheres of university activity.

Research methods. The goal and the tasks of the research conditioned use of the following research methods: empirical methods for studying directions of AI implementation, singling out and systematising AI tools for different university activities; survey for defining educational process participants' attitudes to AI and their vision of AI role in different spheres of university activity; general scientific methods of analysis and synthesis for structuring the results of the research; modelling method for interpretation and classification of received data.

The research has descriptive character and the problem is being studied at the initial level, which was considered in the process of the survey design and type of statistical analysis choice. Cluster analysis was used to determine groups of educational process participants with different levels of awareness of AI, vision of AI influence on HEIs activity, AI policy requirements and later define the spheres of AI implementation at HEIs.

2. THE THEORETICAL BACKGROUNDS

To define the role of AI in a university ecosystem and single out the spheres of AI implementation at a university we have to determine what we understand under the open university ecosystem. Open university ecosystem is a complex of interacting human and material resources, physical and virtual campuses, which ensure the development of the university as an integral system to achieve the strategic goals of the sustainable development of the university, and is formed as a result of the synergy of education, science, innovation, the state, business, investors, and the academic community. The structure of a university ecosystem according to the main university activities [29] predetermined the following spheres for the research of AI utilisation: management and administration, teaching and learning, research and scientific activity, infrastructure, and security. Digitisation of education laboratory of Borys Grinchenko Kyiv Metropolitan University conducted a survey (https://forms.gle/yxA78fMLzCMAt2D7A) of educational process participants in line with the defined areas to discover their vision of artificial intelligence influence on the open university ecosystem, AI implementation primary readiness and the level of AI mastery.

There are 115 participants in the survey, among whom there are 56,5% research and teaching staff, 31,3% students, 6,1% pedagogical workers, 4,3% scientific workers, and 1,8% other categories. Only 0.9% of respondents are not familiar with AI. However, the majority of respondents have basic knowledge of AI: 28,7% hardly ever use AI and 55,7% use a few AI

tools. As much as 6,1% of the survey participants actively use various AI tools and 8,7% research and teach topics connected to AI utilisation. That means that understanding of the role of AI in the university ecosystem presented in the research is limited to the level of AI knowledge and the widespread ideas of AI including myths and preconceptions and may not respond to reality. 92% of respondents believe that AI will have from moderate to very high influence on education, research and innovation, 73% estimate the moderate impact of AI on university management, 79% expect moderate to high level of change in university image, sustainable reputation and infrastructure, almost 95% predict tangible changes in digital space, 76% foresee moderate impact of AI on social issues, PR, partnership and collaboration with other institutions, and 77% of respondents envision the same perspectives for university openness (see Fig.1).

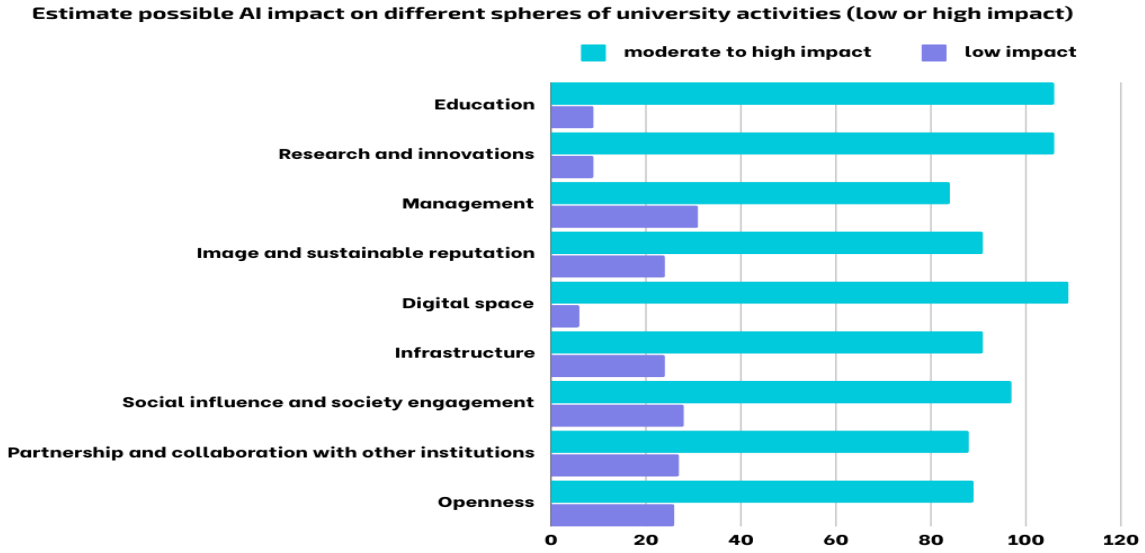

Figure 1. The impact of AI on different spheres of a university activities (survey results)

The research has shown apprehension of the role of artificial intelligence in the quality of education and security. Among the main warnings are: data reliability, lack of policy on AI utilisation in education, in particular, for performing academic tasks, possible negative influence on cognitive abilities of students [2], [8], [9], [11], [16]. The integration of AI systems in higher education institutions presents significant methodological concerns regarding data validity and reliability. AI algorithms demonstrate strong dependencies on input data quality and accuracy, potentially introducing systematic biases and measurement errors. The absence of standardized regulatory frameworks for AI implementation in educational contexts raises ethical considerations. Of particular concern is the potential compromise of academic integrity protocols when students utilize AI-assisted tools for academic tasks. Additionally, overreliance on AI-based technologies may negatively affect students' cognitive development by reducing critical thinking, problem-solving, and independent learning. At the same time, the respondents positively evaluate the impact of AI on education accessibility, innovation in education, changes in approaches to teaching and learning, personalisation of education (see Fig.2).

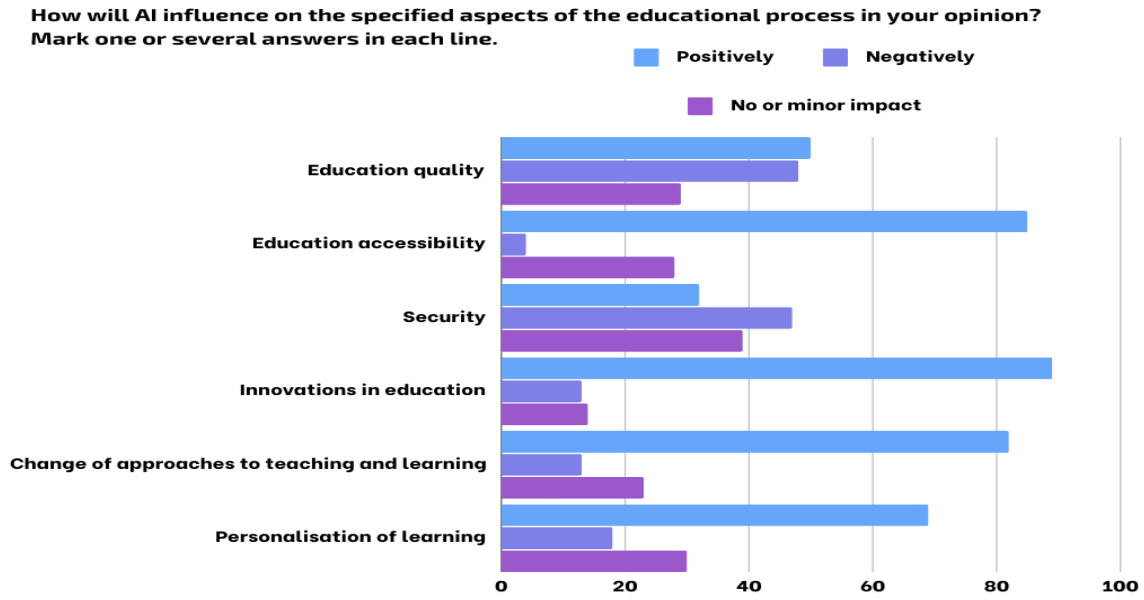

Figure 2: The impact of AI on educational process (survey results)

Despite the AI-related warnings and insecurities, the educational process participants mainly (73,9%) agree that AI should be implemented in different spheres of university activities. The main spaces within the university ecosystem, which are interacting and integrated with each other, are technical and physical resources space, human resources space, digital system space. These spaces include all the main directions of a university activities including infrastructure, security, management and administration, research, ratings, e-learning, learning personalisation (individual learning trajectory).

Each direction includes university activities, where AI can be integrated. Thus, infrastructure includes predictive analytics for its management, performance optimization, insights for IT operation, optimization of resource allocation, monitoring IT services and preventing IT issues; security provision consists of intrusion detection and prevention systems, data backup and recovery, network security monitoring and multi-factor authentication. For management and administration the authors singled out automation of routine tasks, schedule optimisation, big data analysis, students and employees support, monitoring and efficiency evaluation, resources planning and visibility in social networks. In the research direction the main activities are research organisation, search and selection of references, research visibility, research network analysis, research results visualisation. E-learning includes adaptive learning and personalisation, learning assistance (intellectual assistants), assessment and feedback, learning analytics (analytics and forecasting), learning content creation and plagiarism detection. Individual learning trajectory in the context of AI utilisation was divided into educational process participants' digital competence (AI as a part of digital competence) and personal and professional development (AI for learning). The structural model of AI integration into the university ecosystem is presented in Figure 3.

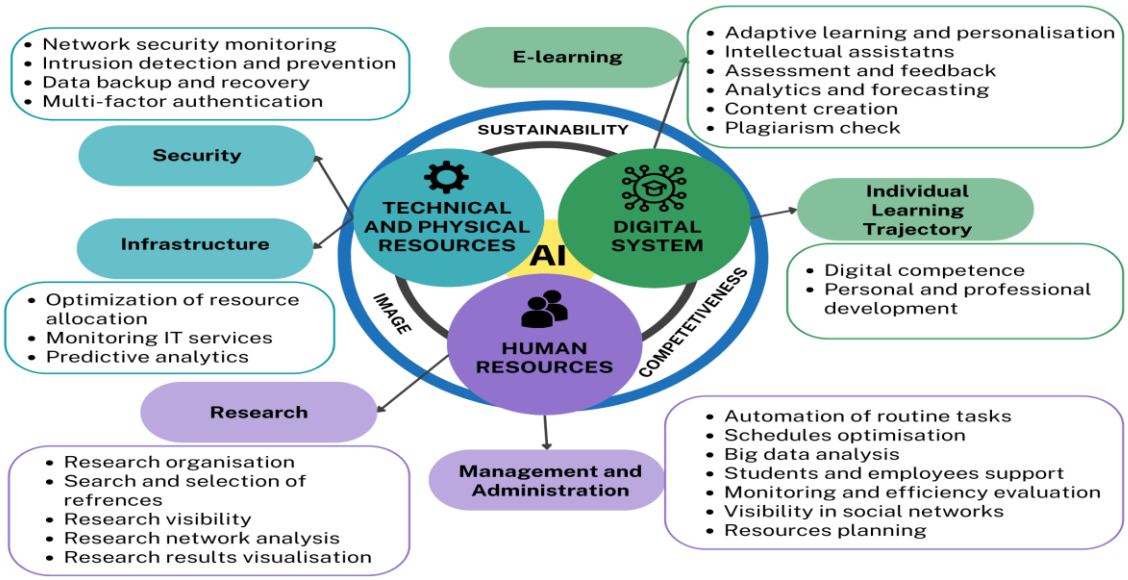

Figure 3: AI integration spheres in open university ecosystem (structural model)

3. THE RESULTS AND DISCUSSION

The integration of artificial intelligence in higher education institutions has a significant potential for the transformation of the educational process, increasing the efficiency of management functions and scientific research. Under the conditions of rapid technological progress and growing higher education quality requirements, a strategic approach to the introduction of AI technologies into the ecosystem of an open university becomes important, which allows for defining specific goals of AI implementation that correspond to the mission and strategic objectives of the university. However, the implementation of such technologies is associated with several challenges, among which are data security and privacy insurance, ethical and legal issues, imperfection of algorithms and insufficient transparency of decision-making. At the same time, the implementation of AI will require significant technical knowledge and resources to integrate new systems into the existing infrastructure of a HEI, which includes the need to update software and hardware and ensure interoperability between different technological platforms. The implementation of new technologies can be met with resistance from educational process participants who may fear negative consequences, for teachers in particular, there are fears of losing their jobs because AI may replace teachers in some aspects of the educational process, restrictions on teachers' autonomy in choosing teaching methods, fears that the role of a teacher may be reduced to technical support for AI systems, and the need to master new technologies can be stressful, especially for the older generation of teachers; for students - depersonalisation of learning due to loss of personal contact with teachers, dependency on technology due to loss of ability to learn independently and think critically, inequality of access as not all students will have equal opportunities to use AI technologies, concerns about the collection and use of personal data by AI systems; for administration - the risks of a reduction in the quality of education, the risk of disruption to the educational process due to technical problems, the need for significant financial investment to implement AI technologies, data security issues due to the risks associated with the protection of personal data of students and teachers, management difficulties due to the need to develop new policies and procedures for working with AI systems, and the emergence of complex ethical dilemmas regarding the use of AI in education.

The implementation of AI in HEIs is associated with certain risks, in particular the risk of data security violations, since large volumes of personal and academic information can

become a target for cyber attacks, AI algorithms can be biased due to unrepresentative data or software errors, which can negatively affect learning outcomes and assessment. At the same time, high costs for the development and implementation of AI systems can be a financial burden for HEIs, especially for smaller and budget-constrained institutions.

Effective integration of AI in higher education requires careful planning and adequate resources, including investments in the latest technologies, staff training and technical support, and the availability of qualified specialists in the field of AI, data analytics and IT support, infrastructure upgrades, including computer networks and servers are important for ensuring effective operation of AI systems and processing of large volumes of data. Thus, the presented research is not presented as a guideline for AI implementation in a HEI, but rather highlights the spheres of prospective AI introduction in open university ecosystem to be considered in the process of AI implementation planning.

The authors analysed available AI-based tools and presented them in the following categories: administration and management, e-learning, infrastructure and security, research and open science.

3.1 Administration and management

The integration of artificial intelligence technology into university administration and management provides many strategic advantages that enable institutions to work with increased efficiency [3]. AI streamlines administrative processes through automation, delegating daily tasks. AI uses predictive analytics capabilities for data-driven decision-making by offering insight into student enrollment trends, resource allocation, and academic performance, thereby optimising strategic planning. AI-driven chatbots and virtual assistants enhance user interaction by providing instant and personalised responses to queries of stakeholders. The ways of AI utilisation in administration and management are presented in Table 1.

Table 1

AI for managerial and administrative activities

Activity	**Function**	**Tools**	**Terms of took usage**
Administrave	Automatisation of routine tasks	**Otter.ai** performs transcription of Zoom, MS Teams, and Google Meet Online meetings **Zapier** – automation software	Basic free plan and paid plans Basic free plan and paid plans
	Schedules optimisation	**OptaPlanner** is a tool for optimising schedules, task allocation, and maintenance planning **Google Calendar+ AI Integrations** uses Google Calendar to manage schedules with the integration of artificial intelligence tools such as OpenAI GPT-3.5 to automate and optimise scheduling **UniTime** is a comprehensive study planning system that supports the development of course and exam schedules, management of changes to these schedules, etc. Free	Free Free Free
	Schedules Students and employees support	**HubSpot Chatbot** is a tool for creating and automating communication with site visitors **Dialogflow** is a platform for creating chatbots with AI from Google, which supports the understanding of natura language. Can be used to automate student and teacher support	Paid, has free trial Paid, 300$ trial credit
Managerial	Forecasting, decision-making	**Qlik Sense** is a data visualization platform that allows you to create interactive reports and	Paid, has free trial Paid, has free trial

	support based on the big data analysis	dashboards from data to predict trends, identify problems and make better decisions **Tableau** is a data visualization platform that allows you to create interactive reports and dashboards with data to predict trends, identify problems and make better decisions about your business	
	Monitoring and efficiency evaluation	**Toggl** is an application for analysing the time spent on various tasks **Gephi** is an open source software for visualisation and analysis of collaboration and research networks, widely used in academic circles including digital humanities, social sciences, and computer science	Free plan and paid plans Free
	Resources planning	**OpenAI Finance Tools** – OpenAI tools for financial analysis and forecasting that use artificial intelligence to process large volumes of financial data **Asana** – a platform for managing projects and tasks with the ability to integrate with artificial intelligence to automate tasks and monitor progress	Free plugins with limitations and paid ones Paid, free for groups up to 10 people
	Analysis of visibility in social networks	**Repustate** evaluates content from social media, news, reviews, and more. Visibility analysis in social networks, university reputation monitoring, data analysis **Awario** is a social media monitoring tool that can track university mentions, analyse audience sentiment and respond to them **Brandwatch** is a platform for analysing content from social networks, news, and websites. Features influencer discovery, conversation analysis, and data visualization **Aylien** is a platform for analysing university visibility based on news aggregation, data search and monitoring	Paid, free trial and demo Paid, free trial Paid, free trial and demo Paid, free trial

Under the conditions of digital transformation and the transition to the model of an open university, the issues of competitiveness of a higher education institution are becoming strongly bound to HEIs results presentation in digital space. One of the tools for measuring the competitiveness of an open university is participation in international educational ratings. High positions in the rankings contribute to increasing the prestige of the university, attracting talented applicants, teachers and researchers, and expanding opportunities for international cooperation. In addition to traditional academic ratings, ratings that evaluate the contribution of HEIs to the achievement of the Sustainable Development Goals defined by the United Nations and their environmental, social and economic responsibility are becoming increasingly important. The sustainable development rating methodologies are based on a set of thematic indicators, each of which consists of separate indicators that evaluate the achievements of universities in implementing the Sustainable Development Goals based on information from open sources, university reports, surveys of university representatives, and the effectiveness of scientific research. An effective tool for achieving these goals is the implementation of internal university ratings, the formation of strategic guidelines for the university's activities, aimed at the systematic integration of the principles of sustainable development into educational, scientific and administrative activities, in particular the Roadmap (Policy) of sustainable development, which will contribute to the effective implementation of relevant initiatives, improvement university practices and increasing rating indicators, including using artificial

intelligence tools [30]. AI-based tools for analysis of visibility in social networks (Table 1) and for visibility and dissemination of research results (Table 3) can be used to analyse the presentation of a university online and plan actions for better visibility, sustainability strategy and ratings positions.

3.2 E-learning

The integration of artificial intelligence technologies in a learning management system can significantly increase the efficiency of the educational process, provide individualization and personalization, improve the quality of feedback and contribute to a better understanding of the needs and success of learners. As at Borys Grinchenko Kyiv Metropolitan University Moodle is used to provide e-learning, the authors concentrate on the possibilities of AI for Moodle. AI in an e-learning system can be used for analysis of the knowledge level and students' individual characteristics for adaptive content; individual educational trajectory design; virtual assistants design to provide students with real-time support; automated assessment and feedback; analysis of big data on the students' activities to identify patterns, predict the probability of successful completion of the discipline; automatic generation of educational content, such as tests, assignments or interactive exercises, based on specified criteria and objectives; detection of cases of plagiarism and content generated by AI in the works of students. The plugins for Moodle with AI for the above mentioned tasks in e-learning systems are presented in Table 2.

Table 2

AI for e-learning

Activity	**Function**	**Moodle Plugin**	**Terms of took usage**
Adaptive learning and personalisation	Adaptive learning	**IADLearning** – uses adaptive AI technologies to create personalized learning trajectories	Requires licensed software
	Personalised education content	**Personalized Study Guide format** – a course format that allows you to create personalised study plans and structures for each student based on their needs and performance	Free
Intellectual assistans	OpenAI-based chatbots	**OpenAI Chat Block** – a block that adds on OpenAI-enabled chatbot to Moodle, allowing learners to ask questions and receive answers generated by AI **Ulibot** is an AI-enabled chatbot that can be integrated into Moodle to communicate with and assist learners	Reguires commercial OpenAI subscription Paid, 30-days trial
	Virtual assistans Automated essay assesment	**Free Teaching Assistant Block** – provides access to a virtual assistant capable of answering students' questions and providing explanations of educational material	Free and paid plans Free
Assessment and feedback	Automated essay assesment	**Essay (auto-grade)** – allows you to automatically grade the essays of students with the help of AI and provide feedback	Free
	Automated code assessment	**Coderunner** is a question type that allows learners to enter code that is then automatically checked and scored by AI	Free
Analytics and forecasting	Success analytics	**Analytics for Moodle with IntelliBoard** – provides data analytics on the activities of	Paid software

		learners, including predicting their success and the risk of not completing tasks	
Content creation	Quiz questions generation	**OpenAI Question Generator** – uses OpenAi to automatically generate test questions based on the entered study material **AI Text to questions generator** - Converts the entered text into multiple test questions using AI	Requires commercial OpenAI subscription Open AI API key is required
	Images generation	**AI Text to Image** – uses AI models to generate images based on text input, which can be useful for creationg visual content	Open AI API key is required
	Text content generation	**AIC content generator** – generates a variety of content such as articles, essays, etc. using AI models	Open AI API key is required
Plagiarism check	Plagiarism and AI-created content detection	**PlagiarismCheck.org plugin** – checks the students' works for plagiarism and AI-generated content **Compilatio Plagiarism and AI Content Detector plugin** – uses machine learning algorithms to detect plagiarism and AI-generated content **Copyleaks Plagiarism and AI Content Detector plugin –** integrates the Copyleaks service into Moodle to check students' works for plagiarism and AI content	Paid subscription Paid subscription Paid subscription

3.3 Research and open science

The concept of an open university is based on the principles of active interaction with the external environment, which is characterised by the transparency of research activities, free access to research results and educational resources, which contributes to the strengthening of competition between higher education institutions. One of the tools for measuring the competitiveness of an open university is participation in educational ratings. The key indicators of educational ratings are indicators of the effectiveness of scientific research of scientific and pedagogical workers of the university [31], therefore, the issue of ensuring high quality of scientific research, compliance with the principles of open science, ensuring open access to scientific publications and research data, visibility, distribution and monitoring of the effectiveness of scientific research results becomes important. Modern challenges require universities not only to adapt to new realities, but also to actively introduce innovative approaches in all areas of university activity, in particular research. The use of artificial intelligence technologies, including machine learning, deep learning, and natural language processing in research activities significantly expands the possibilities of scientific activity, contributes to the improvement of the quality of scientific publications, the simplification of the data analysis process, and the increase of the accuracy of the results, which increases the competitiveness of the open university and its promotion in international educational ratings (Table 3). Ensuring the principles of open science - open access to the results of scientific research, openness and availability of scientific data contributes to increasing the number of citations of scientific publications and increasing the university's ranking indicators and influence in the scientific world [32].

Table 3

AI for open science

Activity	Function	Tools	Terms of took usage
Infrastructure	Monitoring and optimization	**IBM Watson AIOps** offers AI-driven insights for IT operations, helping to predict and prevent outages, optimise resource allocation, and automate routine tasks	Paid
	Monitoring and optimization	**Splunk IT Service Intelligence** is a powerful tool for infrastructure monitoring, event management and mature AIOps platforms	Paid, free trial
	Monitoring and optimization	**Dynatrace** provides AI-powered application performance management and infrastructure monitoring	Paid
Security	Threats detection	**Darktrace** is a self-learning Cyber AI to discover unpredictable cyber-threats	Paid, demo availiable
		Vectra AI Platform employs AI to automate threat detection and response	Paid, demo availiable
	Security information and event management	**QRadar SIEM** is a SOC tool, with integrated, advanded AI and automation capabilities	Paid, demo availiable
	Analytics of user behaviour	**Exabeam** uses machine learning to create basic models of normal user and system behaviour, allowing for accurate detection of anomalies **Securonix** an advanced next-generation security platform (Next-Gen SIEM) that integrates AI capabilities to detect and neutralise complex cyber threats	Paid, demo available Paid, demo availiable
	Malware detection	**CrowdStrike** uses advanced machine learning algorithms to detect and block threats on devices in real time **SentinelOne** the system analyses the behaviour of processes and users in teal time, detecting anomalies and potential threats, predicts and blocks attacks before they are carried out, based on the analysis of behavioural patterns **Cylance** is an innovative cybersecurity platform that uses advanced artificial intelligence technologies to protect organisations from sophisticated cyber threats	Paid, free trial Paid, demo availiable Paid, demo availiable

Significant weight in methodologies of leading sustainable development ratings is given to the performance indicators of scientific research published under affiliation to the university and classified by Elsevier as research under a specific Sustainable Development Goal [33]. Determining whether a publication belongs to a specific Sustainable Development Goal is carried out using a complex algorithm that combines linguistic analysis and machine learning, based on which the degree of compliance of the content of a scientific publication with one or more Sustainable Development Goals is assessed. Such an approach allows for efficient and accurate classification of scientific publications according to their contribution to the achievement of the Sustainable Development Goals, providing a valuable tool for analysing and evaluating the impact of scientific research on global sustainable development issues.

3.4 Infrastructure and security

One of the priority tasks defined by the Concept of the Development of Artificial Intelligence in Ukraine [34] is to increase the level of information security and data protection in the information and communication systems (ICS), assessment of information threats, use of the of forecasting and prediction of threats potential in order to timely prepare ICS for possible attacks, reduce the number of attempts of unauthorised interference in the work of information and communication systems, computer networks, etc. Therefore, when designing the ecosystem of an open university, the issue of security should be given a rather important role.

The integration of artificial intelligence technologies into the infrastructure and security systems of the open university significantly strengthens the level of protection of online platforms, optimises access management, increases the speed and accuracy of cyber defence systems [35, 36], ensuring a more effective response to cyber threats in an open educational environment. Machine learning algorithms can be applied to analyse network traffic, detect abnormal patterns and potential threats in real time, allowing for prompt response to unauthorised access attempts, DDoS attacks and other types of cyber threats, monitoring user behaviour and access patterns, notifying of anomalies that may signal compromised accounts or insider threats. At the same time, AI can be used for multifactor authentication, analysis of users' behaviour to detect suspicious activity, dynamic adjustment of access rights based on context and level of risk, to automate routine security tasks such as vulnerability scanning, patch management and log analysis. At the scale of an open university infrastructure, intelligent systems are capable of optimising resource allocation, predicting network load, automating routine security administration tasks, correlating data from different sources to provide a unified view of the security state and prioritise the most critical risks. However, it is important to implement AI responsibly with strong governance, transparency and human oversight to reduce potential risks and unintended consequences. It is worth noting that the implementation of AI solutions requires careful planning, training of university employees and compliance with ethical norms regarding the processing of personal data. There are several AI tools that help IT staff to monitor network security, including anomaly detection, pattern recognition, predictive analysis, managing events, monitoring infrastructure, automating routine tasks etc. (Table 4).

Table 4

AI for infrastructure and security

Activity	**Function**	**Tools**	**Terms of took usage**
Research organisation	Search and selection of references on the research topic	**Dimensions AI** offers powerful analytical tools that allow scientists and researchers to obtain detailed information about the state of scientific fields, trends and connections **Consensus** helps researchers find relevant research papers and provides a brief summary of each publication **Scinapse** provides an opportunity to search and organise scientific publications by research topic, analyse citation indicators, scientific trends with the help of visualised anaylytics tools **Typeset** provides the ability to search, organise, summarise scientific research, create personal bibliographic databases, and automatically create bibliographic citations **Elicit** selects documents that match the request, displays a list of documents and a summary of key information in an easy-to-use table	Free and paid versions Free and paid versions Free and paid versions Paid Free and paid versions

Activity	Function	Tools	Terms of took usage
	Organisation of scientific publications by research topic	**ReadCube Papers** is a reference manager and scientific literature organisation and management software that provides access to a large database of scientific publications, allows you to organise scientific literature, easily read, comment on and share articles	Paid
	Video to text conversion	**Eightify** provides the ability to extract key information from YouTube videos	Free
Visibility and dissemination of research results	Increasing visibility	**Kudos** allows you to create websites to present and promote research results, communicate with readers and other users, present scientific research and answer questions. At the same time, the service provides access to analytical data, which includes the number of citations, downloads and other metrics	Free
	Research network analysis	**Research Rabbit** is an AI tool that helps researchers manage their research, track citations, create bibliographies, and generate article summaries	Free
Presentation of research results	Visualisation	**Talbeau** is an interactive data visualisation and business intelligence software that automatically generates visualistations based on uploaded data **Data Robot** allows you to create automated visualisations for machine learning and predictive analytics, interpret complex models through graphical representations **Sisense** is a business analytics and data visualisation platform that detects trends, anomalies and insights in data, automatically generates relevant visualisations, selects optimal algorithms for forecasting depending on the nature of the data	Paid, free trial Paid, demo available Paid, demo available

3.5 Authors' contributions

As the research concerns a complex problem of AI implementation in different spheres of university activity, specialists in different areas of information and communication technologies were involved in the project.

Oksana Buinytska is responsible for the overall research design and implementation, task management, final checks and corrections. She is the curator of the Digitization of Education Research Laboratory's theme "Designing an open university ecosystem in the context of digital transformation of society", in the framework of which the current research is performed.

Tetiana Terletska performed general theoretical exploration and analysis of the recent studies. She designed and conducted a survey of education process participants vision of artificial intelligence influence on the open university ecosystem, AI implementation primary readiness and the level of AI mastery, and built a structural model of AI integration spheres in open university ecosystem under the supervision of O. Buinytska. She structured all information added by the authors into a paper.

Valeria Smirnova is responsible for AI in research and open science section. She contributed into theoretical exploration of the topic and analysis of the recent studies. V. Smirnova also added information concerning sustainable development. She was responsible for the technical preparation of the article for the presentation on the workshop "Navigating

Success Through Intellectualization of Educational Trajectories (IntelEdu)", 2024, where the research results were presented.

Anastasiia Tiutiunnyk conducted research on AI tools in e-learning. Performed overall editing and preparation for the publication of the article.

Iryna Kovalenko is responsible for AI in administration and management. She provided colleagues with support in AI tools search as the most experienced AI user in the team.

Bohdan Hrytseliak conducted research and provided information for AI in the infrastructure and cybersecurity section.

4. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

The research has shown that integration of artificial intelligence in university activities is an inevitable change that sooner or later will be faced by all higher education institutions. Although many educational process participants are worried by possible consequences of AI utilisation such as improper use of AI for academic and scientific purposes, decrease of students' cognitive abilities, the majority of them agree that artificial intelligence should be considered in different spheres of university activities and its utilisation must be properly documented. Artificial intelligence will lead to changes in approaches to learning activities creation and teacher-student interaction. However, implementation of AI in higher education is not limited to teaching and learning only. It can be used for administrative and managerial purposes, image formation and increasing in ratings positions, infrastructure and security issues, research and open science. Artificial intelligence can help with such tasks as scheduling, routine tasks performing, big data analysis, communication, learning management and personalisation, learning content generation, research organisation, visibility and dissemination etc. Most educational process participants either do not use artificial intelligence or use a very limited number of resources which leads us to conclusion about the general low level of readiness of higher education institutions to implement artificial intelligence. All higher education institutions' stakeholders must raise their awareness of artificial intelligence possibilities for higher education and increase their artificial intelligence competence. The results of the research can be used to plan a road map of AI implementation into different spheres of a university activities as well as for AI training planning for educational process participants. The authors see as future research perspectives deeper research of AI implementation in particular spheres and designing a policy on artificial intelligence implementation in a higher education institution

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ШТУЧНИЙ ІНТЕЛЕКТ В КОНТЕКСТІ ЕКОСИСТЕМИ ВІДКРИТОГО УНІВЕРСИТЕТУ

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Анотація. Штучний інтелект (ШІ) – одна з найпоширеніших тем у сучасній науці. Вона також знайшла своє відображення у сфері вищої освіти. Впровадження ШІ в діяльність університетів вимагає попереднього аналізу сфер, де він може бути розумно та відповідально використаний. На основі опитування учасників освітнього процесу автори проаналізували рівень готовності респондентів до використання штучного інтелекту, їхнє уявлення про роль штучного інтелекту в різних сферах діяльності університетів. Результати опитування показали, що більшість учасників освітнього процесу або не використовують штучний інтелект, або використовують дуже обмежену кількість ресурсів. Проте респонденти оцінили можливий вплив ШІ на різні сфери діяльності університету як помірний або високий. Сфери екосистеми відкритого університету, у яких може бути використаний штучний інтелект, були виокремлені та представлені у вигляді структурної моделі. Серед сфер діяльності університетів, де можна впроваджувати ШІ, – інфраструктура, безпека, управління та адміністрування, дослідження, рейтинги, сталий розвиток, персоналізація навчання та електронне навчання. Здійснено підбір та представлено інструменти штучного інтелекту для кожної сфери. Обговорено виклики впровадження ШІ, серед яких безпека даних, конфіденційність, етичні та правові питання, упередженість ШІ, вимоги до технічних знань співробітників університету та університетської інфраструктури, опір викладачів, деперсоналізація освіти, ризики зниження якості освіти. Описано переваги впровадження ШІ в кожній з визначених сфер. Наголошено на необхідності документування правил використання ШІ у ЗВО. Результати дослідження можуть бути використані для планування впровадження ШІ в закладах вищої освіти та формування політики у сфері ШІ.

Ключові слова: штучний інтелект (ШІ); екосистема відкритого університету; сфери діяльності університету