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# MODEL OF THE BUSINESS PROCESS FOR FORMING RECOMMENDATIONS TO IMPROVE HEI PERFORMANCE IN THE QS WUR RANKING

*In contemporary conditions, the strategic development of higher education institutions (HEIs) in Ukraine is closely linked to the enhancement of research activities and improvement of teaching and learning processes, which serve as key factors in the modernisation of the national education system. This article presents a model for generating recommendations aimed at improving the performance indicators of higher education institutions in the QS World University Rankings (QS WUR). The research focuses on improving the system of Key Performance Indicators (KPIs) using the case of the National Technical University «Kharkiv Polytechnic Institute» (NTU «KhPI»), with the goal of enhancing the quality of educational, research, and international activities.*

*The purpose of the study is to increase the efficiency of strategic management within higher education institutions through the use of analytical and optimisation methods to produce well-grounded recommendations for improving QS WUR indicators. The methodological foundations of the QS WUR ranking are examined, nine key evaluation indicators of universities are defined, and the dynamics of leading Ukrainian HEIs for the period 2022–2025 are analysed. Methods of strategic analysis were applied to comprehensively study both external and internal factors influencing a university's position in the QS WUR.*

*The proposed IDEF0 model reflects the interaction between the analytical department, the information system, and the intelligent module (LLM), which ensures the automation of analytics, scenario development, and recommendation generation. The integration of methods of strategic analysis, optimisation modelling, and artificial intelligence enhances the efficiency of management decisions, optimises resource allocation, and supports the formulation of well-substantiated strategies for improving a university's position in the global ranking.*

*The proposed model serves as a strategic management tool for the development of higher education institutions and can be adapted for various types of universities in Ukraine and abroad. Future research should focus on developing a software prototype of the recommendation system, which would enable integration of the model with real university databases and performance monitoring systems.*

*Key words: key performance indicators, decision-making, ranking, resource optimisation, business process, software component, strategic management, education, model, higher education institution.*

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# МОДЕЛЬ БІЗНЕС-ПРОЦЕСУ ФОРМУВАННЯ РЕКОМЕНДАЦІЙ ДЛЯ ПІДВИЩЕННЯ ПОКАЗНИКІВ ЗВО У РЕЙТИНГУ QS WUR

*У сучасних реаліях стратегічний розвиток закладів вищої освіти України тісно пов'язаний з активізацією наукових досліджень, удосконаленням процесів викладання та навчання, що виступає одним із провідних чинників модернізації національної освітньої системи. У статті представлено модель формування рекомендацій для підвищення показників закладів вищої освіти (ЗВО) у рейтингу QS World University Rankings (QS WUR). Досліджено ключові показники ефективності на прикладі Національного технічного університету «Харківський політехнічний інститут» із метою підвищення якості освітньої, наукової та міжнародної діяльності.*

*Метою дослідження є підвищення ефективності стратегічного управління ЗВО шляхом використання аналітичних та оптимізаційних методів для формування обґрунтованих рекомендацій щодо покращення показників рейтингу QS WUR. Розглянуто методологічні основи рейтингу QS WUR, визначено дев'ять ключових показників оцінювання університетів і проведено аналіз динаміки показників провідних українських ЗВО за 2022–2025 рр. Застосовано методи стратегічного аналізу для комплексного дослідження зовнішніх і внутрішніх чинників, що впливають на позицію університету у QS WUR. Запропонована IDEF0-модель відображає взаємодію аналітичного відділу, інформаційної системи та інтелектуального модуля (LLM), що забезпечує автоматизацію аналітики, формування сценаріїв розвитку та рекомендацій. Інтеграція методів стратегічного аналізу, оптимізаційного моделювання й штучного інтелекту дає змогу підвищити ефективність управлінських рішень, оптимізувати розподіл ресурсів і формувати обґрунтовані стратегії покращення позицій університету у глобальному рейтингу.*

*Запропонована модель є інструментом стратегічного управління розвитком ЗВО, який може бути адаптований для різних типів університетів України та інших країн. Подальші дослідження доцільно спрямувати на розроблення програмного прототипу рекомендаційної системи, що забезпечить інтеграцію моделі з реальними базами даних університетів і системами моніторингу ефективності.*

*Ключові слова: ключові показники ефективності, прийняття рішень, рейтинг, оптимізація ресурсів, бізнес-процес, програмний компонент, стратегічне управління, освіта, модель, заклад вищої освіти.*

## Introduction and problem statement

In the current context, the relevance of developing a strategy for the advancement of higher education institutions (HEIs) in Ukraine is linked to innovations in the educational process and in scientific research. The growing influence of global university rankings encourages Ukrainian HEIs to improve the quality of educational programmes, strengthen research activities, and enhance their competitiveness within the international educational environment. The focus on international rankings has become an important direction of strategic management in the development of higher education in Ukraine.

International rankings such as QS World University Rankings (QS WUR) [1] and Times Higher Education (THE) [2] are becoming key tools for assessing the competitiveness of universities, influencing their image, funding, international cooperation, and attractiveness for students and employers. Universities actively use rankings as marketing tools to demonstrate the quality of teaching and research. Information sources featuring international rankings attract millions of visitors annually [3], and many applicants rely on these rankings when choosing a university.

A university's position in international rankings, particularly in QS WUR, becomes a key indicator of HEI success, influencing its appeal not only to applicants but also to partners and investors. For Ukrainian universities aiming to integrate into the global academic and educational space, improving their QS WUR positions is a strategic goal at both national and institutional levels. However, achieving this goal is complicated by several factors: lack of systematic analytics and integrated mechanisms for monitoring ranking indicators, limited resources and insufficient alignment between strategic and operational goals of HEIs, the need to adapt management processes to international assessment standards, and the fragmented use of modern intelligent data analysis methods in decision-making.

For Ukrainian technical universities seeking to enhance their positions in international rankings while adapting to the requirements of the digital economy and European educational standards, research aimed at improving the efficiency of strategic management through analytical and optimisation methods to develop well-grounded recommendations for improving QS WUR indicators is of particular importance.

## Analysis of recent studies and publications

In the modern context of globalisation and digital transformation of education, the issue of improving HEI management efficiency gains strategic importance and remains a relevant area of research.

In study [4], the authors conducted descriptive statistical and logistic regression analyses of data from 150 universities across different countries, using sustainability indicators from UI GreenMetric and THE. The study examined the relationship between global ranking positions, geographical location, and typology of universities. The researchers found that traditional rankings often fail to fully reflect sustainable development in HEIs and proposed integrating THE indicators into the UI GreenMetric system.

In [5], researchers assessed the current state of rankings and principles of university classification in Ukraine and its national university network. They identified problematic aspects of QS WUR, particularly the weakening of university ranking characteristics due to contradictions between university missions and ranking criteria. The authors provided recommendations for developing universities to support Ukraine's reconstruction based on innovation, high intellect, and advanced technologies, as well as for successful European integration.

The results of study [6] emphasise that the QS ranking has turned universities' means into their goals. The performance of universities should lead to improved quality of life, accelerated technological progress, and increased economic and social welfare of the nation. The increase in scientific publications is merely one of the means of achieving these objectives.

In research [7], the authors proposed a model for predicting university research performance using four variables (number of published papers, number of researchers, total number of citations, and number of uncited papers) and examined their impact on the ranking of the top 100 universities in QS WUR. The results showed that applying the proposed model leads to changes in QS WUR indicators among the selected universities.

In article [8], country-specific factors influencing the three most influential world university rankings (Academic Ranking of World Universities, QS WUR, and THE) are examined. The authors demonstrated that university positions are determined by country-specific variables such as economic potential, research and development expenditure, long-term political stability (absence of war, occupation, coups, or significant political upheaval), and institutional variables, including government efficiency.

The authors of [9] demonstrated that the variables used to construct rankings primarily measure two core indicators: university reputation and research activity. By analysing these indicators and building a regional aggregated index of universities, they determined their influence on ranking positions. The authors provided evidence of the ambiguous nature of quantitative assessments of university success in rankings.

In paper [10], the authors examined two of the most influential rankings (Shanghai Jiao Tong University ranking and THE) and concluded that these rankings alone cannot form recommendations for improving the quality of education. They highlighted the importance of ensuring «clean» rankings – transparent and methodologically coherent – whose use would stimulate improvements in university performance.

The authors of [11] analysed 18,466 public comments from China addressed to QS WUR experts using sentiment analysis and Latent Dirichlet Allocation (LDA) topic modelling. They summarised the complex emotions and diverse cognitive perspectives of the public regarding expert questions related to QS WUR.

In study [12], a ranking of technical universities worldwide was presented, including 137 universities listed in THE. Among these, national technological «flagships» were identified – institutions that bring new achievements in technology transfer and commercialisation of university research results. The study revealed differences between the indicators of technical HEIs and universities of other profiles.

In the context of global competition among universities, ranking evaluations define an HEI's reputation, investment attractiveness, and academic partnerships. The analysed approaches to university ranking, based solely on expert assessments and inter-university comparisons, do not provide management with sufficient information for adapting to changes in the international educational environment. Therefore, developing new approaches to formulating development strategies for HEIs aimed at improving their position in the global educational space remains an urgent task.

## The aim and objectives of the research

The aim of the research is to increase the efficiency of strategic management of higher education institutions through the use of data analytics methods, optimisation methods, and artificial intelligence techniques for analysing key university performance indicators and forming substantiated recommendations for improving those included in the QS WUR ranking.

## Presentation of the main research material

In the context of increasing competition among universities in the global educational and research space, their participation in international rankings, particularly in QS WUR, is gaining strategic importance. This study examines the methodological features of the global QS WUR university ranking [3], which annually analyses the performance of universities. According to the QS WUR methodology, the overall score is calculated based on nine key indicators, namely: academic

reputation, employer reputation, student-to-faculty ratio, citation rate of scientific publications, share of international students, share of international faculty, graduate employment outcomes, international research networks, and sustainability (Table 1). The weighting coefficients of the categories and indicators of the global QS WUR ranking are presented in Table 1. The values of indicators of leading Ukrainian universities in the global QS WUR ranking are shown in Table 2.

Table 1

Weighting coefficients of indicators in the global QS WUR ranking

| Category Name | Category Weight | Indicator Name | Indicator Weight, $w_i$ |
|---|---|---|---|
| Research and Discovery | 0,5 | Academic Reputation (AR) | 0,30 |
| | | Citations per Faculty (CPF) | 0,20 |
| Employability and Outcomes | 0,20 | Employer Reputation (ER) | 0,15 |
| | | Employment Outcomes (EO) | 0,05 |
| Global Engagement | 0,15 | International Student Ratio (ISR) | 0,05 |
| | | International Faculty Ratio (IFR) | 0,05 |
| | | International Research Network (IRN) | 0,05 |
| Learning Experience | 0,10 | Faculty/Student Ratio (FSR) | 0,10 |
| Sustainability | 0,05 | Sustainability (SUS) | 0,05 |

Table 2

Values of indicators for leading Ukrainian universities

| № | University Name | Indicator Values of HEIs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | AR | ER | FSR | CPF | IFR | ISR | IRN | EO | SUS |
| 1 | Ivan Franko National University of Lviv | 5,7 | 12,8 | 30,2 | 1,3 | 1,3 | 1,5 | 12,6 | 18,6 | 2 |
| 2 | Kharkiv National University of Radio Electronics | 3,9 | 12,3 | 21,6 | 1,5 | 1,4 | 5,1 | 11,9 | 4,1 | 1,4 |
| 3 | Lviv Polytechnic National University | 8,4 | 13,5 | 28,4 | 1,9 | 1,4 | 1,2 | 18,9 | 15,2 | 11,5 |
| 4 | National Technical University «Kharkiv Polytechnic Institute» | 6,5 | 10,6 | 54,3 | 1,3 | 1,7 | 20,1 | 11,4 | 4 | 1,6 |
| 5 | National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» | 16,2 | 31,8 | 37,4 | 1,5 | 1,7 | 2 | 20,4 | 21,3 | 4,3 |
| 6 | National University of Kyiv-Mohyla Academy (NaUKMA | 5,1 | 10,6 | 44,2 | 1,2 | 2,1 | 1,1 | 6,3 | 13,5 | 1 |
| 7 | Sumy State University | 5,8 | 5,3 | 35,1 | 2,5 | 3,1 | 40,5 | 28,9 | 3,8 | 7,5 |
| 8 | Taras Shevchenko National University of Kyiv | 18,9 | 36,6 | 27 | 2,2 | 1,5 | 3,9 | 40,3 | 45,5 | 1,6 |
| 9 | V. N. Karazin Kharkiv National University | 12,6 | 16,9 | 64,6 | 1,4 | 3,3 | 55,7 | 29,4 | 4 | 4,9 |

To calculate the overall score based on nine key indicators, the following formula is used:

$$S^t = \sum_{i=1}^{m} w_i \cdot K_i^t,$$

where

$S^t$ – the overall value of the HEI for the *t*-th period;

$w_i$ – the weight coefficient of the *i*-th indicator, $i = \overline{1, m}$;

$K_1^t$ – the academic reputation indicator for the $t$-th period, AR;

$K_2^t$ – the employer reputation indicator for the $t$-th period, ER;

$K_3^t$ – the number of students per one lecturer for the $t$-th period, FSR;

$K_4^t$ – the number of citations per one scientific article for the $t$-th period, CPF;

$K_5^t$ – the share of international faculty for the $t$-th period (%), IFR;

$K_6^t$ – the share of international students for the $t$-th period (%), ISR;

$K_7^t$ – the international research network indicator for the $t$-th period (%), IRN;

$K_8^t$ – the overall employment outcomes indicator for the $t$-th period (%), EO;

$K_9^t$ – the sustainable development index of the HEI for the $t$-th period (%), SUS.

We provide an example of calculating the overall value in the ranking for NTU «KhPI».

$$S_4^{2025}\left(0.30\times6.5\right)+\left(0.15\times10.6\right)+\left(0.10\times54.3\right)+\left(0.20\times1.3\right)+\left(0.05\times1.7\right)+\left(0.05\times20.1\right)+$$
$$+\left(0.05\times11.4\right)+\left(0.05\times4.0\right)+\left(0.05\times1.6\right)=11.17$$

After calculating the overall value for each university (Raw Score), linear normalisation of the results is performed according to the following formula:

$$S_{norm}^t = \frac{S^t}{S_{max}^t}\times100,$$

where:

$S^t$ – the overall value of the university across all indicators;

$S_{max}^t$ – the maximum Raw Score among all universities (the highest score);

$S_{norm}^t$ – the normalised overall indicator (Overall Score) on a scale from 0 to 100.

An example of calculating the normalised overall ranking score for NTU «KhPI» is as follows:

$$S_{norm4}^{2025} = \left(\frac{11.17}{99.06}\right)\times100 = 11.28.$$

A study of the dynamics of the normalised overall indicator $S_{t,norm}$ of leading Ukrainian HEIs according to the QS WUR ranking has been conducted. As a result, the best HEI (Massachusetts Institute of Technology) receives a score of 100, while all others obtain proportionally lower values. The calculated values of the QS WUR Overall Score for leading Ukrainian HEIs for 2025 are presented in Table 3.

Table 3

Calculated values of the QS WUR Overall Score of HEIs for 2025

| University Name | Overall Score $S^t$ | Normalised Overall Score $S_{norm}$ | EI Position in the QS WUR |
|---|---|---|---|
| Massachusetts Institute of Technology | 99,06 | 100 | 1 |
| Taras Shevchenko National University of Kyiv | 18,94 | 19,12 | 701-710 |
| V. N. Karazin Kharkiv National University | 17,92 | 18,09 | 741-750 |
| National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» | 16,12 | 16,25 | 801-850 |
| National Technical University «Kharkiv Polytechnic Institute» | 11,17 | 11,28 | 1001-1200 |
| Sumy State University | 10,73 | 10,84 | 1001-1200 |
| Lviv Polytechnic National University | 10,17 | 10,25 | 1001-1200 |
| National University of Kyiv-Mohyla Academy | 8,98 | 9,07 | 1001-1200 |
| Ivan Franko National University of Lviv | 8,71 | 8,79 | 1201-1400 |
| Kharkiv National University of Radio Electronics | 6,67 | 6,73 | 1201-1400 |

To assess the accuracy and homogeneity of the set of values, as well as to serve as a basic criterion when comparing the calculations of different samples and verifying the reliability of statistical analysis results, the following formula is used.

$$\sigma = \sqrt{\frac{1}{n}\sum_{j=1}^{n}\left(S_j^t - S_{normj}^t\right)^2},$$

where: $n$ – number of universities in the ranking QS WUR.

The standard deviation equals 0.1187, i.e. 11.87%, which shows how much the data deviate from the mean value – how stable or variable they are. The magnitude of this indicator demonstrates satisfactory convergence between $S^t$ and $S_{norm}^t$.

Based on the calculations of the normalised Overall Score (Table 2), a chart has been constructed, which is shown in Figure 1.
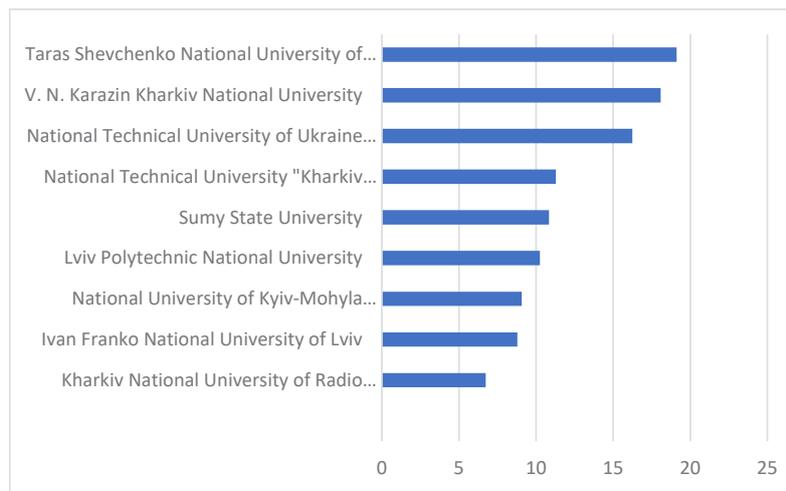


**Fig. 1. Comparison of leading Ukrainian HEIs for 2025 according to the QS WUR Overall Score**

Thus, the chart clearly illustrates the leadership of the universities of Kyiv and Kharkiv in ranking positions, indicating their high academic reputation and competitiveness among Ukrainian HEIs.

A study of the key indicators of NTU «KhPI» and a comparative analysis with other Ukrainian universities were conducted. At the initial stage of the research, the dynamics of the nine indicators of NTU «KhPI» included in the QS WUR ranking for 2022–2025 were analysed in Figure 2.
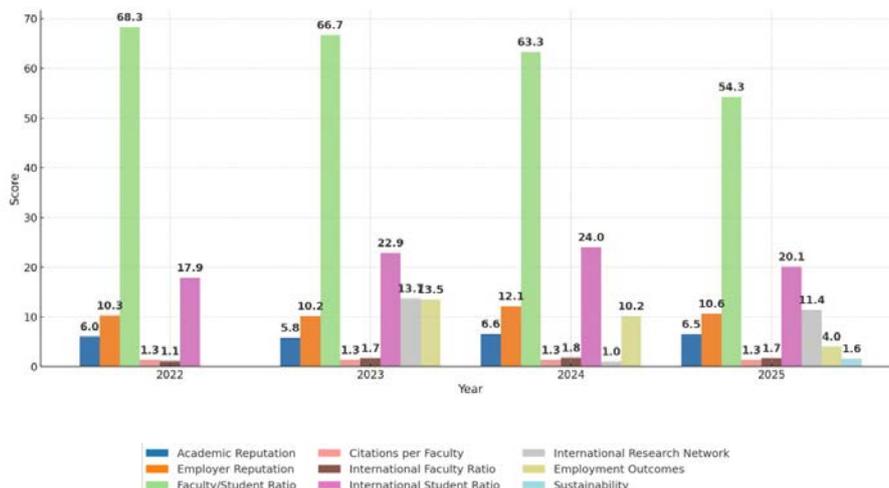


**Fig. 2. Dynamics of NTU «KhPI» indicators according to the QS WUR ranking for 2022–2025**

To develop strategies for improving NTU «KhPI» positions in the QS WUR ranking, the dynamics of each indicator for 2022–2025 were analysed. For NTU "KhPI", the academic reputation (AR) indicator remains relatively stable throughout the period: from 6.0 in 2022 to 6.5 in 2025. Despite a slight absolute increase (+0.5 points), the university's position remains among the lowest compared to other technical HEIs in Ukraine. The minor growth indicates gradual but slow improvement of the university's academic image within the scientific community.

The employer reputation (ER) indicator forms 15% of the QS WUR ranking and is a key measure of a university's ability to prepare competitive graduates [2, 14]. In the case of NTU «KhPI», there is a slight increase: from 10.3 in 2022 to 10.6 in 2025, despite a temporary rise to 12.1 in 2024. This demonstrates an unstable evaluation of graduate reputation among employers.

The next indicator in the QS WUR ranking is the faculty-to-student ratio (FSR). This indicator reflects the degree of individualisation in the learning process: the fewer students per lecturer, the more attention can be given to each student [2; 14]. At NTU «KhPI», the FSR decreased from 68.3 in 2022 to 54.3 in 2025, showing gradual improvement in teaching conditions.

Next, the dynamics of the QS WUR indicator related to citations per faculty (CPF) were examined. CPF is a key indicator of a university's research productivity and influence, weighted at 20% in QS WUR. The calculation is based on data from major scientometric databases and considers the total number of citations of academic publications relative to the number of faculty members [1; 14]. At NTU «KhPI», the CPF indicator remains stable during 2022–2025 at 1.3, indicating a relatively low citation rate of the university's publications. The main reasons include the focus of some researchers on regional conferences and specialised journals, as well as limited participation in international research programmes.

The share of international faculty (IFR) reflects the level of internationalisation of academic staff and carries a weight of 5% in the QS WUR ranking. High IFR values are typical for universities that actively attract foreign scholars, offer English-language programmes, promote academic mobility, and maintain transparent staffing policies [1; 14]. At NTU «KhPI», IFR increased from 1.1 in 2022 to 1.7 in 2025, showing positive dynamics, though still insufficient for a significant breakthrough in the international educational environment.

The share of international students (ISR) is an important indicator of a university's international attractiveness, with a total weight of 5% in the QS WUR ranking. It is calculated based on the share of students of foreign citizenship in the total student body [1; 14]. NTU «KhPI» demonstrates a positive growth trend in the share of international students – from 17.9% in 2022 to 20.1% in 2025. This indicates the effectiveness of implementing English-language programmes, increasing participation in international education fairs, and cooperation with recruitment agencies.

The international research network (IRN) indicator accounts for 5% of the QS WUR ranking structure. It measures the number of publications created in collaboration with international partners and indexed in major scientometric databases [1]. NTU «KhPI» had an IRN of 13.7 in 2023, which dropped to 1.0 in 2024 and rose again to 11.4 in 2025. Such instability indicates fragmented participation in international research projects.

The employment outcomes (EO) indicator is a key measure of university success in the labour market, with a weight of 5% in the QS WUR. It consists of the employment index (percentage of graduates employed in their field within 15 months after graduation) and the alumni impact indicator across industries. For NTU «KhPI», EO in 2025 equals 4.0, significantly lower than in 2022 (10.3). This suggests strengthened practical components in educational programmes and interaction with employers but also reflects labour market fluctuations.

The sustainability index (SUS) is a new QS WUR indicator weighted at 5%. It consists of three components: environmental impact, social impact, and equality and inclusion policies [1; 14]. At NTU «KhPI», the SUS index increased to 1.6 in 2025, demonstrating early progress in implementing environmental and social initiatives. The basis for this includes energy efficiency projects, an innovation campus, and other innovative initiatives.

Overall, the structure of changes in the ranking indicators for NTU «KhPI» indicates a gradual shift of the university from a traditionally academic model to a more practice-oriented and internationally integrated one. Most indicators remain relatively stable, which may result from targeted strategic measures to expand international partnerships, increase the attractiveness of educational programmes for foreign students, and update research policy.

To improve the efficiency of strategic management in HEIs, an analysis of the university's external and internal environment was carried out using strategic analysis methods such as PESTLE analysis, SWOT analysis, and TOWS analysis [13; 15]. PESTLE analysis was used to identify external factors affecting HEI indicators in the QS WUR ranking. Applying SWOT analysis provided a clear understanding of NTU «KhPI»'s position in the global ranking environment, its strengths on which development strategy can be built, and the threats to consider in strategic goal formation.

To determine strategic development options for NTU «KhPI» in the context of the QS WUR global ranking, taking into account both external and internal factors, the analytical strategic planning tool TOWS analysis was applied.

Based on the conducted TOWS analysis [15], four interrelated strategic directions for the university's development were identified.

1. Using scientific and educational potential to realise global opportunities (SO-strategy). This direction is linked to active utilisation of the university's strengths, such as a strong scientific school, highly qualified teaching staff, and the presence of international double-degree programmes and academic mobility projects. The main objective is to expand NTU «KhPI» participation in international research projects, increase joint publications in journals indexed in Scopus and Web of Science, and promote innovative English-taught educational programmes. Implementation of these measures will enhance the Academic Reputation and International Research Network indicators, which have significant weight in the QS WUR ranking.

2. Overcoming internal limitations through external opportunities (WO-strategy). This direction involves addressing internal weaknesses by leveraging external environment opportunities. Key success factors include strengthening international communication, increasing the university's visibility in the global digital space, and forming a positive image of KhPI as a modern scientific and educational centre. It is advisable to create an integrated English-language PR strategy to promote the university among QS experts and potential partners. At the same time, it is necessary to activate alumni participation in global professional networks by creating an Alumni platform for collecting Employment Outcomes data. Another important element is the digitalisation of publication activity and citation monitoring, improving the analytical efficiency of ranking data preparation.

3. Using scientific and educational advantages to minimise external threats (ST-strategy). This direction focuses on leveraging the university's strengths to reduce the impact of external negative factors, such as increased regional competition, funding instability, and student and faculty migration. Key tasks include developing strategic partnerships with leading global universities, establishing interregional and international research laboratories, and engaging industrial partners in joint innovation projects. An essential component is the formation of a reputational package for participation in the QS Academic Survey, emphasising the unique engineering and technological competencies of NTU «KhPI».

4. Minimising internal weaknesses and avoiding risks (WT-strategy). This strategic direction is aimed at stabilising internal management processes and enhancing the university's resilience to external challenges. The main tasks include developing an anti-crisis digital transformation strategy, optimising internal data collection mechanisms for rankings, and implementing an internal rating system for departments and institutes based on QS WUR criteria. Additionally, it is necessary to diversify funding sources through increased participation in grant programmes, business partnerships, and corporate education projects. This will reduce dependence on state funding and ensure the university's sustainable development even under economic instability.

Thus, the implementation of these strategic directions will contribute to increasing NTU «KhPI» competitiveness in the global educational space in the medium term, improving indicators of key QS WUR metrics (Academic Reputation, Employer Reputation, Citations per Faculty, Internationalisation), and strengthening the university's reputation as one of Ukraine's and Europe's leading educational and research centres.

To provide recommendations to the university's administration for improving its QS WUR ranking indicators according to the defined directions, a recommendation formation model was developed, presented in Figure 3.
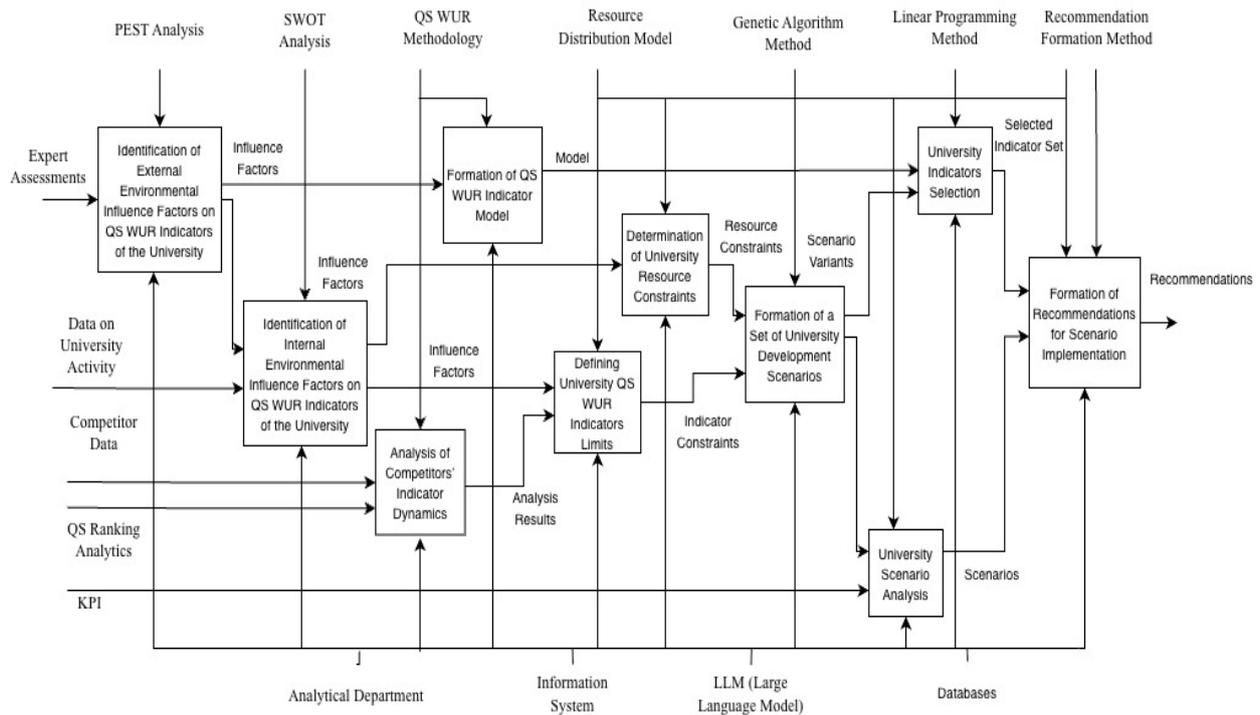


**Fig. 3. Business process model for forming recommendations to improve HEI performance in the QS WUR ranking**

The developed model in IDEF0 notation represents an integrated process of forming recommendations aimed at improving HEI positions in the QS WUR ranking. The model describes the interaction between the analytical department, information system, intelligent module (LLM), and databases that provide comprehensive support for managerial decision-making.

The main goal of the model is to enhance the effectiveness of university strategic management through the use of analytical and optimisation methods (PEST, SWOT analysis, TOWS analysis, linear programming, genetic algorithms) to generate well-grounded recommendations for improving QS WUR indicators.

The model's input flows include data on HEI activities, publication activity statistics, staff composition, international cooperation, employer engagement, and student mobility. Data on competitor universities comprise information about selected HEIs' indicators used for comparative analysis. Expert evaluations are the results of surveys of internal and external experts on the university's strengths and weaknesses.

The controlling influences include the QS WUR methodology, which defines the structure of indicators, weighting coefficients, and evaluation methods, as well as the university's KPIs aligned with its development strategy. The management function is performed by QS WUR analytics, which set the benchmarks for improving specific indicators.

The main functional blocks of the model that form the logical sequence of actions are as follows:

1. Formation of the QS WUR indicator model. Integration of data collection and processing results on HEI activities, allowing the creation of a QS WUR indicator structure relevant to a specific university (NTU «KhPI») and assessment of its current state.

2. Identification of external environmental factors (PESTLE analysis). At this stage, political, economic, social, and technological factors influencing university performance and QS WUR position are analysed.

3. Identification of internal environmental factors (SWOT-analysis). Internal strengths and weaknesses of the HEI are examined, including human resources, research quality, international cooperation, and the level of digitalisation.

4. Determination of HEI resource constraints and indicators. The resource allocation model defines possible limits for funding, staffing, publication activity, and other resources.

5. Formation of HEI development scenarios. Using an evolutionary approach, possible university development scenarios are generated considering constraints and QS WUR target indicators.

6. Selection of the optimal set of indicators. The optimisation procedure determines the most effective combination of indicators that ensures the maximum increase in ranking score within the available resources.

7. Formulation of recommendations for scenario implementation. Based on the scenario analysis results, specific recommendations for university management are formed (for example, increasing the share of international students, raising the number of publications in leading scientometric databases, and developing partnership programmes).

The model's outcome is a set of recommendations that includes: priority development areas, optimal resource-use scenarios, forecasts of expected QS WUR indicator improvements, and analytical evaluation of the proposed decisions' effectiveness.

The model will be integrated with the university's information system, databases, and LLM (Large Language Model) module. This approach ensures adaptability and self-learning of the system as historical data accumulates.

The proposed model for forming recommendations to improve HEI performance in the QS WUR ranking serves as the systemic foundation of a recommendation management system, integrating strategic analysis methods and artificial intelligence. Implementing such a model allows automation of managerial decision-making, enhances the effectiveness of research, educational, and international activities, and ensures sustainable growth of HEI positions in the QS WUR ranking.

**Conclusions**

The proposed study is timely and practically significant, as it combines modern business process modelling methods for the strategic development of Ukraine's higher education system. The developed model enables a comprehensive assessment of external and internal factors affecting HEI ranking indicators. Based on the obtained data, a model for forming recommendations to improve HEI performance in the QS WUR ranking has been created, which defines the relationships between individual indicators according to the QS WUR methodology and HEI activities.

The main functions of the model encompass resource allocation using genetic algorithms and linear programming methods to search for optimal HEI development scenarios, considering resource constraints and university management priorities. The integration of an LLM ensures intelligent data analysis, automatic scenario generation, and synthesis of recommendations. The model allows for the creation of scientifically grounded recommendations to enhance university performance and provides feedback for the analytical department and HEI information system.

Thus, the proposed model is a comprehensive tool for systematising the factors influencing ranking indicators, identifying priority development directions, optimising resource allocation, and forming managerial decisions for university leadership. The implementation of the proposed model will create the prerequisites for increasing HEI competitiveness in the global educational and research environment.

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