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ANALYSIS OF HIGHER EDUCATION INSTITUTIONS' PERFORMANCE INDICATORS BASED ON QS WORLD UNIVERSITY RANKINGS ASSESSMENT

In the modern context of globalization and increasing competition among universities, a key factor for the successful development of higher education institutions (HEIs) is the ability to accurately assess their performance. This study provides a review of research related to global ranking assessments and performance management of HEIs using key performance indicators (KPIs), substantiating the relevance of this research. The aim of the study is to improve the system of key performance indicators (KPIs) at the National Technical University "Kharkiv Polytechnic Institute" (NTU "KhPI"), which will contribute to enhancing the quality of educational services and improving the university's position in international rankings. The task of the study is to establish the relationship between the planned target indicators defined in the university rector's contract and the QS World University Rankings (QS-WUR) indicator system, which influences the institution's position in this global university ranking. Based on an analysis of NTU "KhPI" performance according to the QS-WUR methodology, an approach for formalizing the QS-WUR indicators that determine its ranking position is proposed. The developed model for forming QS-WUR ranking indicators for NTU "KhPI" explains who provides the information for calculating each indicator and illustrates the interconnections between these indicators in the university evaluation process. The study also formalizes the performance results of NTU "KhPI," which are annually published on the university's official website and calculated based on the performance indicators of its institutes, departments, and other units. This comprehensive approach to evaluating university performance allows for the identification of strengths and weaknesses in managing scientific and international activities and organizing the educational process. The implementation of the improved KPI system at NTU "KhPI" will facilitate the optimal allocation of resources, the introduction of innovative approaches in academic, research, and international activities, and, in turn, ensure high standards of education quality and international recognition of the university.

Keywords: key performance indicators, management, model, indicator system, ranking, QS World University Rankings, resource allocation, information system.

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АНАЛІЗ ПОКАЗНИКІВ ЕФЕКТИВНОСТІ ДІЯЛЬНОСТІ ЗАКЛАДІВ ВИЩОЇ ОСВІТИ НА ОСНОВІ ОЦІНЮВАННЯ QS WORLD UNIVERSITY RANKINGS

У сучасних умовах глобалізації та зростаючої конкуренції між університетами ключовим фактором успішного розвитку закладів вищої освіти (ЗВО) є здатність точно оцінювати свою ефективність. У роботі проведено огляд досліджень, які пов'язані із світовим рейтинговим оцінюванням та управлінням ефективністю діяльності ЗВО з використанням KPI, обґрунтовано актуальність дослідження. Метою дослідження є удосконалення системи ключових показників ефективності (KPI) у Національному технічному університеті «Харківський політехнічний інститут» (НТУ «ХПІ»), що сприятиме підвищенню якості освітніх послуг та покращенню позицій у міжнародних рейтингах. Завданням роботи є встановлення зв'язків між плановими цільовими показниками, визначеними у контракті керівника університету, та системою показників QS-WUR, які впливають на позицію ЗВО у цьому світовому рейтингу університетів. На основі аналізу ефективності діяльності НТУ «ХПІ» відповідно до методики QS World University Rankings (QS-WUR) запропоновано підхід щодо формалізації показників QS-WUR, які визначають його позицію у рейтингу. Розроблена модель формування показників рейтингів QS-WUR для НТУ «ХПІ» пояснює, хто та як надає інформацію для розрахунку кожного показника, а також відображає взаємозв'язки цих показників у процесі оцінювання університету. Проведено формалізацію результатів діяльності НТУ «ХПІ», які щорічно оприлюднюються на офіційному сайті університету та розраховуються на основі показників роботи інститутів, кафедр та інших підрозділів. Це забезпечує комплексний підхід до оцінювання ефективності діяльності університету, дозволяє визначити його сильні та слабкі сторони в управлінні науковою та міжнародною діяльністю та в організації освітнього процесу. Впровадження вдосконаленої системи KPI у НТУ «ХПІ» буде сприяти оптимальному розподілу ресурсів, запровадженню інноваційних підходів у навчальну, наукову та міжнародну діяльність, що, своєю чергою, забезпечить високі стандарти якості освіти та міжнародне визнання університету.

Ключові слова: ключові показники ефективності, управління, модель, система показників, рейтинг, QS World University Rankings, розподіл ресурсів, інформаційна система.

Introduction. In the strategy for the development of higher education in Ukraine for 2022-2032, one of the main challenges for higher education institutions (HEIs) is the improvement of KPIs that characterize the position of HEIs in global rankings. The impact of global rankings on the strategic development of HEIs is significant and substantial. This is due to the following aspects. Firstly, high positions in global and national rankings strengthen the reputation of HEIs, contributing to the attraction of the best students and recognized scientists from around the world. Secondly, the desire to improve their ranking positions encourages HEIs to review and optimize internal processes in educational, research, and international activities. For this, HEI management needs to engage in strategic planning and adapt to the changing conditions of the global education market to effectively allocate resources and determine priority areas for development to improve the HEI's ranking positions. Researchers and practitioners pay attention to the analysis of KPIs as a tool for assessing HEI performance and enhancing the ranking of Ukrainian education. The use of KPIs is becoming crucial in managing the efficiency of HEIs.

Analysis of research and publications. Currently, the leading global academic university rankings include QS World University Rankings (QS-WUR), Times Higher Education (THE) World University Rankings, Academic Ranking of World Universities (ARWU), and Leiden Ranking [1]. They play a key role in determining the international reputation of higher education institutions.

The QS-WUR ranking [2] considers academic and employer reputation, which accounts for a significant portion of the overall score (a combined 50%). The Times Higher Education ranking [3] uses reputation surveys to

assess the quality of teaching and research, providing a systematic view of academic reputation. These rankings reflect the subjective evaluation of education and research quality provided by a broad pool of respondents, and therefore, they can influence the perception of universities at the international level. Since they are largely dependent on respondent opinions, the results of such rankings are influenced by subjective factors [4-5].

The authors of the study [6] propose key changes in the QS-WUR ranking methodology, which have significantly impacted the positions of HEIs. The main changes concern data collection and evaluation methods, particularly reputation surveys and faculty-related indicators. The study results showed that these changes led to significant shifts in university rankings, sparking debates about the transparency of the methodology. The drawback of this approach is that the changes may have negatively affected universities that traditionally held strong positions but experienced a ranking decline due to methodological adjustments.

The study [7] presents a predictive model for assessing university competitiveness in the QS-WUR ranking using statistical methods and machine learning algorithms. The model allows for accurate forecasting of university performance, which can be useful for improving strategies aimed at attracting top students, faculty, and funding. The results showed a low prediction error, making the model highly reliable. However, a disadvantage of the approach is the difficulty in adapting the model to new ranking changes and the need for continuous algorithm and data updates.

Key research on the methodology and impact of ARWU, also known as the Shanghai Ranking, has been reviewed [8]. ARWU evaluates universities based on the number of Nobel laureates and Fields medalists among alumni and faculty, the number of publications in prestigious journals, and citation levels. ARWU is one of the most influential international university rankings, focusing on academic and research achievements such as the number of publications in high-ranking journals, the number of Nobel laureates among faculty and alumni, and other scientific indicators. The analysis of scholarly works highlights the key advantages of this ranking, particularly its objective evaluation criteria, as well as its drawbacks, such as underestimating educational indicators and giving less attention to the humanities.

The study [9] conducted a graphical comparison of global university rankings, emphasizing that ARWU (Shanghai Ranking) is the most stable indicator of university research activity. At the same time, THE and QS-WUR rankings rely heavily on reputation surveys, which leads to underestimation of universities with high research performance and overestimation of universities with less developed research activities. The results showed that the reputation component significantly influences university positions in THE and QS-WUR rankings, which can be considered a drawback of this approach. Meanwhile, ARWU focuses more on objective scientific criteria, making it more reliable for assessing research productivity.

The article [10] provides a critical analysis of the ARWU Shanghai Ranking methodology, particularly its impact on the "Big Five" South African research universities. The authors compare the performance of these universities in the context of international rankings and note that ARWU focuses on quantitative indicators of scientific activity, such as the number of publications and awards. The research results show that South African universities perform relatively well in ARWU due to their research achievements. However, the drawbacks of the approach include limited attention to educational activities and universities' social responsibility.

Leiden Ranking [11-12] employs bibliometric analysis, allowing the measurement of scientific publications and citations while considering research volume and quality. This ranking provides a more objective assessment of university research productivity but may underestimate other important aspects such as teaching quality and the social impact of HEIs.

Key research related to the methodology and impact of THE ranking [3] on universities has been reviewed. THE is one of the leading international rankings, based on a wide range of indicators such as teaching, research, internationalization, and citation impact. The analysis of scholarly literature will help identify the strengths and weaknesses of THE’s methodology and understand how universities can use the ranking results to enhance their reputation and research activities.

The study [13] analyzes the impact of macroeconomic indicators, such as GDP and the Human Development Index (HDI), on university positions in THE rankings. The results indicate a significant correlation between these country-level characteristics and university scores in the ranking, suggesting that financial stability and socio-economic conditions can influence university quality and sustainability. However, the study has the drawback of not considering internal university factors, such as management and innovation, which can also affect rankings.

The author of the study [5] conducts a critical analysis of THE methodology, particularly concerning the citation metric. The paper raises concerns about potential distortions in assessments due to the use of fractional counting for certain scientific publications, which may inaccurately reflect university research productivity in benchmarking. The results show that this methodology can skew results for universities specializing in niche scientific disciplines. The drawback of this approach is that it does not consider alternative methods for improving citation counting.

The study [14] presents a visual analysis of THE university rankings using Tableau, allowing for a clear demonstration of the relationships between various indicators such as teaching, research, and citations. The research results indicate that data visualization facilitates a better understanding of the factors affecting university ranking positions. However, the drawback of the approach is that visualization does not always reveal all complex interdependencies between metrics and does not provide a deep analysis of potential factors that could improve university positions.

For universities to succeed, it is essential to focus on key HEI performance indicators that form the basis of these rankings [15]. Identifying and tracking these indicators enables universities to develop and adjust strategies to improve their positions in global rankings. The analysis of KPIs becomes an essential tool for university leaders in decision-making, enhancing their reputation in academic rankings, attracting resources, and expanding development opportunities in the dynamic educational environment. HEI KPIs directly influence their positions in international university rankings, as these indicators form the foundation for evaluating academic productivity, teaching quality, research activities, and international collaboration.

The study [16] analyzes KPIs used by foreign universities, particularly leading institutions in Europe and the United States. These indicators cover a wide range of activities, from student and faculty satisfaction levels to research achievements. For example, Harvard University demonstrates a high level of innovation activity, reflected in its KPIs. Partnerships with corporate research enable the university to collaborate closely with leading global companies. The significant volume of corporate research funding facilitates the implementation of cutting-edge scientific projects.

The authors of the study [17] define the concept of a "Creative University" and describe management practices aimed at improving KPIs. They establish that university KPIs consist of the Institutional Activity Index (IAP) and the Core Productivity Index (IMP), which are constrained by time and cost. The "Creative University" model ensures KPI attainment in a shorter period and at lower costs. The authors propose three key strategies for accelerating KPI improvement: minimizing the gap between IAP and IMP, efficient activity planning, and scheduling management according to academic phases. The main research findings demonstrate that these strategies can significantly enhance KPI performance. However, the drawbacks of the proposed approach include a high dependence on the accuracy of KPI definitions and the complexity of integrating management processes into the existing university structure.

The article [18] describes a KPI calculation system for faculty at the Eurasian National University. The research results show that the proposed system can accurately assess faculty productivity but has drawbacks, such as dependence on data accuracy and completeness. Additionally, the complexity of collecting and processing large amounts of information may impact the timely availability of results.

The authors of the article [15] explore the implementation of performance management systems, including KPIs, at Donetsk National University. The study identifies issues such as faculty resistance to KPI systems and the need for tools to improve acceptance and effectiveness. The authors provide recommendations for enhancing management culture and fostering productive dialogue, which can improve performance management efficiency. The main drawbacks include the necessity of changing management approaches and the difficulty of overcoming faculty resistance.

In the article [19], the authors investigate the strategy for optimizing the achievement of Indikator Kinerja Utama (IKU) at Jambi University. The authors found that IKU exceeded the target by 142.05% but did not show growth compared to the previous year. To address this issue, the study employs action research methods aimed at identifying key problems and developing optimization strategies for achieving IKU. The main strategies include improving Lecturer Performance Burden (LPB) management, providing incentives, and increasing faculty participation in research and other activities. The main findings indicate that the proposed strategies can effectively enhance KPIs. The drawbacks include the complexity of strategy implementation and the need for continuous monitoring.

The authors of the article [20] study the development of a KPI monitoring panel for higher education institutions in Indonesia using a single data source. The authors integrate data from various information systems into a single database, allowing for easy tracking of different indicators at the program, faculty, and university levels. The main findings of the study indicate that the monitoring panel significantly simplifies the process of tracking and analyzing KPIs. At the same time, the disadvantages include high dependence on the accuracy of the collected data and the complexity of integration with existing information systems.

Researchers in article [21] analyze the role of information technology in higher education through a KPI-focused model. A case study from the University of La Verne compares data from different institutions to develop a KPI-based model for measuring student expectations and satisfaction with technology in education. The main findings indicate that the proposed model helps institutions achieve continuous improvement of their strategic goals. The drawbacks include dependence on data quality and the need for continuous technology updates.

In the study [22], the authors highlight the absence of KPIs that universities could use to measure academic quality and achieve strategic goals. The authors propose the formation of KPIs based on faculty perception and emphasize their importance in guiding the development and improvement of HEIs. The main findings of the study show that incorporating faculty perceptions can significantly enhance the quality assessment process. The drawbacks include the complexity of collecting and analyzing subjective data.

Researchers in the study [23] propose the development of an integrated faculty profile system for KPI monitoring, focusing on KPIs that assess teaching quality. The authors used the extreme programming methodology to develop a system that interacts with university and ministry of education databases. The results showed successful implementation and testing of user stories, demonstrating the system’s effectiveness. However, the drawbacks of the approach include the need for highly qualified users and potential integration issues with existing management systems.

The authors [24] address the problem of automating KPI calculation for university executive staff based on a

mathematical model and an evaluation algorithm for faculty and administrative staff performance, including an example of a scientific and methodological activity report. The study results indicate that automation can significantly improve the accuracy and speed of KPI evaluation. At the same time, the disadvantages include the complexity of developing and implementing algorithms, as well as the need for continuous data updates and adaptation to changes in evaluation methodology.

Some researchers analyze the existing performance evaluation system for private universities and propose a dual evaluation model that combines KPIs and competency-based assessment. The authors of the study [25] believe that this model will improve the efficiency and competitiveness of university faculty. The main findings of the study demonstrate that the proposed model takes into account the specific needs of private universities. The drawbacks include the complexity of system implementation and the need for staff training.

In the study [26], the authors explore a model for studying and measuring KPIs in HEIs. They analyze the use of KPIs to assess and improve the overall efficiency of HEIs using the example of the Institute for Statistical Research and Cairo University Research Institute. The study results show that the application of KPIs contributes to significant improvements in achieving HEI goals. At the same time, the authors identified challenges in implementing KPIs, such as the need to adapt existing processes to new requirements.

The authors of the article [27] examine the application of data mining techniques to identify relevant KPIs in higher education institutions. Using open university initiative data, they identify characteristics and target groups for each KPI. The main results indicate that data mining techniques significantly facilitate the identification and application of KPIs, improving university operations. However, the main drawback is the dependence on the quality and completeness of available data.

Researchers in the study [28] present KPIs for optimizing the environmental efficiency of HEIs using an environmental management system. They emphasize the importance of integrating environmental KPIs into management systems to improve sustainable development practices and achieve environmental goals. The implementation results of these KPIs at the Polytechnic University of Valencia showed that they could significantly enhance the institution's environmental efficiency. However, the challenge remains in integrating new KPIs into already existing management systems.

The authors of the article [29] investigate the use of learning analytics and KPIs in HEIs to improve high-level decision-making. They highlight the integration of learning analytics tools with KPIs to provide comprehensive recommendations for improving the learning process, increasing institutional efficiency, and enhancing strategic planning. The study results show that applying these approaches can significantly improve HEI management efficiency through data-driven decision-making. However, the disadvantages of the approach include dependence on data quality and the need for significant resources for implementation.

Researchers in article [30] consider cognitive modeling as a tool for strategic analysis of the competitive status of IT companies. They emphasize that cognitive models allow for the effective identification of key factors influencing a company's competitiveness and predicting possible development scenarios. The study presents an example of building a cognitive model for an IT company, which enables the analysis of relationships between internal and external factors. The application of this approach revealed its significant potential for supporting strategic decision-making aimed at strengthening the company's competitive position. However, the authors note that the accuracy of cognitive modeling depends on the availability of high-quality data and requires considerable time for model construction and verification.

An analysis of global indices and rankings regarding the level and quality of higher education in Ukraine shows that several Ukrainian universities are included in major global rankings, but they do not occupy top positions. For Ukrainian HEIs to successfully improve their ranking positions, they need to focus on key aspects such as academic reputation, research, international activities, and more.

Several researchers analyze how KPIs can be used to monitor academic productivity, teaching quality, student satisfaction, and the achievement of strategic goals. For example, the above-mentioned articles discuss approaches to improving KPI monitoring and management in educational environments, as well as models for faculty evaluation based on KPIs. The main findings of these studies indicate that the implementation of KPIs can significantly improve efficiency management in educational institutions; however, it requires significant adaptation to the specific conditions and needs of each institution.

Thus, the analysis of scientific sources shows that KPIs are a powerful tool for assessing and managing HEI efficiency. Improving the KPI system and its planned values can enhance the adaptation of Ukrainian HEIs to participate in global university rankings and provide an opportunity to improve their ranking positions.

Aim and tasks of the study. The analysis of KPIs is one of the key elements in determining the competitiveness of HEIs at the national and international levels. In the modern context of globalization and increased competition among universities, the ability to accurately measure and evaluate performance has become a crucial component of HEI development. This includes assessing academic achievements, the quality of the educational process, research productivity, international collaboration, and the implementation of innovations. Defining KPIs allows for identifying the strengths and weaknesses of HEI activities, helping to formulate strategies for their improvement [31].

HEI quality policies aim to ensure the quality of educational services by improving the scientific-methodological, pedagogical, and methodological

expertise of the teaching staff, implementing innovative teaching technologies, strengthening the university's material and technical base, utilizing advanced information technologies, and incorporating the results of fundamental and applied scientific research in accordance with market demands for educational services and labor market needs.

The objective of this study is to improve the HEI KPI system, which will contribute to the enhancement of educational service delivery and the university's position in international rankings.

The task of this study is to establish the relationship between the planned target indicators of HEIs, as outlined in the contract with the head of the higher education institution, and the QS-WUR indicator system, which determines the university's position in global university rankings.

Materials and methods. This study proposes the use of the QS-WUR ranking. This choice is justified by the fact that, unlike the existing major global rankings such as the Academic Ranking of World Universities (ARWU) and Times Higher Education (THE), the QS-WUR website [32] provides open access to the input data used to compile the ranking.

To analyze data from ARWU or THE, one must contact the respective company. QS-WUR strives to identify gaps and seek additional data and methodological clarifications to enhance the accuracy of its rankings. Starting from 2024, QS-WUR has identified five key areas that contribute to the classification of a world-class university. These areas include research and discovery, employability and outcomes, global engagement, learning experience, and sustainability. Each area and its associated indicators have a specific weight. Table 1 presents the areas and indicators of the QS-WUR ranking.

Table 1 – List of Indicators in the QS World University Rankings

Category	Category Weight	Indicator	Indicator Weight
Research and Discovery	50%	Academic Reputation	30%
		Citations per Faculty	20%
Employability and Outcomes	20%	Employer Reputation	15%
		Employment Outcomes	5%
Global Engagement	15%	International Student Ratio	5%
		Ratio of International Faculty to Total Faculty	5%
		International Research Network	5%
Learning Experience	10%	Student-to-Faculty Ratio	10%
Sustainability	5%	Sustainability	5%

Let us consider the formation of HEI indicators according to the QS-WUR methodology [32].

1. Academic Reputation – the most important component of the QS-WUR ranking, accounting for 30% of the university's overall score. This parameter is based on a global survey of more than 100,000 academic staff, who, through online questionnaires, name up to 10 universities they consider the best in their field of knowledge. Responses from the last five years are taken into account, with a lower weight assigned to data from four and five years ago. The responses are weighted by region and discipline to ensure an even distribution, and all scores are normalized to obtain the final score. This indicator is calculated using the formula

$$K_t^1 = \frac{\sum_{i=1}^{n} FA_i \cdot WA_i}{PA_t} \times 100\%, \quad (1)$$

where

K_t^1 – academic reputation score for the t-th period;

FA_i – number of positive reviews about the university from the i-th respondent, $i = \overline{1, n}$;

WA_i – weighting coefficient for the i-th respondent (depends on the respondent's authority in their field);

PA_t – total number of all positive reviews from respondents received by other universities for the t-th period.

This indicator reflects how the HEI is perceived in academic circles compared to other HEIs and considers the quality and impact of research, the level of teaching, and the university's academic reputation.

2. Employer Reputation – this indicator accounts for 15% of the QS-WUR ranking's overall score. It is based on an online survey of more than 50,000 employers worldwide, who name up to 10 universities whose graduates are the most competent. This indicator allows for assessing the preparedness level of graduates from specific educational institutions and is calculated using the formula

$$K_t^2 = \frac{\sum_{j=1}^{m} FR_j \cdot WR_j}{PR_t} \times 100\%, \quad (2)$$

where

K_t^2 – employer reputation score for the t-th period;

FR_j – number of positive reviews about the university from the j-th employer, j= $\overline{1,m}$;;

WR_j – weighting coefficient for the j-th employer (depends on the employer's authority and influence in the relevant field);

PR_t – total number of all positive reviews from employers received by other universities for the t-th period.

This indicator reflects how employers evaluate

university graduates, particularly their knowledge, skills, and readiness for employment.

3. Faculty/Student Ratio – this parameter has a weight of 10% in the QS-WUR ranking. It determines the quality of education by measuring the ratio of students to faculty members. The data is provided by universities, and the calculation formula is simple. The higher this ratio, the better the quality of education is considered to be, and it is calculated using the formula

$$K_t^3 = \frac{R_t}{S_t}, \quad (3)$$

where

K_t^3 – faculty/student ratio for the t-th period;

R_t – total number of faculty members at the university for the t-th period;

S_t – total number of students enrolled at the university for the t-th period.

This indicator reflects the extent to which an individualized approach to education is ensured: the fewer students per faculty member, the more attention can be given to each student.

4. Citations per Faculty – an important indicator accounting for 20% of the university's overall QS-WUR ranking score. This metric is based on data from globally recognized scientometric databases, where the number of citations of research papers is divided by the number of faculty members. This parameter allows for assessing the global impact of a university's research and is calculated using the formula

$$K_t^4 = \frac{C_t}{SA_t}, \quad (4)$$

where

K_t^4 – number of citations per research article for the t-th period;

C_t – total number of citations of all university publications for the t-th period;

SA_t – total number of research articles published by university faculty and researchers for the t-th period.

This indicator evaluates the scientific impact and quality of university research by considering how frequently the university's academic papers are cited in other studies.

5. International Faculty Ratio – a parameter that accounts for 5% of the QS-WUR ranking. It is based on university-provided data regarding faculty citizenship. The calculation determines the proportion of international faculty as a percentage of the total number of faculty members. A high percentage of international faculty reflects the global attractiveness and diversity of the institution and is calculated using the formula

$$K_t^5 = \frac{IR_t}{R_t}, \quad (5)$$

where

K_t^5 – proportion of international faculty for the t-th period (%);

IR_t – number of international faculty members (who are citizens of other countries) for the t-th period;

R_t – total number of faculty members at the university for the t-th period.

This indicator reflects the internationalization of the university's faculty, which is an important factor in creating a multicultural academic environment and enhancing the quality of education and research.

6. International Student Ratio – a parameter with a weight of 5% that reflects the university's international attractiveness. Universities provide data on student citizenship, and the proportion of international students is calculated as a percentage of the total student population. This indicator assesses the level of internationalization of the student body and is calculated using the formula

$$K_t^6 = \frac{IS_t}{S_t}, \quad (6)$$

where

K_t^6 – proportion of international students for the t-th period (%);

IS_t – number of international students (who are citizens of other countries) at the university for the t-th period;

S_t – total number of students enrolled in the HEI for the t-th period.

This indicator demonstrates how attractive the HEI is to students from different countries, which is an important aspect of creating an international academic environment and fostering cultural exchange and collaboration.

7. International Research Network – a parameter with a weight of 5% that evaluates the number of joint publications with international partners. It considers the number of publications in globally recognized scientometric databases, the number of partner countries, and the citation rate of joint publications. It is calculated using the formula

$$K_t^7 = \frac{\sum_{k=1}^{s} CA_k \cdot WC_k}{SA_t} \times 10, \quad (7)$$

where

K_t^7 – international research network indicator for the t-th period (%);

CA_k – number of joint articles with the international k-th partner for the t-th period, $k = \overline{1, s}$;

WC_k – weighting coefficient for the k-th partner, which may depend on the quality, quantity, or other characteristics of the partner;

SA_t – total number of research articles published by HEI faculty and researchers for the given t-th period.

8. Employment Outcomes – this parameter accounts for 5% and evaluates the impact of graduates on the labor market and their employability. It includes the graduate employment index and the influence of graduates across various industries. It is calculated using the formula

$$K_t^8 = v_1 \times \frac{E_t}{G_t} + v_2 \times \frac{I_t}{B_t}, \quad (8)$$

where

K_t^8 – overall employment outcomes indicator for the t-th period (%);

E_t – number of graduates who found employment after university graduation for the t-th period;

G_t – total number of graduates who completed their studies for the t-th period;

I_t – graduate impact index across various industries for the t-th period;

B_t – total number of industries where graduates have a significant impact;

v_1 і v_2– weighting coefficients for each component, with the sum of the coefficients equal to 1 (or 100%).

9. Sustainability Indicator – this parameter has a weight of 5% and evaluates the contribution of the HEI to sustainable development and its achievements. It considers the environmental and social impact of the university, as well as the presence of equality and inclusion policies. The calculation formula includes social impact (45%), environmental impact (45%), and governance (10%), and is calculated using the formula

$$K_t^9 = f_1 \times EI_t + f_2 \times SI_t + f_3 \times PEI_t, \quad (9)$$

where

K_t^9 – overall sustainability indicator for the t-th period (%);

EI_t – environmental impact indicator of the HEI for the t-th period;

SI_t – social impact indicator of the HEI for the t-th period;

PEI_t – indicator of the presence of equality and inclusion policies for the t-th period;

f_1, f_2, f_3– weighting coefficients for the components of environmental impact, social impact, and governance,

respectively, with the sum of the coefficients equal to 1 (or 100%).

The model for forming university indicators according to the QS-WUR methodology is presented in Fig. 1.

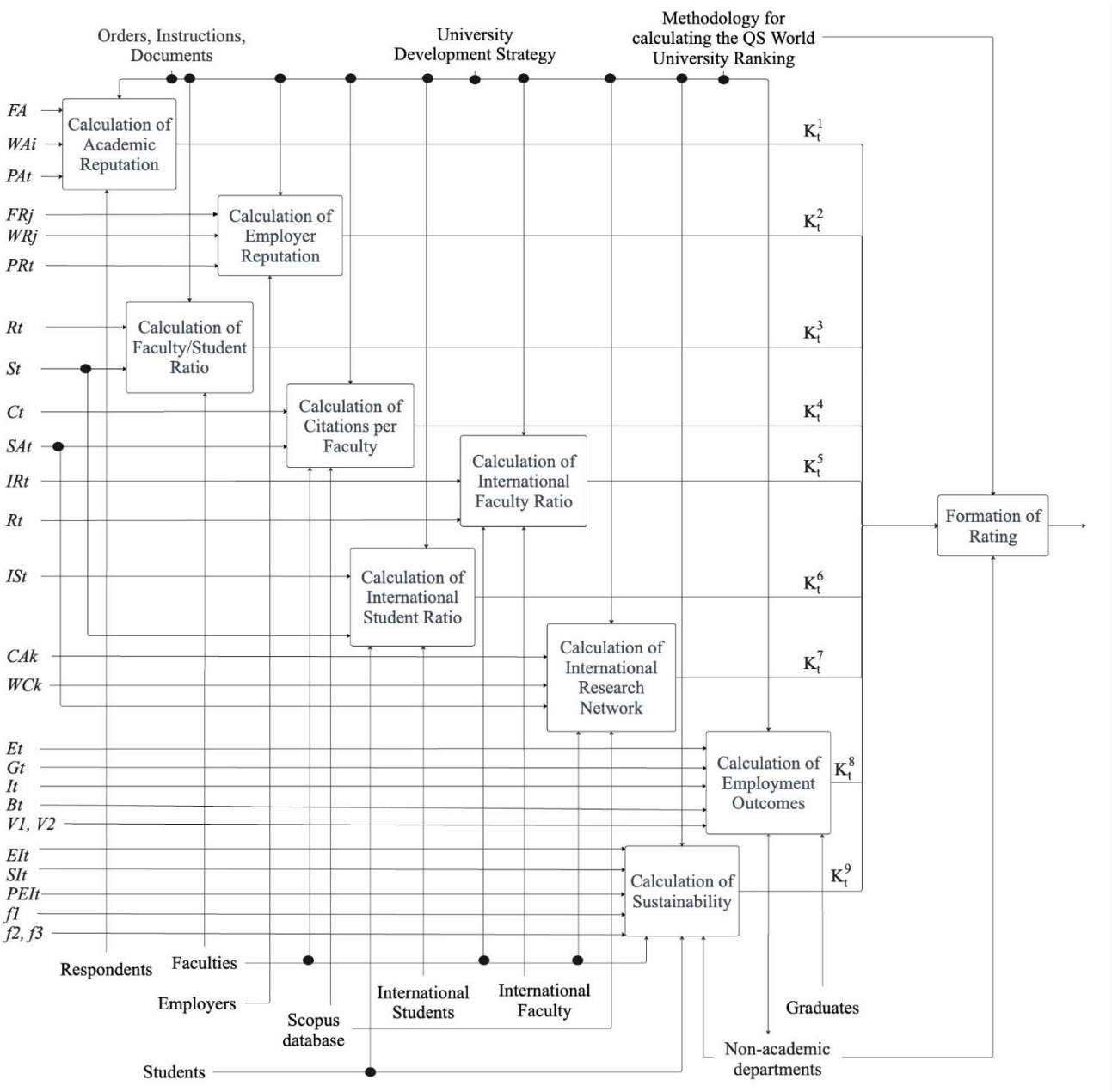

Fig. 1. Model for the Formation of QS-WUR Ranking Indicators

The object of this study is the National Technical University "Kharkiv Polytechnic Institute." The main structural units of the university that are directly involved in organizing the educational process include educational and scientific institutes, departments, the postgraduate studies department, and the library. The status and functions of these units are defined by the University Statute [33] and corresponding regulations, while the formation of units is carried out based on the decision of the University Academic Council.

Educational and scientific institutes unite departments, laboratories, research centers, and other structural units that provide training at the bachelor's, master's, and educational-research levels. Departments conduct educational, methodological, and scientific activities in specific disciplines and are responsible for the training of academic and teaching staff. The postgraduate studies department oversees the preparation of PhD and Doctor of Science candidates, contributing to the advancement of scientific qualifications. The library provides information services to students and faculty, ensuring access to educational and scientific resources.

The management of the university is carried out by the rector, who is responsible for educational, scientific, and financial-economic activities. Supporting bodies include the Academic Council, which defines the development strategy and approves educational programs, and the Supervisory Board, which facilitates resource acquisition and oversees their utilization. Additionally, there are bodies of public self-governance, student self-governance, and scientific societies that ensure the participation of students and faculty in university management and the protection of their rights.

At the end of each year, the rector of NTU "KhPI" compiles and publicly publishes a report on the university's performance and achievements, which are measured by specific KPIs [34]. This information enables the assessment of the university's effectiveness, aligning with global educational trends and ranking requirements. Based on an analysis of the alignment between the university's KPIs and indicators defined in global rankings, adjustments to the KPI system of NTU "KhPI" have been proposed.

The KPI performance indicators of NTU "KhPI" include the results of educational, scientific, scientific-technical, and innovation activities, as well as financial-economic activities. The rector is responsible for implementing and maintaining modern educational programs and curricula approved by the Academic Council, ensuring the quality of the educational process and scientific research. The rector also oversees the performance efficiency of educational and scientific institutes, departments, postgraduate studies, and the library, particularly their contributions to training professionals and academic staff. Financial-economic KPIs under the rector's supervision include cost optimization, securing additional financial resources, and maintaining and efficiently utilizing university property. High efficiency indicators contribute to enhancing the university's competitiveness at both the national and international levels. Each year, the rector publishes key performance indicators of the university on the official NTU "KhPI" website [34]. The formation of the rector's target KPI values is based on the performance indicators of institutes, departments, and other units, ensuring a comprehensive approach to evaluating the university's and its structural units' performance.

The KPI indicators of institutes and departments at NTU "KhPI" are interdependent. The KPI indicators of institutes are calculated as the sum of the KPI indicators of their respective departments, allowing for a two-level evaluation system instead of a three-level one. The main KPIs include educational and research performance, the number and quality of trained professionals, the volume and quality of scientific research, the successful implementation of educational programs, and other factors. Financial indicators such as resource utilization efficiency and additional financial inflows are also considered. This approach ensures a more holistic and coordinated management of educational and research processes within the university, contributing to the achievement of NTU "KhPI"'s overall strategic goals.

The objective of university management is to achieve the target KPI values at the end of the planning period for specific functions of all structural units. As basic criteria for each structural unit, it is proposed to use the deviation level of current KPIs from the target values at the end of the planning period. The criteria for structural units will be considered for different management levels of the hierarchical HEI system.

Let us take a closer look at the calculations of these indicators.

The change in the share of classroom hours taught in foreign languages ΔR_1 (%), is calculated using the formula

$$\Delta R_1 = \frac{R_t^1 - R_{t-1}^1}{R_{t-1}^1}, \quad (10)$$

where

ΔR_1 – change in the share of classroom hours taught in foreign languages (in percentage);

R_t^1 – new share of classroom hours taught in foreign languages (as a percentage of the total number of hours) for the current year;

R_{t-1}^1 – initial share of classroom hours taught in foreign languages (as a percentage of the total number of hours) in the previous calendar year.

The change in the number of higher education students participating in international academic mobility programs (lasting at least 1 month, per calendar year) ΔR_2 (%), is calculated using the formula

$$\Delta R_2 = \frac{R_t^2 - R_{t-1}^2}{R_{t-1}^2} \times 100\%, \quad (11)$$

where

ΔR_2 – change in the number of higher education students participating in international academic mobility programs (in percentage);

R_t^2 – number of students who participated in international academic mobility programs in the current calendar year;

R_{t-1}^2 – number of students who participated in international academic mobility programs in the previous calendar year.

The change in the number of full-time academic and research staff participating in international academic mobility programs (lasting at least 1 month, per calendar year) ΔR_3 (%), is calculated using the formula

$$\Delta R_3 = \frac{R_t^3 - R_{t-1}^3}{R_{t-1}^3} \times 100\%, \quad (12)$$

where

ΔR_3 – change in the number of full-time academic and research staff participating in international academic mobility programs (in percentage);

R_t^3 – number of staff members who participated in international academic mobility programs in the current calendar year;

R_{t-1}^3 – number of staff members who participated in international academic mobility programs in the previous calendar year.

The change in the number of classrooms equipped with multimedia equipment or other specialized equipment that ensures multimedia functionality (%) is calculated using the formula

$$\Delta R_4 = \frac{R_t^4 - R_{t-1}^4}{R_{t-1}^4} \times 100\%, \quad (13)$$

where

ΔR_4 – change in the number of classrooms equipped with multimedia equipment (in percentage);

R_t^4 – number of classrooms equipped with multimedia equipment in the current calendar year;

R_{t-1}^4 – number of classrooms equipped with multimedia equipment in the previous calendar year.

The change in the number of foreigners and stateless persons among higher education students of the HEI, including citizens of OECD member countries ΔR_5 , is calculated using the formula

$$\Delta R_5 = \frac{R_t^5 - R_{t-1}^5}{R_{t-1}^5} \times 100\%, \quad (14)$$

where

ΔR_5 – change in the number of foreigners and stateless persons among higher education students (in percentage);

R_t^5 – number of foreigners and stateless persons among higher education students in the current calendar year;

R_{t-1}^5 – number of foreigners and stateless persons among higher education students in the previous calendar year.

The change in the number of higher education students who submitted StartUp projects (%) (ΔR_6), is calculated using the formula

$$\Delta R_6 = \frac{R_t^6 - R_{t-1}^6}{R_{t-1}^6} \times 100\%, \quad (15)$$

where

ΔR_6 – change in the number of higher education students who submitted StartUp projects (in percentage);

R_t^6 – number of higher education students who submitted StartUp projects in the current calendar year;

R_{t-1}^6 – number of higher education students who submitted StartUp projects in the previous calendar year.

Implementation of comprehensive automation of higher education institution management, including an electronic document management system R_t^7. Yes/No

Implementation of a key performance indicator system in the contracts of deputy heads of the HEI and heads of structural units R_t^8. Yes/No.

Annual improvement of all subsystems of the corporate university management information system, including the current set of personal learning systems within the Learning Management System (LMS). This indicator R_t^9 is determined in the current calendar year based on availability (Yes/No).

The change in the number of indexed publications by academic and research staff in journals referenced in the Web of Science and Scopus scientometric databases, ΔR_{10}, s calculated using the formula

$$\Delta R_{10} = \frac{R_t^{10} - R_{t-1}^{10}}{R_{t-1}^{10}} \times 100\%, \quad (16)$$

where

ΔR_{10} – change in the number of indexed publications by academic and research staff (in percentage);

R_t^{10} – number of indexed publications by academic and research staff in the current calendar year;

R_{t-1}^{10} – number of indexed publications by academic and research staff in the previous calendar year.

Comparison with international KPIs will help identify opportunities for improvement and adaptation of best practices in the context of NTU "KhPI" activities. Analyzing these data for the university allows for determining which approaches to performance evaluation may be most relevant for the further development of the university, as well as which practices from other institutions can be implemented to enhance its global competitiveness.

To improve managerial activities, it is necessary to consider the indicators of the proposed QS-WUR ranking indicator formation model when determining the performance indicators of the university leader.

Results. Based on the conducted research on the performance indicators of NTU "KhPI" in accordance with the QS-WUR methodology, an approach to formalizing QS-WUR indicators that determine NTU "KhPI"'s position in this ranking has been proposed. A model for forming QS-WUR ranking indicators for NTU "KhPI" has been developed, providing an understanding of the information sources and the processes involved in determining each indicator's value. The model reflects the interaction of QS-WUR indicators used to create the university's ranking position.

The performance indicators of NTU "KhPI" management have been formalized and are published annually on the university's official website. They are calculated based on the system of activity indicators of NTU "KhPI" institutes and departments, ensuring a comprehensive approach to evaluating the university's performance and helping to understand how successfully

the institution fulfills its mission and achieves strategic goals. These indicators help identify strengths and weaknesses in management and the organization of the educational process.

Conclusion. The proposed KPI system for NTU "KhPI" will be used to determine effective resource allocation strategies and implement it as an innovative approach to managing educational, research, and international activities, ensuring high-quality standards and international recognition of the university.

Further research is focused on developing a tool for the optimal allocation of NTU "KhPI" resources, which will be used to improve the internal environment and enhance the university's external position in the QS-WUR global ranking. The application of this tool will contribute not only to achieving planned KPIs but also to increasing the institution's international competitiveness, creating a foundation for its sustainable development. Additionally, further research aims at developing an information system that will provide recommendations to NTU "KhPI" management regarding university resource allocation based on the KPI system. This will improve university efficiency by enhancing performance, increasing staff motivation, ensuring the rational use of resources, and strengthening the university's competitiveness in the global arena.

References

1. Hazelkorn, E. (2015). *Rankings and the Reshaping of Higher Education: The Battle for World-Class Excellence.* Palgrave Macmillan. https://doi.org/10.1057/9780230306394
2. QS Quacquarelli Symonds. (n.d.). *QS World University Rankings*. Available at: https://support.qs.com/hc/en-gb/articles/4405955370898-QS-World-University-Rankings. (accessed 18.01.2025)
3. Times Higher Education. (2025). *World University Rankings 2025 Methodology.* Available at: https://www.timeshighereducation.com/world-university-rankings/world-university-rankings-2025-methodology. (accessed 18.01.2025)
4. Muñoz-Suárez, M., Guadalajara, N., & Osca, J. M. (2020). A Comparative Analysis between Global University Rankings and Environmental Sustainability of Universities. *Sustainability*, 12(14), 5759. https://doi.org/10.3390/su12145759
5. Natt, A. (2018). *The methodology used for the Times Higher Education World University Rankings' citations metric can distort benchmarking*. University of Bedfordshire Repository. Available at: https://uobrep.openrepository.com/handle/10547/622340. (accessed 03.08.2024)
6. Baccini, A., Banfi, A., De Nicolao, G., & Galimberti, P. (2015). University ranking methodologies: An interview with Ben Sowter about the Quacquarelli Symonds World University Ranking. RT. *A Journal on Research Policy and Evaluation*, 3(1). https://doi.org/10.13130/2282-5398/6446
7. Estrada-Real, A. C., & Cantu-Ortiz, F. J. (2022). A data analytics approach for university competitiveness: The QS world university rankings. *International Journal of Interactive Design and Manufacturing*, 16, 871–891. https://doi.org/10.1007/s12008-022-00966-2
8. ShanghaiRanking Consultancy. (2024). *Academic Ranking of World Universities 2024*. Available at: https://www.shanghairanking.com/rankings/arwu/2024. (accessed 18.01.2025)
9. Vidal, P., & Filliatreau, G. (2014). Graphical Comparison of World University Rankings. *Higher Education Evaluation and Development*, 8(1), 1-14. https://doi.org/10.6197/HEED.2014.0801.01
10. Boshoff, N. (2009). Shanghai Academic Ranking of World Universities (ARWU) and the 'big five' South African research universities. *South African Journal of Higher Education*, 23(4), 635-655. https://doi.org/10.4314/sajhe.v23i4.51056
11. Leiden University. (n.d.). *CWTS Leiden Ranking*. Available at: https://www.leidenranking.com. (accessed 18.01.2025)
12. Nees Jan van Eck, & Waltman, L. (2018). Analyzing the activities of visitors of the Leiden Ranking website. *Journal of Data and Information Science*, 3(2). https://doi.org/10.2478/JDIS-2018-0015
13. Orsolin, A., Bortoluzi, A., Ávila, L., Souza, A., & Selli, L. (2023). Analysis of the performance of the best participating universities in the World University ranking - Times Higher Education (THE). *Avaliação: Revista da Avaliação da Educação Superior (Campinas)*, 28. https://doi.org/10.1590/s1414-40772023000100027
14. Ji, C. Y. (2023). The development of world's best universities - Visual analysis of TIMES university rankings based on Tableau. *The 2023 2nd International Conference on Education, Philosophy, and Social Sciences*, 8(1). https://doi.org/10.56028/aehssr.8.1.410.2023
15. Shaulska, L., Laktionova, O., Nagornyak, T., & Sereda, H. (2021). Performance management at Ukrainian university: A case of the KPIs use. *Problems and Perspectives in Management*, 19(1), 78-89. https://doi.org/10.21511/ppm.19(1).2021.07
16. Harvard Office of Technology Development. (n.d.). *Productivity highlights.* Available at: https://otd.harvard.edu/impact/productivity-highlights. (accessed 18.01.2025)
17. Sutanto, S., Christy, A. Y., & Sandi, D. K. (2021). Creative University: A Definition and Activities Management Based on the Completion of Key Performance Indicator (KPI). *Journal of Technology Management & Innovation*, 16(3). https://doi.org/10.4067/s0718-27242021000300013
18. Omarbekova, A. S., Saukhanova, Z. S., Zakirova, A. B., Abduraimova, B. K., & Saukhanova, M. S. (2019). KPI Estimation for the University Faculty. *Proceedings of the 12th International Conference on Computer Science & Education (ICCSE)*, 36, 333–336. https://doi.org/10.1145/3330431.3330468
19. Kurniadi, R., Arpizal, A., Fajarsari, A. D., Yaldi, D., & Mayasari, M. (2023). Strategy for Optimizing the Achievements of IKU 5 Universitas Jambi. *Anterior Jurnal*, 22(1), 106–110. https://doi.org/10.33084/anterior.v22i1.4100
20. Komarudin, M., Suharno, Mardiana, D., Despa, H. D., Septama, H. D., & Yulianti, T. (2023). 'Design of Key Performance Indicator Dashboard for Indonesian Higher Education based on One Data', *Proceedings of the 2023 International Conference on Converging Technology in Electrical and Information Engineering (ICCTEIE)*, pp. 6-11. DOI: https://doi.org/10.1109/ICCTEIE60099.2023.10366722.
21. Gordon, L. C., Gratz, E., Kung, D. S., Dyck, H., & Lin, F. (2017). Strategic Analysis of the Role of Information Technology in Higher Education – A KPI-centric model. *Communications of the IIMA*, 15(1), Article 2. https://doi.org/10.58729/1941-6687.1367
22. Varouchas, E., Sicilia, M.-Á., & Sánchez-Alonso, S. (2018). Academics' Perceptions on Quality in Higher Education Shaping Key Performance Indicators. *Sustainability*, 10(12), 4752. https://doi.org/10.3390/su10124752
23. Septama, H. D., Komarudin, M., Wintoro, P. B., Pratama, M., Yulianti, T., Sulistiono, W. E. Implementation of One Data-based Lecturer Profile Information System for Key Performance Indicator Monitoring. *Proceedings of the 2022 Seventh International Conference on Informatics and Computing (ICIC)*, 2022, pp. 1-7. DOI: https://doi.org/10.1109/ICIC56845.2022.10006928.
24. Karimova, V. Automation of KPI Calculation for Leadership Personnel of Higher Educational Institutions. *Proceedings of the 6th International Conference on Information Systems and Computing Technologies (ICISCT)*, 2021, pp. 212–220. DOI: https://doi.org/10.1109/icisct52966.2021.9670079.
25. Chang, Z. (2019). Exploration on the Performance Evaluation Reform of Private University Teachers Based on the "KPI Plus Competency" Dual-Track System. *Advances in Economics, Business and Management Research*, 124–130. https://doi.org/10.2991/aebmr.k.191225.116
26. Ahmed, A. E.-A., Badawy, M., & Hefny, H. A. (2017). Exploring and Measuring the Key Performance Indicators in Higher Education Institutions. *ResearchGate*, 18(1), 32–48. Available at: https://www.researchgate.net/publication/321781292_Exploring_and_Measuring_the_Key_Performance_Indicators_in_Higher_Education_Institutions. (accessed 18.01.2025)

27. Peral, J., Maté, A., & Marco, M. (2016). Application of Data Mining Techniques to Identify Relevant Key Performance Indicators. *Computer Standards & Interfaces*, 50, 9–19. https://doi.org/10.1016/j.csi.2016.09.009
28. Lo-Iacono-Ferreira, V. G., Capuz-Rizo, S. F., & Torregrosa-López, J. I. (2017). Key Performance Indicators to Optimize the Environmental Performance of Higher Education Institutions with Environmental Management System – A Case Study of Universitat Politècnica de València. *Journal of Cleaner Production*, 178, 105–120. https://doi.org/10.1016/j.jclepro.2017.12.184
29. Lytras, M. D., Aljohani, N. R., Visvizi, A., De Pablos, P. O., & Gasevic, D. (2018). Advanced Decision-Making in Higher Education: Learning Analytics Research and Key Performance Indicators. *Behaviour & Information Technology*, 37(10), 987–1002. https://doi.org/10.1080/0144929X.2018.1512940
30. Hrinchenko, M. A., Moskalenko, V. Yu. (2024). Kohnetyvne modeliuvannia dlia stratehichnoho analizu konkurentnoho statusu IT-kompanii [Cognitive modeling for strategic analysis of the competitive status of an IT company]. *Visnyk Natsionalnoho tekhnichnoho universytetu "KhPI". Seriia: Stratehichne upravlinnia, upravlinnia portfeliamy, prohramamy ta proektamy* [Bulletin of the National Technical University "KhPI". Series: Strategic Management, Portfolio, Program, and Project Management], 1(8), pp. 17–25. DOI: https://doi.org/10.20998/2413-3000.2024.8.3.
31. Shaposhnikov, M. I., Hrinchenko, M. A., & Hrinchenko, Ye. M. (2024). Informatsiina tekhnolohiia rozpodilu resursiv universytetu z metoiu pokrashchennia yoho reitynhovykh pozytsii [Information technology for university resource allocation to improve its ranking positions]. *Informatyka, informatsiini systemy ta tekhnolohii: tezy dopovidei dvadtsiat pershoi vseukrainskoi konferentsii studentiv i molodykh naukovtsiv, Odesa, 26 kvitnia 2024 r.* [Informatics, Information Systems, and Technologies: Abstracts of the 21st All-Ukrainian Conference of Students and Young Scientists, Odesa, 26 April 2024], pp. 104-106. Available at: http://dspace.pdpu.edu.ua/bitstream/123456789/19142/1/2024%20Zbirka_tez_IIS%26T-2024.pdf (Accessed: 18 January 2025).
32. QS World University Rankings 2024: найкращі світові університети. Available at: https://www.topuniversities.com/world-university-rankings/2024. (accessed 18.01.2025)
33. (n.d.). Statute. Available at: https://public.kpi.kharkov.ua/administrativna-diyalnist/statut/. (accessed 18.01.2025)
34. National Technical University "Kharkiv Polytechnic Institute". (n.d.). Report of the Rector. Available at: https://public.kpi.kharkov.ua/administrativna-diyalnist/zvit-rektora/. (accessed 18.01.2025)

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