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Bridging global trends and national realities: The 4r-model for Ukrainian higher education sustainable development

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Abstract: The key global trends in higher education are digital transformation, AI, internationalization, a focus on results and cost-effectiveness, and the negative demographic situation. The above-mentioned global trends in higher education in Ukraine are further amplified and superimposed on national specifics and the war, which cause difficulties in implementing offline education in some regions, suppression of motivation for higher education due to the population’s psycho-emotional state, and a lack of funding and grants in education. The challenge is to overcome the large gap between political educational trends (digitalization, introduction of competitive and operational financing of Ukrainian universities, public openness and accountability, internationalization) and the institutional and financial capabilities of Ukrainian universities. The purpose of this article is to identify key actions in higher education policy that will combine global trends and Ukrainian realities to enhance the sustainability, quality, and financial independence of higher education institutions. The article identifies the main global trends in financing, management, governance, and the assessment of education quality, and develops the key measures most relevant to Ukraine in the context of war and future reconstruction. Higher education policies are coordinated taking into account regional asymmetries, demographic decline and new competencies. The article summarizes a systematic review of scientific publications and policy documents on the main trends in the management, financing, and quality assurance of higher education worldwide, and attempts to combine global practices with local needs. Based on the analysis, a conceptual 4R-Model was proposed to reconcile global trends with Ukrainian realities and outline four key areas of higher education development. The 4R model, formed on the basis of research into global trends and analysis of the main challenges of modern higher education, can be used as a basis for developing a long-term strategy for sustainable recovery and development of the nation’s intellectual potential in the field of higher education and used in decision-making by state bodies, international institutions, and universities. Harmonization of global trends with Ukrainian realities allows synergy achieving sustainable development.

Keywords: global and national trends in higher education, higher education policy, university efficiency, higher education financing, digitalization

1. Introduction

Over the past decade, higher education has undergone significant transformations in response to significant technological advances and social changes, including digitalization, the development of artificial intelligence, the internationalization of education, and the shift in focus and metrics toward the effectiveness of learning outcomes. In Ukraine, these vectors are superimposed on special national realities: a war that has been ongoing for more than three years, demographic decline, patchy territorial development, important domestic migration due to military operations, and small budgetary resources [1]. In this context, higher education policy finds itself between the need for speedy adaptation to European standards and digitalization, and small financial resources, as well as tendencies to reduce and merge higher education institutions [2].

The main reason for this tension is the reduction in funding, which is also happening at the global level in the 2024–2025 academic years. In the European Union, and especially in the USA, education systems stimulate universities to diversify their sources of funding (tuition fees, grants, partnerships with business, joint projects). A clear methodology has also been introduced, with transparent formulas and mechanisms that reward the quality of education and the achievement of results. But Ukrainian universities have special modern realities and significant financial constraints, which determine unequal starting positions between universities and the destruction of university infrastructure due to Russian attacks. As a result, a significant gap arises between the declared reforms and ambitions in the educational sphere and the institutional capabilities of the state authorities and universities to implement them [2].

The study's hypothesis is that integrating global trends in higher education development, forecasts of future changes, and national characteristics enables the creation of a strategic development model that will contribute to the rapid restoration and improvement of the quality of higher education in Ukraine.

Universities are barometers of changes occurring in cultural and political spheres and are usually among the first to respond to societal changes. Political reforms often begin with education, as the primary area that lays the foundation for a nation's future. The consequences of change are conventionally divided into two main categories: Changes in personnel and students, and organizational changes that affect the activities of educational institutions. Higher education is living through a new, perhaps dangerous, period of turbulence and facing new challenges. The development of higher education is good for the country not only because of students' education and their future, but also because it is an important bastion of democracy and the guardian of fundamental values, and because of its role in innovative development and talent training.

2. Materials and methods

The theoretical and methodological basis of the study is a review and critical analysis of scientific sources devoted to global trends in higher education [1, 3–6], the impact of artificial intelligence on education [6–8], and the peculiarities of the functioning of higher education systems under martial law [8]. The methodological

tools include analysis and synthesis, the comparative method, systematization and generalization, processing of statistical data, survey results, and analytical reports. This made it possible to identify key trends in higher education, track the influence of political and economic sentiments on its financing, monitor changes in public attitudes and requirements for higher education, and examine the transformation of its content, quality, and social and economic role. The integration of scientific works with analytical, statistical, regulatory and other materials ensured the comprehensiveness of the research and allowed for a deeper understanding of the relationship between global educational trends, public expectations and political decisions in the field of higher education and allowed for the formation of a model of strategic development of higher education in accordance with global and national trends.

To integrate global trends and national realities into Ukraine's higher education policy, we conducted an extensive review of scientific sources, policy papers, reports, and regulatory acts. Data and literature searches were conducted in Scopus, Web of Science, analytical studies and statistics of international organizations (OECD iLibrary, World Bank Documents and Reports, UNESCO, European Commission), on national educational portals of Ukraine (Ministry of Higher Education of Ukraine, National Agency for Quality Assurance in Higher Education, reports of higher education institutions) and websites of EU projects/international donors (e.g., Erasmus+, World Bank, EIB). The main time interval of the research and the collection of statistical data is 2014–2025, with special attention to turning points in Ukraine's history, the 2014 reforms, and the period of the beginning of a full-scale war in 2022. The analytical block conducted a comparative analysis of strategic educational policy (such leading countries as the USA, Great Britain, the Netherlands and the EU as a whole - as reference cases with modern educational policy in Ukraine - as a case of adaptation to global trends and current circumstances) with the determination of the possibility of transferring best practices, as well as descriptive statistics and analysis of trends for the period 2014–2025. Methodological triangulation (combining academic publications and official statistics) was also used, and a discourse on the importance of education for restoring the Ukrainian economy was conducted. The limitations of this study are associated with gaps and delays in the reporting process during wartime, problems comparing indicators across countries, and possible political manipulation of official documents in countries with a high degree of geopolitical uncertainty. At the final stage of the study, the results of the systematic review, comparative analysis, and statistical data were synthesized into a conceptual 4R-Model. The model was developed as an analytical tool to reconcile global trends with Ukrainian realities and to structure key policy directions in higher education.

3. Results and discussion

3.1. Key trends shaping higher education in the United States

The USA is the country where all educational trends are born. Therefore, it would be worthwhile to consider the main drivers of development in US higher education. Over the past year, many American colleges have faced a financial crisis.

There's also been a recent climate of uncertainty due to a proposed five-year freeze on federal funding as well as tax policy. Yet even amid an inefficient bureaucracy, the clouds of uncertainty are gathering in 2025 with a temporary freeze on federal funding and possible tax policy changes. The main directions of change in the field of higher education in the United States have been identified [9]:

- 1 The government's cancellation of diversity, equity, and inclusion (DEI) initiatives and the abolition of the recognition of gender identity as separate from biological sex.
- 2 The preservation of uncertainty in federal funding. In early 2025, the Trump administration announced a temporary suspension of certain federal payments to ensure that funding decisions are consistent with new political priorities. Many academic and educational institutions have been hit by funding cuts (the Institute of Educational Sciences (IES), an independent research arm of the Department of Education responsible for collecting and disseminating data on teaching practices and student achievement). Some educational institutions have temporarily frozen staffing increases due to significant financial uncertainty.
- 3 Uncertainty about future taxes. Announcements of potential tax increases and the implementation of new tax rules are among the primary sources of financial uncertainty for higher education in the United States. Congress is currently considering budget bills that include eliminating individual tax credits and deductions for education expenses, student loan interest, and scholarships. The proposed increase in the university endowment tax could increase the tax rate on net investment income from 1.4% to 14% for private higher education institutions.
- 4 Decentralization of educational policy. The U.S. Department of Education has set a goal of transferring control of education to the states, with a gradual corresponding reduction in federal oversight and control of educational institutions. The defined policy aims to reduce bureaucratic pressure and grant greater rights in education while simultaneously expanding opportunities for parents and local authorities to make independently informed and impartial decisions about local education [1,9].

The trust in higher education in the United States has been decreasing as well, per recent Gallup data (**Figure 1**). Doubt and worry about the cost of higher education and obtaining a degree, politicization, expensive tuition fees, and friction with labor market needs are the primary drivers of this trust decrease (**Figure 1**).

According to a Gallup survey, respondents identify the following as the main factors supporting higher education: increased and developed innovation and inventions (76% agree), better work and career development (69%), and increased income (66%) [10].

The National Endowment for Education, in response to the survey results, initiated a national discussion on the possibilities and ways to restore trust. At the same time, it focuses on transparency, accountability, community and parent involvement. But the most significant indicator of trust in higher education is student success, their employment, growth in income after graduation and professional realisation, which is the primary social key to restoring confidence.

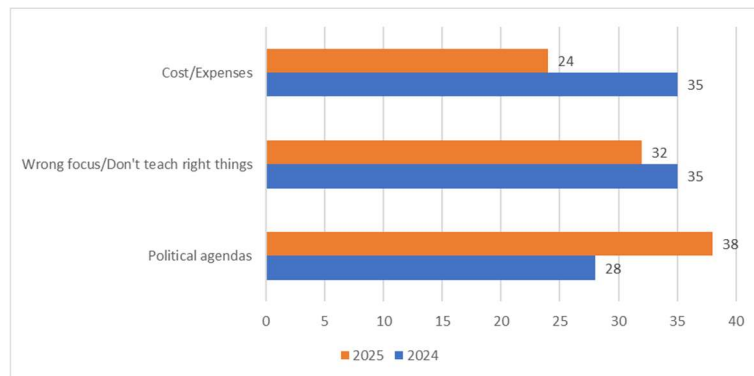


Figure 1. The reasons why Americans lack confidence in higher education, 2024–2025 (% of respondents) (4) (% from respondents) [10].

3.2. Trends in the allocation of higher education funding and key influencing factors

In the 2025–2026 academic year, the main widespread problem of higher education in the United States remains the financial instability of colleges and universities, which is only getting worse due to the unstable political situation. Universities are struggling to plan their finances and budgets due to uncertainty about federal funding. In addition, reforms are being discussed at the state level, which include an increase in the tax burden on universities and taxes on income from endowment funds, and a planned reduction in state student loan programs, which could negatively affect the number of students. Approximately 30% of the 14 universities that make up the Big Ten Conference reported significant operating deficits in 2023. More than 40 colleges in the United States have closed since 2020. State and local funding for higher education totaled \$139.1 billion. The largest source of funding was state tax appropriations, which accounted for \$114.5 billion or 82.3% of total funding (**Figure 2**) [11].

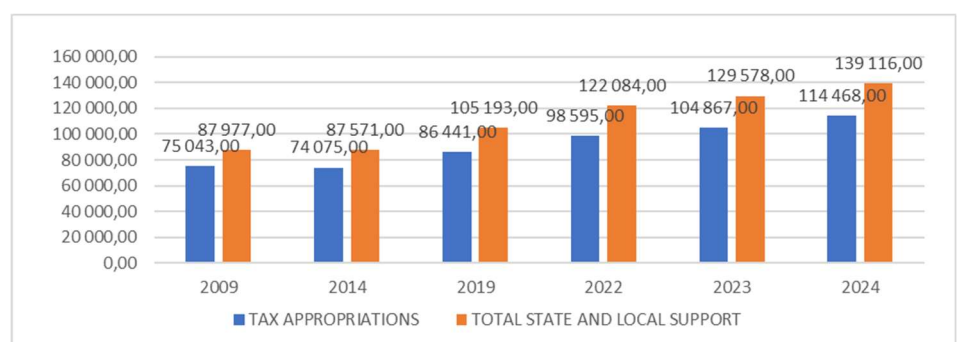


Figure 2. Major sources of funding for higher education in the United States (FY 2009–2024 (in millions of dollars)) [11].

To overcome significant financial challenges, educational institutions need to better align their financial resources with institutional and strategic priorities, while ensuring increased accountability and consistency of budget decisions with long-term goals and values, as well as taking into account demographic trends and the development of education, and taking into account the development of artificial intelligence and its implementation in all areas of life. Nearly half of college and

university presidents surveyed by Inside Higher Ed said their institutions have too many academic programs, and some should be closed. Institutional leaders also noted that expanding partnerships with philanthropic foundations, the private sector, and government could help identify new models of financial sustainability for universities.

An important step is to implement the use of artificial intelligence. Artificial intelligence-based tools offer enhanced data analytics and strategy development for educational institutions. AI can also be utilized in budgeting, program development, and labor market forecasting and labor demand analysis [12].

The rapidly changing economic, political and social landscape, as well as digitalization, have changed the perception of the need for a four-year education. Educational institutions have shifted their focus to new qualifications, in line with the demands of the time and the labor market, expanding dual enrollment programs, increasing practical training and developing flexible study programs. In the USA, some states already offer three-year bachelor's programs, providing students with a faster path to employment and ensuring a high quality of education [13]. The role of vocational training is increasing, with 76% of vocational school graduates considering their education valuable compared to only 56% of college graduates [13].

Special funds (Higher Education Emergency Relief Fund (HEERF), American Council on Education (ACE), Association of Public and Land-Grant Universities (APLU)) play a significant role in financing higher education in the United States. Additionally, increased public attention to advocacy for open educational resources (OER) has led to their widespread adoption in the United States [14].

In Ukraine, financing of higher education from international organizations plays a significant role, thanks to programs from the World Bank, the EU, the EIB, the UK, and Germany. If we analyze international support, then in 2023–2024, there is systematic support from the World Bank, the EIB, the EU, Germany, the UK and Poland (Table 1).

Table 1. Updated international programs (initiatives) to support higher education in Ukraine.

Programme/initiative	Period	Volume/quantity	Source
Horizon Europe	2021–2024	48 mln euro, 179 projects	[15]
MSCA4Ukraine (EU)	2022–2024	174 research, budget 25 million euros	[16]
Erasmus+ (EU)	2015 - 2024 (especially in 2021–2024)	33,000+ mobility participants; 95+ CBHE projects; 8000+ mobilities 2021–2024	[17]
World Bank - IHERP	2020–2024	200 mln USD (from which 154,9 mln USD disbursed, 222764 scholarships)	[18]
EIB - Ukraine Higher Education	2018–2024	120-million-euro framework loan; €13+ million allocated	[19]

Table 1. (Continued).

Programme/initiative	Period	Volume/quantity	Source
IIE scholar rescue fund (SRF)	2022–2023	30 researchers supported	[20]
UK-Ukraine twinning (UK)	2022–2025	100 twinings	[21]
Research England research and innovation twinning	2023–2024	33 projects, £5 million	[22]
DAAD - Ukraine digital (Germany)	2022–2024	43 projects (2024), 73 projects (2022)	[23]
DAAD - DUHN (Germany)	2025–2029	€24 million, 29–30 projects	[24]
Poland - NAWA solidarity with Ukraine	2022–2023	PLN 25.7 million + PLN 16 million	[25–27]
Canada - mitacs internships	2022–...	up to 600 internships for students	[28]

Another challenge facing most developed countries is the decline in student numbers. A new report by the Higher Education Policy Institute in the UK indicates that the youth population is expected to decline sharply after 2030. If participation rates do not continue to improve, the overall demand for higher education is projected to fall by 20% between 2030 and 2040 [29]. In Ukraine, the demographic situation is much worse. UNICEF statistics show that at least 2 million children have left Ukraine. According to the World Bank, there has also been a rapid decline in the number of 18-year-old citizens since 2007. The war in Ukraine has further worsened negative demographic trends and the age and sex structure of the population in the country (**Figure 3**).

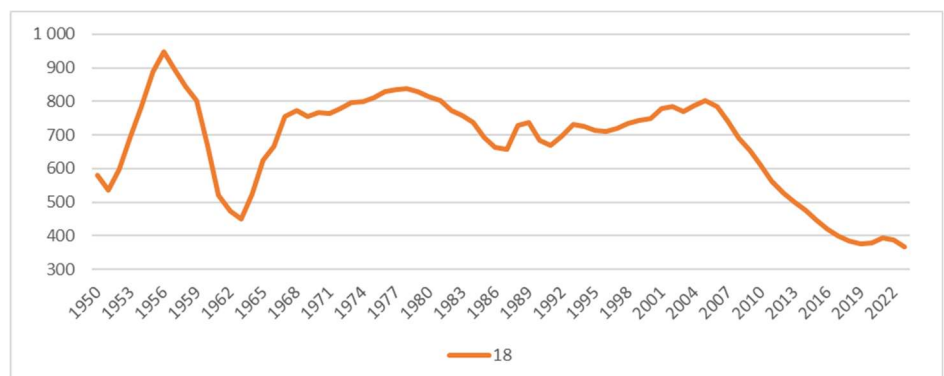


Figure 3. Total population (both sexes combined) by 18 ages in Ukraine annually for 1950–2100 (thousands) [30].

In the EU, the Netherlands and the United Kingdom have faced a policy of reducing funding for higher education this year. The Dutch government has sharply reduced funding for higher education this year, with a total reduction of €497 million. A particularly large reduction in funding has been made for international student support programmes, by €186 million [31]. The UK is also planning to reduce its higher education budget by £1.4 billion by 2025–2026 [32]. Such trends have long-term negative consequences, as education is a key element of a country's economic growth, innovation and sustainable development, the population is the main asset of

any country, and a nation with a high level of education is a strategic priority and the basis for the development of democratic values and economic development. That is why investment in higher education is vital not only for the individual success of students but also for the overall prosperity of the country. Therefore, the global negative trend in reducing funding for public higher education institutions may disproportionately harm students from low-income families or with special needs, and may also have significant negative consequences for countries' medium- and long-term development. In Ukraine, it is difficult for people with middle and lower-middle incomes to obtain paid higher education due to the underdevelopment of the grant system (especially for adults) and education loans. The prices for master's programs are 3–4 times higher than the average monthly salary and grow every year faster than inflation and the average salary in the country (**Table 2**).

Table 2. Comparison of the dynamics of master's degree fees, average salary and inflation in Ukraine [33].

Year	Average annual master's degree fee (UAH)	Average yearly salary UAH/month	Inflation, %
2020	34,000	11,596	2,73%
2021	42,000	14,018	9,36%
2022	38,000	14,857	20,18%
2023	45,000	17,442	12,85%
2024	60,000	21,473	6,5%

There is also a significant disparity in state funding for colleges and universities across the United States. Higher education spending in fiscal year 2023 ranged from \$3990 per full-time student (New Hampshire) to \$22,590 (Illinois), with a national average of \$11,040, so there are significant disparities in per-student spending across universities and states. Historically, local governments have also contributed to the funding of public universities, using local property taxes as a source, which remains a common source of revenue. But current trends are increasing the share of higher education funding from other sources, including sales and fuel taxes, gambling, utility, and tourism fees. Endowments and fundraising through the provision of ancillary services are also common [34].

In the UK, changes were made to the higher education funding system in 2006, which is now based on relatively high tuition fees and student maintenance loans. However, along with the increase in tuition fees, a system of income-related loans was developed at the same time. A significant share of university tuition fees comes from international students, accounting for 42% of higher education tuition fees [35]. Also important for funding is the ratio of students to teaching staff; the lower this indicator, the more a personalized approach and flexible curriculum can be implemented for the student. So, in the UK this indicator is 14:1, compared to the OECD average of 18:1, also at the state level, the UK supports an increase in the intensity of scientific research and development. Thus, promoting economic growth based on innovation, there is also an annual increase in funding for the Higher Education Innovation Fund, which promotes the development of cooperation

between universities and business (HEIF) [36].

The general trend is also to study at a more mature age. And universities should change their tuition fees and hours in accordance with the needs of different ages. Thus, in Ukraine, despite the overall decrease in the number of students over the past 5 years by 26%, the number of students aged 34 and older has increased almost 2 times (**Table 3**).

Table 3. Number of students in higher education institutions by age (number of full years completed on 01.01.2024) [37].

Year	2019	2020	2021	2023	2024	2024 to 2019 %
under 20	702,348	548,178	630,251	567,612	519,594	73,9%
21–25	396,110	437,268	284,556	323,551	238,523	60,21%
26-33	88,746	70,037	56,692	106,408	81,780	92,15%
34 and above	78,917	86,406	75,170	151,087	116,510	147,63%
Total	1,266,121	1,141,889	1,046,669	1,148,658	956,407	75,53%

The strengths of higher education in the EU are its international attractiveness, the country with the highest share of students from abroad in HEIs being Luxembourg - 52.3%, and some countries focus on doctoral studies to support innovation (PhD share in all students: Luxembourg - 12.7%, Germany - 6.2%, Czech Republic - 6.1% [38].

Also, one of the indicators of the effectiveness of higher education is the employment rate of EU graduates. According to statistics, the “employment rate of recent graduates” (for graduates who completed their education 1–3 years ago). Over 90% of employment is in countries such as Ireland, Austria, Belgium, Sweden, Slovakia, Poland, and Germany. The lowest in Greece and Italy (less than 80%) [39]. According to the European Innovation Scoreboard in 2025, Sweden is the leader, with high rates in Denmark, Finland, and the Netherlands. These countries have strong research and development ecosystems that correlate with students’ creative/entrepreneurial capabilities [40]. It is also very important to assess work by specialty, or skill/field mismatch indicators. For example, in the Netherlands (HBO-Monitor, an example for applied bachelors): 77% of graduates work “in their own or a related field”; the highest employment rates by phase are in healthcare - 89% and education - 88%, the lowest - in the arts - 62% [41]. In the UK (HESA “Graduate Outcomes”) - there is a variable in the reports on “job relevance of qualifications” [42]. Also, an additional indicator is - education–employment match (vertical), i.e. the share of graduates whose level of education meets the requirements of their current job (correspondence of the diploma level to the level of the position). So, in the EU, on average, this indicator is 60% [43].

3.3. Artificial intelligence as a driver of the transformation of higher education and its financing

Artificial intelligence is increasingly integrated into daily life and university education. In the coming years, AI is expected to fundamentally transform student engagement and teaching methods [44]. According to a UNESCO study, nine out of

ten teachers already utilize AI tools in their professional activities, particularly for research and writing. Nearly half are experimenting with AI for teaching, lesson planning, assessment, plagiarism detection, and administrative tasks. Additionally, 86% of students incorporate AI into their learning, with 54% using AI on a weekly basis. Artificial intelligence is evolving from a supplementary tool to a core educational infrastructure.

Despite the proliferation of AI tools, both students and educators require practical and effective examples of AI applications. When implemented appropriately, AI can enhance critical thinking skills and facilitate the production of original research by automating routine tasks.

In the near future, AI tools and methodologies are expected to be integrated into curricula, becoming central to academic projects, assignments, and research activities. Consequently, higher education institutions should foster a culture of innovation in the field of AI.

Establishing and funding specialized centers dedicated to the continuous development and implementation of AI-based innovations is recommended. Accordingly, it is necessary to support the creation of a comprehensive network of AI centers at the state level, equipped with databases and technologies accessible to universities [44].

Universities should increase investment in AI tools and allocate greater institutional funding toward AI-related research and development [45].

In the United States, the National Science Foundation (NSF), in collaboration with Capital One and Intel, plans to invest \$100 million to support five National Research Institutes for Artificial Intelligence and a central public center. The primary objectives are to accelerate open innovation, develop an AI-ready workforce, and enhance the United States' global competitiveness. These institutes will contribute to a national infrastructure for AI education and workforce development, supporting educators and engaging communities. Executive Order 14,277, "Advancing AI Education for America's Youth," further emphasizes the importance of increasing AI literacy and expanding access to training and tools nationwide. This initiative aims to foster partnerships between universities and businesses, establishing new public-private collaborations [46]. The creation of the National Artificial Intelligence Research Resource (NAIRR) provides researchers and educators with access to AI resources, supporting the development of a robust AI ecosystem that drives innovation and workforce advancement [47].

Although AI is a strategic priority in higher education, significant financial constraints and policy gaps are contributing to a widening digital divide among universities. Only 2% of higher education institutions are funding AI initiatives from new sources, and many leaders underestimate the financial requirements for effective AI implementation. Despite these challenges, continued investment in resources and policies is essential for the sustainable adoption of AI. Smaller institutions with limited funding should consider forming partnerships with national research centers or larger universities to share resources and expertise [48].

For instance, the National Research Institutes for Artificial Intelligence, led by the US National Science Foundation (NSF), comprise 29 institutes that bring together over 500 funded and collaborating institutions across the United States and

internationally. The United States continues to lead globally in ICT-related fields, producing more graduates in this area than any other country [49] (**Table 4**).

Table 4. Key government initiatives for investment and development of AI projects involving universities.

Country	AI R&D financing involving universities
United states	100 million USD announced in 2025 for 5 new NSF National AI Research Institutes, the network now includes 29 institutes and 500+ funded/collaborative institutions [50]
United Kingdom	1,6 billion pounds committed by UKRI for 2026-2030 directly targeted at AI [51]
Canada	Budget 2021 allocated more than 443 million Canadian dollars to phase 2 of the Pan-Canadian AI Strategy. Canada also reports that granting agencies provided nearly 200 million CAD in 2021–2022 for AI research and training [52]
European Union	Horizon Europe has a total budget of 93,5 billion EUR for 2021-2027. By the report of the Commission, AI-related research initiatives have received over 1,7 billion EUR under Horizon 2020 and Horizon Europe [53]
Germany	According to Germany’s federal ministry, the AI strategy includes experimental AI research support and funding for researchers. The federal government provide around 4 billion EUR each year to universities in addition to base funding [54]

To achieve strategic competitiveness and prepare graduates for the modern labor market, universities must invest in the implementation of AI tools. Leading countries in technology and AI recognize the importance of institutional and financial support for university-based AI projects and are implementing numerous state-level funding initiatives.

3.4. Key structural challenges of Ukrainian higher education (2014-2025)

Analysis of statistical data from the Ministry of Education and Science of Ukraine, the State Statistics Service, the World Bank, UNESCO, OECD, and other international organizations show that in 2014–2025, the Ukrainian higher education system faced a number of deep structural challenges that continue to determine its current state and development prospects:

1. Demographic decline and youth migration. Ukraine is experiencing one of the deepest demographic declines in Europe. According to the World Bank, the number of young people aged 17–19 has been decreasing for more than a decade. After the escalation of the war on February 24, 2022, about 6.3–6.5 million people became refugees, most of whom are currently in European countries, and as of February 2024, 392,776 students were abroad [55]. All this directly affects the volume of admissions campaigns, the financial stability of universities, and the feasibility of long-term planning.
2. Financial instability and limited resources. Financing of higher education remains unstable and insufficient. Reports by the Ministry of Education and Science and the World Bank indicate that a significant part of universities operate under resource constraints, and the mechanisms for distributing funds do not always take into account the real needs of institutions. The source [56] states that the recovery will require significant funds, and the Ukrainian state budget operates under extreme strain, with a 26.5% deficit

as a share of GDP (excluding grants). International programs – in particular, the World Bank IHERP, the European Investment Bank HEI Project and Horizon Europe – partially compensate for the lack of funding, but do not solve systemic problems.

3. Regional disparities and unequal access. The war significantly exacerbated regional inequality. According to NAQA and the Ministry of Education, dozens of universities were relocated, and part of the infrastructure was damaged or destroyed. Institutions in the central and western regions faced overcrowding, while universities in the east and south lost a significant portion of their students and staff. According to [57], 146 accreditation certificates were reissued in 2023 alone due to the relocation of higher education institutions.
4. Destruction of infrastructure and digital inequality. The World Bank [56] estimates that damage to educational infrastructure has exceeded \$10 billion, including universities, creating an uneven playing field for institutions, making it difficult to modernize and implement digital solutions, and affecting the quality of education. The report [58] confirms that the war has exacerbated inequalities in access to education – students in rural areas and frontline areas are falling behind by the equivalent of two years of schooling, and the lack of safe shelters (as of December 2023, only 80% of institutions had them) is forcing more than 2 million children to study online or in a blended format, which negatively affects the quality of the education process.
5. Internal migration of students and teachers. According to IOM, in 2022–2024, the number of internally displaced persons was about 5 million, a significant part of whom were young people and students [59], which led to a sharp redistribution of the contingent between regions: universities in the east and south lost up to half of their students, while institutions in the central and western regions are operating with increased workload. NAQA and MES reports [57] confirm that the relocation of universities was accompanied by significant staff losses, and UNESCO estimates that about 12% of teachers and researchers were forced to relocate [60]. The World Bank in RDNA2 emphasizes that internal migration has become one of the main drivers of regional disparities in access to higher education and the sustainability of universities [56]. Taken together, these factors create an environment of high uncertainty in which universities are forced to operate. That is why there is a need for systemic models of sustainability and development, such as the proposed 4R-Model, which integrates global trends with Ukrainian realities.

Thus, the generalization of the results of the comparative analysis and statistical trends allowed us to identify four key areas that determine the sustainability and development of higher education in Ukraine. On this basis, the 4R-Model was formed - a pyramidal model that combines Resilience, Resources, Relevance and Reform.

3.5. Development of the 4R-model

The Ukrainian higher education system today operates under unprecedented challenges: war, demographic decline, unstable financing, rapid digitalization, and changing labor market requirements. In such a situation, universities need a clear, holistic approach to assess their condition and plan for development. That is why, based on the analysis conducted, we propose the 4R Model – a pyramidal model that combines global trends, Ukrainian realities and university capabilities. It consists of four interconnected levels: Resilience, Resources, Relevance and Reform, which together describe the path from basic survival to strategic change.

The first level of Resilience concerns universities' ability to operate even in crisis conditions [61–62]. For Ukraine, this means effective risk management, emergency preparedness, ensuring physical and digital security, adaptation to war conditions and supporting the psychological resilience of students and employees. Without this foundation, the system simply cannot function.

The second level of Resources describes the financial and organizational capabilities of universities [63]. These include diverse funding sources, participation in international programs, endowment development and fundraising, cooperation with business and government agencies, and effective budget management. A sufficient resource base allows universities to invest in infrastructure, digitalization, innovation, and personnel development, which is especially important during the period of the country's recovery.

The third level of Relevance focuses on the extent to which educational programs meet the needs of society and the economy [55]. This includes updating education content in line with labor-market requirements, developing flexible educational trajectories, micro-credentials, and programs for different age groups, as well as strengthening practical training and dual education. Relevance determines trust in universities and the employability of graduates.

The top of the Reform model covers strategic changes that determine the future of the system – digital transformation, integration of artificial intelligence into management and learning, updating management structures, outsourcing of administrative functions, cooperation between universities, and the development of an innovative culture [64–67]. Reforms allow universities not only to respond to challenges, but also to actively shape a new quality of education.

The 4R-Model is not just a hierarchy but a living system in which each level reinforces the others. Resilience provides basic stability, Resources - opportunities for development, Relevance - social significance, and Reform - strategic movement forward (**Figure 4**). The model can be a useful tool for government agencies, universities, donors, and researchers, as it helps identify weaknesses, priorities, and development directions. Its application will contribute to the harmonization of global trends with Ukrainian realities, accelerating post-war recovery and the formation of a modern, competitive higher education system.

4. Discussion and conclusion

For innovative development and rapid post-war recovery, Ukraine needs high-quality and modern education that meets the requirements of the time. To fulfil this

mission, higher education institutions must radically change their activities, take risks and introduce innovations. The main challenges in higher education worldwide and in Ukraine are: overcoming financial difficulties; a new risk paradigm; the future of the four-year curriculum and course structure; changing labor market requirements; and adopting a systemic development approach.

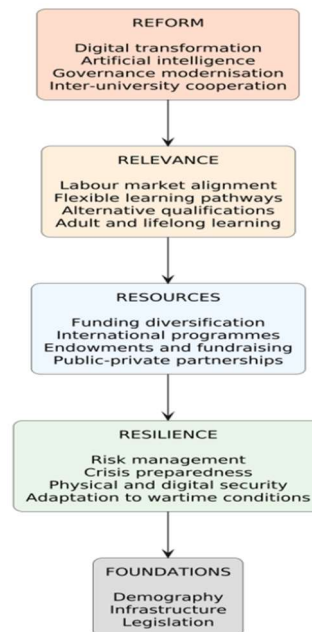


Figure 4. 4R-Model: Pyramid of higher education resilience and development.

Based on the study of the main trends in the development of higher education in the world, the following measures can be recommended to improve the quality, financial sustainability and efficiency of higher education in Ukraine:

1. transfer of administrative services to professional teams for outsourcing;
2. review of programs at the regional level, to consider and develop strategies for the regional labor market, demand and supply for educational and professional programs [68];
3. using the capabilities of artificial intelligence and data analytics to develop scenarios and forecasts and take them into account in educational policies at the regional and university levels;
4. implementing broader risk management, introducing risk management into the strategic planning of universities [69];
5. supporting and developing creative thinking and innovation in management;
6. integration with corporations, including international ones, for online internships and online mobility (for students who cannot leave Ukraine), public or government institutions [69];
7. using the opportunities for sharing resources of universities located nearby, greater cooperation between universities [68];
8. forming a culture of resilience, encouraging innovation and developing reliable action plans in emergency situations;

9. alignment of academic programs with the rapidly changing labour market, and consider alternatives to the traditional diploma, the introduction of courses, and the development of programs in accordance with the needs of different age categories of students;
10. development and implementation of new statistical forms for collecting data on student employment, horizontal and vertical correspondence to the position.

All this will allow Ukrainian universities to strengthen their sustainability and financial independence, improve the quality of education, and, at the same time, harmonize global trends with national realities. It is advisable to implement systemic digital transformation, pay attention to using the advantages of AI in the educational process and modelling curricula, digital transformation in universities and modernization of programs (implementation of a competency-based approach, interdisciplinarity, open educational resources, orientation to the needs of students of different age categories and the student's personality). It is also essential to consolidate stable, predictable state subsidies, expand the competitive component (grants and vouchers), develop endowments and fundraising, and provide targeted support for students. Such a balance of policy, challenges, and funding will help universities not only survive the war but also become drivers of technological growth and rapid post-war reconstruction based on highly educated, innovative, and socially cohesive human capital.

The Ukrainian higher education system is undergoing profound transformations caused by war, demographic changes, and financial constraints. The analysis shows that universities need new approaches to managing, financing, and updating educational programs. The proposed 4R Model summarizes key structural challenges and offers a policy-formulation framework that accounts for both global trends and specific Ukrainian conditions. By monitoring global trends and combining them with the strengths and weaknesses of higher education development, it is possible to identify growth points that can leverage the synergy of specific factors and develop a flexible 4 R model that accounts for changes. Its application can contribute to more effective planning, enhance universities' resilience, and accelerate the post-war recovery of the education system.

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