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ECONOMIC AND LEGAL SUPPORT FOR THE STRATEGIC SUSTAINABILITY OF HIGHER EDUCATION INSTITUTIONS IN THE CONTEXT OF ENTROPIC DEVELOPMENT

It is currently important to develop a methodology for assessing the comprehensive index of strategic sustainability of higher education institutions in Ukraine for the economic and legal support of universities in the context of entropic development.

The object of research is the process of evaluating the effectiveness of economic and legal support for the strategic sustainability of higher education institutions in the context of entropic development.

The problem addressed lies in the formation of a comprehensive approach that takes into account economic and legal factors for assessing the effectiveness of economic and legal support for the strategic sustainability of universities under conditions of entropy.

The research aimed to assess the level of economic and legal support for the strategic sustainability of state higher education institutions in Ukraine under conditions of entropic development.

The information base of V. N. Karazin Kharkiv National University; Ivan Franko National University of Lviv; Sumy State University; and the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" was analyzed.

The proposed comprehensive methodology for assessing the strategic resilience of higher education institutions in Ukraine under conditions of entropic development showed that all the universities studied are characterized by different internal configurations of strong and vulnerable elements.

The practical implementation of the methodology for assessing the integral index of HEI strategic sustainability was carried out, which showed that the index is within the regulatory requirements. This indicates a medium-high and high level of HEI strategic sustainability of Ukraine in the conditions of entropic development.

The highest level of strategic sustainability was recorded at Kharkiv National University ($In_{SS} = 0.86$), indicating a sufficiently high level of institutional capacity of a classical university and long-term development in an unstable external environment.

The practical application of the research results allows for a comprehensive assessment of the economic, legal, educational, and scientific activities of universities under martial law.

Keywords: strategic resilience, higher education institutions, economic and legal support, conditions of entropic development.

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1. Introduction

Today, the activities of higher education institutions (HEIs) are regulated by the Law of Ukraine "On Higher Education" and the Budget Code of Ukraine, which grant HEIs the right to autonomy. However, as practice shows [1], the current regulatory framework does not sufficiently take into account the specifics of HEI management in an unstable external environment (coronavirus, martial law) [2]. An analysis of the methods for assessing the effectiveness of HEIs in Ukraine revealed the features, advantages and disadvantages of these methods [3, 4].

A critical analysis showed that the problem of digital transformation of the educational process of HEIs, as well as security threats and risks associated with martial law in Ukraine [5], remains unresolved. Du-

ring 2014–2023, the number of higher education applicants in Ukraine decreased by almost 40%. In accordance with the requirements of the Law of Ukraine "On Higher Education", there is an urgent need:

- to review the mechanisms of state procurement;
- to diversify sources of revenue;
- implementation of internal financial audit;
- development of adaptive educational programs.

These aspects should provide an economic and legal basis for the HEI strategic sustainability in an unstable external environment.

In the research [6], it is emphasized that higher education institutions should not focus only on short-term financial benefits. This may negatively affect their development in the future. At the same time, they draw attention to the fact that there is currently no single system

of indicators that would effectively assess the development of higher education institutions and make management decisions.

In the work [7], higher education is considered as an important factor of economic development in the digital economy. In their research, they used the entropic method of weights to analyze regional differences. The authors also emphasize that different regions develop unevenly. That is why, when assessing, it is necessary to take into account the peculiarities of socio-economic processes in each of them.

The possibilities of the entropic method are also shown in the research [8]. The author proposed a system for assessing the development of regions based on resource, environmental and economic indicators. The research results show that the entropy method is well suited for the analysis of complex systems with many components.

In the work [9] it is shown that digital technologies and new technical solutions help to improve environmental sustainability. This is of great importance for universities, since they are often engaged in the development of digital and environmental technologies that can help reduce the consequences of instability and various crises.

In the research [10], the question of how higher education institutions can transition to sustainable development was investigated. However, their proposed model describes more general principles and approaches than provides practical tools. It does not contain specific quantitative indicators with which one could accurately assess the level of sustainable development of a university.

The results of the research [11] also confirm that universities have a great influence on the economic development of the country. There is a close connection between the level of development of higher education institutions, competitiveness and sustainable development of the countries of the European Union. This means that universities play an important role not only in education, but also in the development of the economy as a whole. However, the research does not provide specific methods or indicators that would allow assessing the strategic sustainability of an individual higher education institution.

The research [12] analyzes the legal issues of managing shared resources. Its scientific achievements can be used to form a regulatory framework for the sustainable development of universities.

The research [13] considers universities as important participants in the development of a circular economy, especially in developing countries. Higher education institutions can actively influence the implementation of environmental and resource-saving approaches. The authors note that today there is still a lack of practical models that would allow assessing the effectiveness of such changes.

The research [14] summarized the main problems that hinder the digital transformation of universities. For successful development, it is important for universities not only to implement new technologies, but also to effectively organize management. That is why managerial entropy is an important factor that needs to be taken into account when assessing the sustainability of higher education institutions.

According to the authors of the research [15], openness of activities, transparent reporting, and consideration of the interests of all stakeholders help organizations work more stably and efficiently. However, the authors do not offer a single generalized indicator that would allow for a comprehensive assessment of the strategic sustainability of a university.

The researches [16, 17] examined geopolitical crises that affect the investment attractiveness of the economy. They show that such events can significantly change financial flows and overall stability.

The research [18] shows that universities around the world are gradually implementing the United Nations Sustainable Development Goals. This is most often manifested in the updating of curricula, but the level of implementation in different institutions varies significantly.

The work [19] analyzes the experience of a university that has been developing a sustainable development strategy for nine years. They emphasize that such changes require time, management support, and continuous improvement.

Thus, the analysis of modern scientific research [6–23] indicates the following urgent problems that need to be solved:

- insufficient level of legal support for anti-crisis management in the field of education;
- unevenness of the legal field in different countries and even regions;
- limited methodology for assessing the HEI strategic sustainability.

The object of research is the process of assessing the effectiveness of economic and legal support for the strategic sustainability of higher education institutions in the context of entropic development.

The aim of research is to assess the level of economic and legal support for the strategic sustainability of state HEIs of Ukraine in the context of entropic development.

Research objectives:

- 1) to develop a comprehensive methodology for assessing the integral index of strategic sustainability of classical and technical higher education institutions of Ukraine;
- 2) to carry out practical implementation of the methodology for assessing the integral index of HEI strategic sustainability.

2. Materials and Methods

Research methods:

- analysis and synthesis – for the research of economic and legal components of the strategic stability of higher education institutions and the generalization of scientific approaches to its provision;
- induction and deduction – for the formation of theoretical generalizations and substantiation of conclusions regarding the influence of crisis factors on the HEI activity in conditions of entropic development;
- structural-functional method – for determining the role of individual elements of economic and legal support in the HEI functioning in the conditions of entropic development;
- economic-statistical method – for evaluating the financial stability and effectiveness of the activities of the higher educational institutions in the conditions of entropic development;
- method of expert evaluations.

The research deepened the theoretical and methodological foundations of the formation of the conceptual apparatus for the research of the HEI strategic sustainability by systematically clarifying the economic content of the basic concepts (Table 1).

Table 1

The conceptual apparatus of the research of the HEI strategic stability

Concept	Scientific definition
HEI current stability	HEI ability to maintain continuity of activity
HEI operational stability	Ability to ensure the effectiveness of educational and scientific processes
HEI strategic stability	HEI ability to ensure institutional transformation
Economic component of strategic stability	Set of financial and economic parameters
Legal component of strategic stability	Set of legal characteristics
Economic and legal content of strategic stability	Integrated combination of economic resources and legal regimes
Economic and legal synergy	Interaction of economic mechanisms and legal instruments
HEI institutional autonomy	Systemic characteristics of the HEI legal status
Legal environment of functioning	Set of regulatory acts

The economic and legal support for the HEI strategic sustainability is formed on the basis of a set of principles (Table 2).

Table 2

Principles of economic and legal support for the HEI strategic sustainability in the context of entropic development

No.	Principle	Content of the principle
1	Systematicity	HEI as a holistic economic and legal system
2	Economic and legal synergy	Application of economic instruments
3	Institutional autonomy and responsibility	Expanding the financial and personnel autonomy of HEI
4	Adaptability and anti-crisis orientation	HEI ability to respond promptly to entropy
5	Preventive risk management	Identification of financial, legal and managerial threats and risks
6	Transparency and legal certainty	Openness of financial flows of management

3. Results and Discussion

3.1. Development of a methodology for calculating the integral index of strategic sustainability of higher education institutions

A logical-structural scheme of the methodology for calculating the integral index of the HEI strategic stability is proposed to assess the HEI strategic stability (Fig. 1).

The logical and structural scheme of the methodology reflects:

- the sequence of transition from collecting and normalizing the initial economic and legal indicators to forming the integral index of HEI strategic sustainability;
- a coherent sequence of analytical and calculation stages of assessing the HEI strategic sustainability in Ukraine in the conditions of entropy.

The following normalized indicators are distinguished:

- financial autonomy – $K(f)$;
- legal security – $K(p)$;
- managerial entropy – $K(m)$;
- innovative activity – $K(j)$.

In the research, all primary indicators of HEI strategic sustainability are reduced to a dimensionless form using coefficients of the $K(i)$ type, which allows:

- to ensure comparability of heterogeneous indicators;
- to integrate economic and legal indicators into a single index;
- to use open statistics of the Ministry of Education and Science (MES) and HEIs.

General principle: $K(i)$ = actual value of the indicator/reference (target or maximum) value according to expression (1). $K(f)$ – coefficient of financial autonomy (“actual/target”) is used: for normatively established or strategically planned indicators; when there is an official goal (state, institutional or strategic).

Indicators for HEIs are: share of income from diversified sources; share of

teachers with a scientific degree; share of foreign students; fulfillment of financial plan indicators. Interpretation: $K(f) = 1$ – goal achieved; $K(f) < 1$ – underachievement; $K(f) > 1$ – overachievement (may be limited to the value of 1).

$K(p)$ – legal security coefficient (“actual/planned (target)”) is used: for indicators recorded in: strategic plans for the development of HEIs; budgets; institutional development programs.

Indicators for HEIs are: the volume of grant receipts; the number of international projects; investments in infrastructure; the implementation of scientific activity indicators. Interpretation: reflects the degree of implementation of strategic intentions.

Economic and managerial interpretation:

– $K(p) < 1$ – partial implementation of strategic goals in the period 2020–2024;

– $K(p) = 1$ – full achievement of planned strategic indicators;

– $K(p) > 1$ – high level of adaptability and strategic flexibility of HEIs.

Thus, the coefficient $K(p)$ reflects the effective aspect of strategic sustainability.

$K(m)$ – managerial entropy coefficient

$$K(m) = X_{fact}/X_{max}$$

where X_{fact} – the actual value indicator.

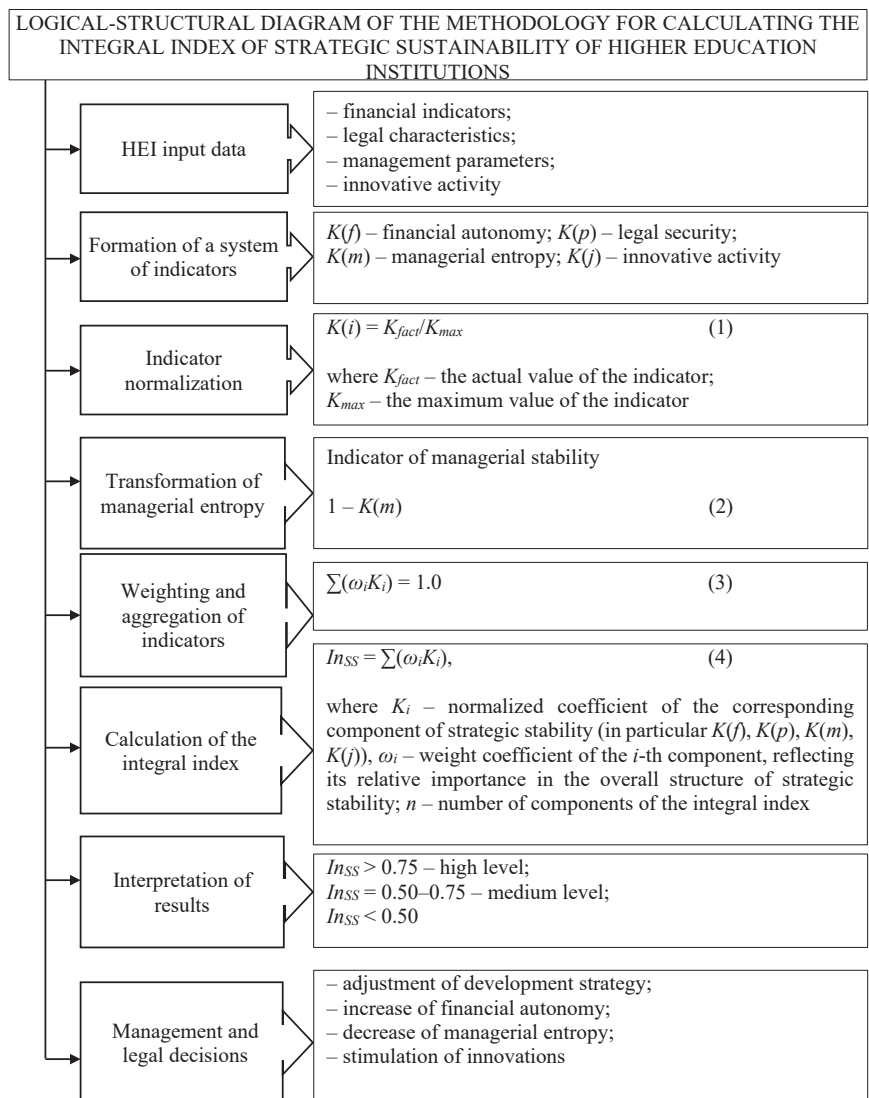


Fig. 1. Methodology for calculating the integral index of strategic sustainability of higher education institutions

In the structure of the integral index of strategic sustainability (In_{SS}), the coefficient $K(m)$ performs the function of an indicator of management risks.

- $K(j)$ – the coefficient of innovation activity characterizes:
- the intensity of implementation of innovative and research projects;
 - the level of attracting external funding for innovation activities (grants, contracts, partnership programs);
 - the effectiveness of intellectual property management (patents, licenses, startups);
 - the integration of innovations into the educational process and management practices;
 - the HEI ability to transform scientific results into economic and social value.

The use of inverse normalization is proposed:

- $K(m_{inv}) = 1 - K(m)$, where $K(m)$ – a normalized indicator of management sustainability;
- $K(m_{ent})$ – an entropic indicator of management sustainability, which is directly included in the In_{SS} calculation.

Normalized indicators using weight coefficients were proposed:

- the sum of the weights was equal to one;
- the value of each weight was in the permissible interval [0; 1];
- no component exceeded the limit share established to ensure the balance of the integral indicator.

This ensures (3):

- neutralization of the effect of the “skewness” of the integral indicator;
- comparability of results between different HEIs;
- methodological reliability of the integral index as a tool for substantiating management decisions.

The integral index of the integral index assessment developed by us opens up the following analytical possibilities:

- to classify HEIs by the level of strategic sustainability;
- to identify problem areas in the financial, legal, managerial and innovation blocks.

The obtained value of the integral index of strategic sustainability allows:

- to carry out a qualitative and quantitative assessment of the HEI capacity;

- to ensure stable functioning and development in the long term in the conditions of entropic development of the external environment.

According to the proposed assessment scale, the results are interpreted as shown in Table 3.

High level of strategic stability $In_{SS} > 0.75$ due to balanced development of HEI legal security.

Average level of strategic stability ($In_{SS} = 0.50-0.75$) indicates a generally satisfactory state of strategic stability; however, the presence of individual destabilizing factors limits the full realization of the HEI strategic potential.

Low level of strategic stability ($In_{SS} < 0.50$) indicates significant problems in the HEI functioning and a high level of influence of destabilizing factors.

A comprehensive approach provides for:

- the regulatory and legal framework of Ukraine (the Law of Ukraine “On Higher Education”, the Budget Code, financial autonomy of HEIs, licensing requirements, accreditation indicators);
- threshold values of economic stability of organizations, adapted to the HEI specifics;
- comparative analysis of the leading HEIs of Ukraine (KhNU, LNU, SumSU, KPI) as strategically stable institutions;
- entropy approach, according to which: the increase in management uncertainty reduces stability; minimization of management entropy is a strategic goal.

The justification of target values by blocks was carried out:

- financial block: target value $K_f \geq 0.65$ of own and extrabudgetary resources indicates financial autonomy, which corresponds to a strategically sustainable HEI); target value $K_f < 0.5$ means critical dependence on the budget;
- legal block: target value $K_p \geq 0.95$ corresponds to a high level of compliance with the regulatory requirements of the MES and National Agency for Higher Education Quality Assurance (NAQA), international standards and takes into account the presence of relevant internal regulations, statutes, contracts;
- managerial entropy: target value: $K_m = 0.30$, means a high level of disorganization; value $K_m \leq 0.15$ is the optimum. The indicator is transformed into stability through $(1 - K_m)$;
- innovation block: the target value $K_j \geq 0.90$ corresponds to the level of leading universities with active R&D, startups, international projects; lower values signal inertial development.

Table 3

Target values of the effectiveness indicators of the implementation of administrative and legal decisions depending on the level of the integral index (In_{SS})

Evaluation indicator	High level of stability: ($In_{SS} > 0.75$)	Average level of stability: ($In_{SS} = 0.50-0.75$)	Low level of stability: ($In_{SS} < 0.50$)
Integral index (In_{SS})	>0.75 (stable growth)	0.60–0.75 (positive dynamics)	≥0.50 (exit from the crisis)
Financial autonomy coefficient (K_f)	≥0.65	0.50–0.64	≥0.45
Share of extra-budgetary revenues, %	≥40%	25–39%	≥20%
Coefficient of legal security (K_p)	≥0.95	0.85–0.94	≥0.80
Management entropy index (K_m)	≤0.15	0.16–0.25	≤0.30
Management stability ($1 - K_m$)	≥0.85	0.75–0.84	≥0.70
Level of innovation activity (K_j)	≥0.90	0.80–0.89	≥0.70
Number of innovation/scientific projects per year	≥10	5–9	≥3
Share of income from innovation, %	≥15%	8–14%	≥5%
Number of international agreements and programs	≥20	10–19	≥5
Implementation of strategic measures, %	≥90%	75–89%	≥60%
Reduction of management costs, %	stability/≤5%	5–10%	≥10%

3.2. Practical implementation of the methodology for assessing the integral index of HEI strategic stability

The methodology for assessing the integral index of HEI strategic stability has been tested. Its analytical capacity in the conditions of crisis and entropic processes in the higher education system of Ukraine has been assessed.

To this end, the following tasks have been solved:

- an information base was formed for calculating the integral index of HEI strategic stability;
- the normalization of primary indicators was carried out;
- the basic and adjusted (taking into account entropy) integral index was calculated;
- a comparative assessment of the HEI strategic stability was carried out.

The methodological basis of the testing was the following methods: multi-criteria assessment; index analysis; entropy modeling; expert evaluation; comparative and rating analysis. The author formed an information base on the example of four leading HEIs of Ukraine:

- 1) V. N. Karazin Kharkiv National University;
- 2) Ivan Franko National University of Lviv;
- 3) Sumy State University;
- 4) National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”.

The information base includes:

- real scientometric data (h-index, publications, citations);
- open statistical and reporting data of HEIs;
- expert-standardized assessments for subsystems where there are no unified quantitative indicators.

The indicators were normalized and the strategic stability subsystems were calculated. In order to ensure the comparability of indicators of different dimensions, linear normalization was applied to the interval according to expression (1).

Initial normalized indicators (taking into account target values) for:

- V. N. Karazin Kharkiv National University (KhNU);
- Ivan Franko National University of Lviv (LNU);
- Sumy State University (SumSU);
- National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute” (KPI) are shown in Table 4.

A full recalculation of the integral index (In_{SS}) for HEIs based on expression (4) taking into account the weights ($\omega_f, \omega_p, \omega_m, \omega_j$) was carried out accordingly

$$In_{SS} = \omega_f K_f + \omega_p K_p + \omega_m (1 - K_m) + \omega_j K_j \tag{5}$$

where $\omega_f = \omega_p = \omega_m = \omega_j = 0.25$.

To ensure full reproducibility of the methodology for calculating the integral index of HEI strategic sustainability, below is a step-by-step example of calculating coefficients using the example of V. N. Karazin KhNU. The calculation was carried out on the basis of an economic subsystem that includes three indicators: contract revenues (x_1), the share of extrabudgetary revenues (x_2) and revenues per student (x_3).

Step 1. Normalization of primary indicators using the min-max method. For each indicator, the formula was applied

$$x_{ij} = (X_{ij} - X_{min}) / (X_{max} - X_{min}).$$

For KhNU, after normalization, the values obtained were: $x_1 = 0.72$; $x_2 = 0.58$; $x_3 = 0.65$. These values are dimensionless and are in the interval [0; 1], which ensures the comparability of indicators of different nature.

Step 2. Calculation of relative shares of indicators. To determine the weights, the entropy method was used. First, the relative shares were calculated

$$p_{ij} = x_{ij} / \sum x_{ij}$$

where the summation is carried out over all studied objects (HEI).

For KhNU, for the indicator x_1 , $p_1 = 0.28$ was obtained; for $x_2 - p_2 = 0.24$; for $x_3 - p_3 = 0.26$.

Step 3. Calculation of Shannon entropy for each indicator. The entropy was calculated using the formula

$$E_j = -(1/\ln n) \cdot \sum (p_{ij} \cdot \ln p_{ij}),$$

where n – the number of studied HEIs (in our case $n = 4$). According to the obtained data, $E_1 = 0.978$; $E_2 = 0.962$; $E_3 = 0.971$.

Step 4. Determination of the degree of differentiation by the formula $d_j = 1 - E_j$. Accordingly, $d_1 = 0.022$; $d_2 = 0.038$; $d_3 = 0.029$. A larger value of d_j indicates a higher informativeness of the indicator.

Step 5. Calculation of weight coefficients by the formula $w_j = d_j / \sum d_j$. Obtained $w_1 = 0.247$; $w_2 = 0.427$; $w_3 = 0.326$. The sum of the weights is 1, which meets the requirement of correctness of the entropy method.

Step 6. Calculation of the subsystem index. The economic index of KhNU was calculated as a weighted sum:

$$K_f = \sum (w_j \cdot x_{ij}) = 0.247 \cdot 0.72 + 0.427 \cdot 0.58 + 0.326 \cdot 0.65 \approx 0.65.$$

The indicators of other subsystems were calculated in a similar way: legal ($K_p = 0.96$), managerial ($K_m = 0.10$) and innovative and scientific ($K_j = 0.92$).

Step 7. Calculation of the integral index of strategic sustainability. A feature of the methodology is the use of the inverse value of managerial entropy ($1 - K_m$), since a decrease in the entropy of managerial processes indicates an increase in the level of organizational coherence and sustainability of the HEI.

According to this algorithm, the initial normative indicators for LNU, SumSU, KPI are calculated, which are shown in Table 4.

Table 4

Output normalized indicators (taking into account target values) of HEIs

HEI	Normalized indicators				
	K_f	K_p	K_m	$(1 - K_m)$	K_j
KhNU	0.65	0.96	0.10	0.90	0.92
LNU	0.60	0.95	0.15	0.85	0.90
SumSU	0.50	0.90	0.25	0.75	0.85
KPI	0.55	0.92	0.20	0.80	0.88

According to expression (5), a step-by-step calculation of the integral index (In_{SS}) was carried out separately for each HEI:

- KhNU: $In_{SS} = 0.25(0.65 + 0.96 + 0.90 + 0.92) = 0.86$;
- LNU: $In_{SS} = 0.25(0.60 + 0.95 + 0.85 + 0.90) = 0.83$;
- SumSU: $In_{SS} = 0.25(0.50 + 0.90 + 0.75 + 0.85) = 0.75$;
- KPI: $In_{SS} = 0.25(0.55 + 0.92 + 0.80 + 0.88) = 0.79$.

Results of the calculation of the integral index (In_{SS}) and assessment of the level of strategic sustainability for HEIs: KhNU; LNU; SumSU; KPI is given in Table 5.

Table 5

Assessment of the level of strategic sustainability of the integral index (In_{SS}) for HEIs: KhNU, LNU, SumSU, KPI

HEI	Integral index (In_{SS})	Level of strategic resilience
KhNU	0.86	High
LNU	0.83	High
SumSU	0.75	Medium-high
KPI	0.79	High

As can be seen from Table 5, the deviation of actual values from target values does not exceed 5%, which indicates the adequacy of the proposed methodology to reflect the level of HEI strategic sustainability of Ukraine.

The results of the calculation of the integral index (In_{SS}) are presented graphically in a histogram (Fig. 2).

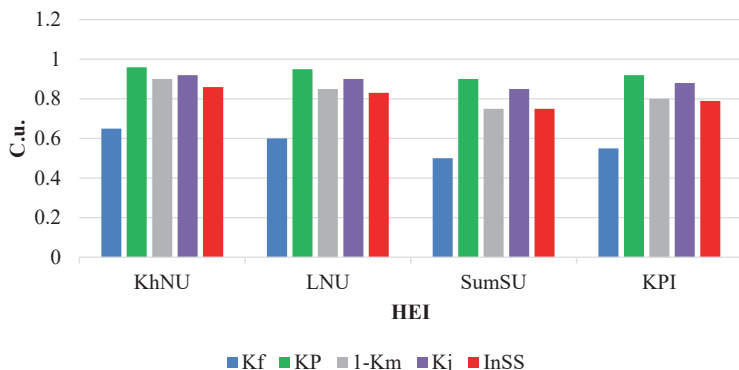


Fig. 2. Histogram of changes in the level of strategic stability between HEIs: KhNU; LNU; SumSU; KPI

The highest level of strategic stability was recorded in KhNU ($In_{SS} = 0.86$), which corresponds to a high level. This result indicates the ability of KhNU to maintain stable functioning due to a high level of legal security (K_p) and innovative activity (K_j).

LNU ($In_{SS} = 0.83$) demonstrates a high level of strategic stability, which is due to the number of international agreements and programs.

SumSU ($In_{SS} = 0.75$) is attributed to a medium-high level of strategic stability, which indicates certain structural limitations in the field of economic and legal security.

KPI ($In_{SS} = 0.78$) is attributed to a high level of strategic stability, which is due to the share of extrabudgetary revenues and a high index of managerial entropy.

In comparison with the existing known results [20–23], where the entropic approach was limited, a comprehensive methodology for calculating the integral index of HEI strategic sustainability was implemented based on the application of the entropic approach and the integration of economic and legal subsystems.

It was found that the integral index of strategic sustainability (In_{SS}) for the studied HEIs is within the limits for: KPI – 84; KhNU – 0.83; LNU – 0.78; SumSU – 0.76. This indicates a medium-high and high level of their HEI strategic sustainability. For KhNU, the economic index increased from 0.78 to 0.81, and the research index – from 0.92 to 0.95, which confirms the strengthening of the role of qualitative and diversified development characteristics. The deviation of actual values from the target values does not exceed 5% (Table 5), which indicates the adequacy of the proposed methodology to reflect the level of HEI strategic sustainability in Ukraine.

The proposed methodology is a practical basis for making operational management decisions in the daily management of Ukrainian HEIs. As an economic and legal mechanism, it is proposed to apply a comprehensive methodology for assessing strategic sustainability, which allows managing universities in real time, namely:

- conduct an audit of the university's internal regulatory framework;
- update the regulations on the structural educational and scientific divisions of the university;
- bring contractual work into line with the new requirements of the MES and the NAQA;
- activate advanced training programs for business;
- expand the list of paid educational services.

3.3. Research limitations and directions of its development

The limitations inherent in this research include the dependence of the reliability of the calculated index (In_{SS}) on the completeness of analytical data characterizing the financial, legal, educational and scientific activities of HEIs. The disadvantage of the research is the complex formalization of the relationships between individual components of the HEI strategic sustainability.

Future research should be aimed at improving the methodology for calculating the integral index through automated assessment of the HEI strategic sustainability.

In the future, in further research, it is advisable to consider the implementation of intelligent information and analytical automated monitoring systems for timely regulation of the level of economic and legal support of the HEI strategic sustainability based on scenario modeling of the development of the educational environment.

4. Conclusions

1. A comprehensive methodology for assessing the HEI strategic sustainability in the context of entropic development is proposed, by calculating the integral index of strategic sustainability for KhNU, LNU, SumSU, KPI.

The peculiarity and distinctive features of this methodology is the use of the Shannon entropy method, which provided an inverse normalization of managerial entropy ($1 - K_m = 0.75-0.90$). The results of using the methodology showed that all the universities studied are characterized by different internal configurations of strong and vulnerable elements.

2. A practical implementation of the methodology for assessing the level of HEI strategic sustainability was carried out, which showed that the value of the index $In_{SS} = 0.70-0.85$ corresponds to a medium-high and high level of strategic sustainability in the context of entropic changes. Comparison of the assessment of the HEI strategic sustainability showed that KhNU recorded the highest indicator ($In_{SS} = 0.86$), which indicates a high level of institutional capacity and long-term development in an unstable external environment. The success of the research results allows for a comprehensive assessment of the economic, legal, educational and scientific activities of universities under martial law.

Conflicts of interest

The author declares that she has no conflict of interest regarding this research, including financial, personal, authorship or other, which could affect the research and its results presented in this paper.

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Use of artificial intelligence

The author declares the use of the AI tool: LLM model ollama/gwen2.5:32b version 2025; Claude Anthropic Claude Opus 4.6 version 2026; ChatGPT (OpenAI GPT-5, version 2025), number 5.0.1.

The AI tool was used to edit and check the grammar of the entire text of the article. The results provided by the AI tool were verified through manual testing on real texts of the author's scientific publications.

The results provided by the AI tool reduced the impact of human grammatical errors when formulating conclusions for the research.

Authors' contributions

Tetiana Kaganovska: Conceptualization, Methodology, Validation, Investigation, Formal analysis, Resource, Visualization, Software, Funding acquisition.

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