METHODOLOGY

Engirank

A NEW, INNOVATIVE EUROPEAN RANKING OF ENGINEERING PROGRAMS

2023

Ranking Organizers

Perspektywy Education Foundation

Foundation for the Development of the Education System

Ranking Partner

ELSEVIER

engirank.eu

Scientists study the world
as it is,
engineers create the world
that never has been

Theodore von Kármán

Engirank

European Ranking of Engineering Programs 2023

Project executed by

Perspektywy Education Foundation (Poland)

in partnership with
Foundation for the Development of the Education System FRSE (Poland's National Agency for the Erasmus+ Programme and the European Solidarity Corps)

and supporting partner
Elsevier

Warsaw - Brussels 2023

Project leaders:

Waldemar Siwinski
Founder, *Perspektywy Education Foundation*
President, *IREG Observatory on Academic Ranking and Excellence*

Pawel Poszytek
General Director, *Foundation for the Development of the Education System (FRSE)*

Team of analytics:
Dr. Miłosz Rojek (chief project scientist), Przemek Nowak

DTP Studio: Artur Żebrowski (head), Mariusz Mechowski, Karolina Sitnicka

Published by Perspektywy Education Foundation

Secretariat:
Ms Magdalena Chrostna
m.chrosta@perspektywy.pl

Ranking website: www.EngiRank.eu

Assumptions

Engineering education plays a key role in securing sustainable development of Europe, it is vital in creating innovative technologies and educating creative engineers capable of using science to solve problems but also aware of the social consequences of their actions. To meet these challenges in the age of growing development of the industry, labor market and education, we need a tool to compare the quality of engineering and technology programs offered by the European universities. Rankings of universities and programs have become accepted form of comparing and assessment understood by a broad range of stakeholders.

The European Rankings of Engineering Programmes *EngiRank* fills a gap regarding current and trustworthy information on engineering education, as well as research and innovation, in European universities and other higher education institutions (HEIs) with strong technical profile.

Our primary concern in designing *EngiRank* was the highest reliability of the rankings. The geographical scope of *EngiRank* covers all 27 member countries of the European Union. One of the reasons for this coverage of the rankings is related to the right of EU citizens to study in other member states under the same conditions as nationals; the exercise of this right is additionally supported by the Erasmus+ mobility programmes. Intensified student mobility brings about demands for information on the quality of European HEIs. Furthermore, consortia of institutions from various member states can apply for research and innovation funding to the Horizon Europe programmes and the recently launched European Universities initiative develops long-term cooperation between the European HEIs. These actions level the playing field for HEIs within the European Union and make comparing those institutions more meaningful.

Another factor considered essential for the *EngiRank* credibility is the quality and reliability of data. The rankings are based only on trustworthy external databases containing information on European HEIs that is collected in a unified way, such as the bibliometric database Scopus, EPO Worldwide Patent Statistical Database (PATSTAT), information on participations in the European Commission's initiatives (Community Research and Development Information Service – CORDIS, information on mobilities within Erasmus+ programmes, participation in the European universities alliances), databases of programmes accredited by quality assurance agencies. No information necessary to compile the rankings were obtained directly from HEIs.

The EngiRank has been initiated and prepared by Warsaw based “Perspektywy” Education Foundation. The main partner of the project is the Foundation for the Development of the Education System – FRSE (Poland’s national agency for the Erasmus + Program and the European Solidarity Corps). Its supporting partner is Elsevier.

The EngiRank is primarily addressed to the following groups:

- **Prospective students and their parents** – it will help in choosing a field of study and institution in Europe that, after graduation, will give best chances of finding a satisfactory job. It will also be helpful in study abroad and finding internship under the Erasmus + program,
- **Employers, including European Hi Tech industry** – will help in looking for talented graduates of technology institutions,
- **University management** – ranking will help monitor reforms and improve the quality of teaching.

Methodology

EngiRank Board decided to reduce diversification of HEIs included in the rankings in order to avoid comparing unmatchable institutions and increase relevance of the rankings.

Entry requirements

The ENTRY CRITERIA for institutional ranking include a qualitative condition:

- The institutions considered to be classified in the *EngiRank* had been checked against the European Engineering Education Database (EEED) run by ENGINEERS EUROPE, a federation of professional engineering associations from European Higher Education Area (EHEA) countries;

and quantitative conditions:

- The HEIs with a significant share of research output in engineering and technology – at least 30% of publications from last 5 years (2018-2022) that are indexed in the Scopus database – were examined. However, the institutions with majority of publications in medical and health sciences or in social sciences between 2018 and 2022 were not considered as HEIs with strong technical profile and they are not listed in *EngiRank*;

The **institutional ranking** within *EngiRank* includes HEIs which are classified in at least three subject rankings.

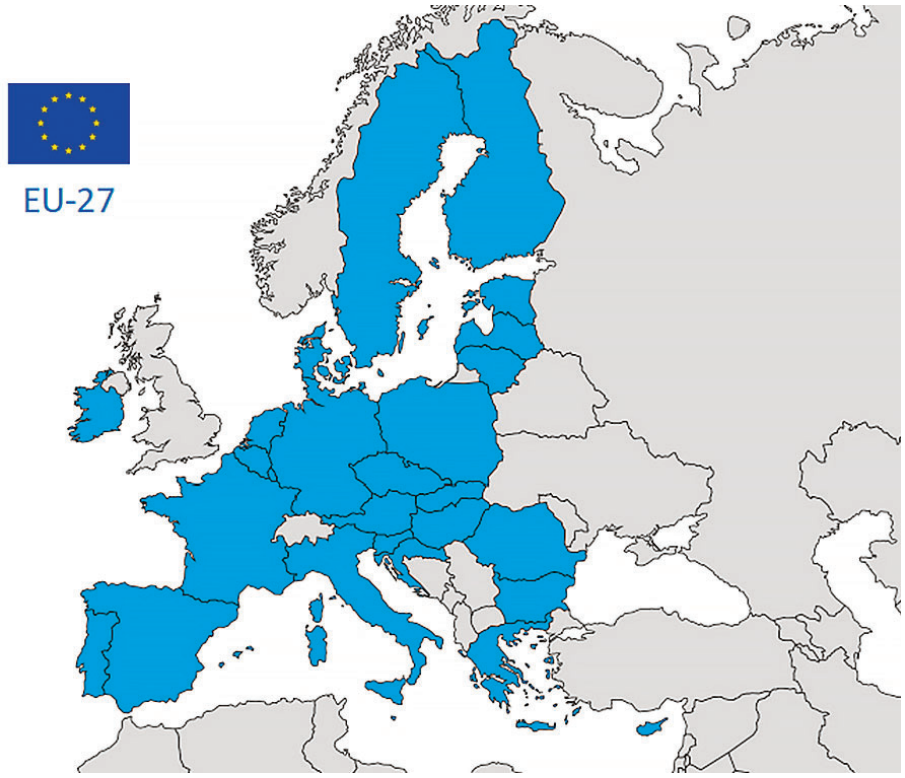
The **subject ranking** satisfying the qualitative condition and both quantitative conditions: share of publications in engineering and technology not less than 30% and a number of publications in a discipline not less than a threshold value.

- The threshold numbers of publications in main engineering disciplines from the last 5 full years that are indexed in the Scopus database are as follows:
    - chemical engineering – 200,
    - civil engineering – 100,
    - electrical engineering, electronic engineering, information engineering – 200,
    - environmental engineering – 100,
    - materials engineering – 250,
    - mechanical engineering – 200,
    - medical engineering – 100.

The classification of disciplines adopted in EngiRank corresponds to the OECD Fields of Research and Development (FORD), both on the level of 1-digit major fields (i.e. 2. Engineering and technology, 3. Medical and health sciences, 5. Social sciences) and on the level of 2-digit categories (2.1 Civil engineering; 2.2 Electrical engineering, electronic engineering, information engineering etc.).

Only in exceptional cases, in order to include leading engineering-profile HEIs from all EU27 countries in the EngiRank institutional ranking, the threshold of E&T publications share was lowered (and if outcomes of two leading institutions were very close, we decided to include both of them in the rankings). That applies to Ireland, Croatia, Malta and Flanders.

EngiRank includes 225 HEIs from all over European Union:



Austria - 4
Belgium - 4
Bulgaria - 4
Croatia - 2
Cyprus - 3
Czechia - 10
Denmark - 2
Estonia - 1
Finland - 3
France - 57
Germany - 31
Greece - 7
Hungary - 5
Ireland - 3
Italy - 16
Latvia - 3
Lithuania - 2
Luxembourg - 1
Malta - 1
Netherlands - 4
Poland - 22
Portugal - 7
Romania - 10
Slovakia - 4
Slovenia - 2
Spain – 10
Sweden - 7

The institutional ranking includes 178 HEIs.

Innovative approache

Our particular concern in designing *EngiRank* was the degree of the institutions' commitment to their economic and social missions. To reflect transfer and application of academic knowledge by HEIs we included the indicators measuring collaboration between academia and industry researchers, use of research output in successful patent applications, as well the very patent activity of HEIs, students internships and contribution to sustainable development goals – where appropriate – into the rankings.

EngiRank is a composition of different categories of indicators. We believe that the scale of institution's activities matters: research and innovation exhibits increasing returns to scale, and the larger the magnitude of HEI's operations, the more opportunities for students and academic staff. Thus indicators of size, measuring volume of research output, amount of research and innovation funding, number of patents or number of publications assigned to the selected sustainable development goals, play an important role in the rankings.

Inclusion of the subject rankings scores into the institutional ranking reflects returns to scope and benefits of interdisciplinarity.

Then we have the conventional efficiency indicators expressed in relative terms, such as citations per publication, share of publication in the top 10% journals, number of patent citations received on average by a publication, percentage of publications that are co-authored by industry researchers or foreign researchers.
Introducing a dynamic indicator, change in citation impact, is a kind of novelty in the universe of HEIs' rankings.

Last, we included qualitative indicators representing engineering degree programmes accreditations and membership in a European university alliance. These indicators are closely related to the European Higher Education Area (EHEA) and clearly illustrate the advantages of a regional approach to academic rankings.

EngiRank INSTITUTIONAL

The institutional ranking encompasses five criteria composed of 20 indicator. The most important criteria, according to their weights, are **Research** (28%) and **Innovation** (27%) – together they constitute 55% of the ranking. The third criterion, Contributon to **SDG 9**, recognizes institution's effort to make headway toward the sustainable development goal 9 - the weight of this single indicator criterion is 5%. The next criterion is **Internationalisation**, with the weight equal to 19%, and the last one is **Interdisciplinarity** (weight of 21%), that links the institutional ranking with the subject rankings.

RESEARCH (28%)

The criterion composed of four indicators originating from the Scopus bibliometric database. **Publications** is the indicator representing the institution's research output in absolute terms. Then **Citations** and **Publications in Top 10% Journals** are indicators expressed in relative terms. The last one, **Change of Impact,** is a dynamic indicator that reflects a change in the citation impact. More detailed information on each indicator is given below.

- **Publications (PUB):** number of publications from the years 2018-2022 in the field Engineering and technology (FORD classification) in the Scopus database which are affiliated with the institution. *Source: Scopus/SciVal (10%)*
- **Publications in Top 10% Journals (TOP-10):** percentage of the institution's publications published in the top 10% journals by CiteScore in the field Engineering and technology in the years 2018-2022. *Source: Scopus/SciVal (6%)*
- **Citations (CIT):** ratio of the number of citations received by the institution's publications from the years 2018-2022 in the field Engineering and technology indexed in the Scopus database to the number of these publications. *Source: Scopus/SciVal (6%)*
- **Change of Impact (FWCI-C):** dynamic indicator calculated as the ratio of field-weighted citation impact (FWCI) for the institution's publications from the years 2018-2022 to FWCI for the publications from the years 2013-2017 in the field Engineering and technology. *Source: Scopus/SciVal (6%)*

INNOVATION (27%)

The criterion composed of four indicators. First, **Research and Innovation Funding** and **Patents** are expressed in absolute terms and refer to the European frameworks of research and innovation funding and patent granting, respectively. The Scopus bibliographic database was the source for calculating the remaining two indicators: **Patent-Citation Count per Scholarly Output** and **Academic-Corporate Collaboration**. Both are expressed in relative terms. More detailed information on the indicators is given below.

- **Research and Innovation Funding (FUND):** value of grants awarded to the institution within the EU framework programmes funding research and innovation between 2018 and 2022. *Source: CORDIS (10%)*
- **Patents (PAT):** number of patents granted to the institution by the European Patent Office in 2018-2022. *Source: EPO-PATSTAT (6%)*
- **Patent-Citation Count per Scholarly Output (PCIT):** average number of patent citations received per scholarly outputs published by the institution in the field *Engineering and technology* in 2018-2022. *Source: Scopus/SciVal (6%)*
- **Academic-Corporate Collaboration (ACC):** percentage of publications the field *Engineering and technology* published between 2018 and 2022 that are co-authored by researchers affiliated to an institution outside academia. *Source: Scopus/SciVal (5%)*

CONTRIBUTON TO SDG (5%)

The single indicator criterion. The indicator measures institution's contribution to sustainable development goal 9 with the number of publications assigned to SDG 9 and the field *Engineering and technology*.

- **SDG-9:** number of publications from 2018-2022 assigned simultaneously to the United Nations *Sustainable Development Goal 9: Industry, innovation and infrastructure* and to the field *Engineering and technology* (FORD classification). *Source: Scopus/SciVal (5%)*

INTERNATIONALISATION (19%)

The criterion composed of five indicators. The **International Collaboration** indicator is derived from the Scopus bibliographic database. The remaining indicators refer to the scale of students' mobility within the Erasmus+ programme and to the institution's participation in a European university alliance. More detailed information on each indicator is given below.

- **International Collaboration (IC):** percentage of the institution's publications in the field *Engineering and technology* in the years 2018-2022 that have co-authors from multiple countries. *Source: Scopus/SciVal (10%)*
- **Outbound student mobility (SMO):** number of institution's students undertaking studies abroad within the Erasmus+ programme in 2018-2020. *Source: Erasmus+ (2%)*
- **Inbound student mobility (SMI):** number of foreign students undertaking studies in the institution within the Erasmus+ programme in 2018-2020. *Source: Erasmus+ (2%)*
- **Student internships (SIN):** number of institution's students undertaking internships abroad within the Erasmus+ programme in 2018-202. *Source: Erasmus+ (1%)*
- **Partnership in a European university alliance (EUNI):** binary indicator showing whether the university is a full member of any European university alliance as of 3.07.2023. *Source: Erasmus+ (4%)*

INTERDISCIPLINARITY (21%)

This criterion identifies universities conducting high-level research in many fields of engineering and technology, which makes it easier for them to create future-oriented, interdisciplinary programs for the High-Tech industry. The criterion combines institutional rankings with subject rankings and rewards institutions classified in a larger number of disciplines and obtaining higher scores in these rankings. Seven "by subject" rankings are taken into account.

- **Chemical Engineering (CHE):** scores received in CHE subject ranking. *Source: EngiRank by subject (3%)*
- **Civil Engineering (CIV):** scores received in CIV subject ranking. *Source: EngiRank by subject (3%)*
- **Electrical engineering, Electronic engineering, Information engineering (EEI):** scores received in EEI subject ranking. *Source: EngiRank by subject (3%)*
- **Environmental Engineering (ENV):** scores received in ENV subject ranking. *Source: EngiRank by subject (3%)*
- **Materials Engineering (MAT):** scores received in MAT subject ranking. *Source: EngiRank by subject (3%)*
- **Mechanical Engineering (MEC):** scores received in MEC subject ranking. *Source: EngiRank by subject (3%)*
- **Medical Engineering (MED):** scores received in MED subject ranking. *Source: EngiRank by subject (3%).*

EngiRank BY SUBJECT

The EngiRank rankings in the following disciplines:

- chemical engineering,
- electrical engineering, electronic engineering, information engineering,
- materials engineering,
- mechanical engineering,

are based on three criteria: Research (64%), Innovation (26%) and Teaching Quality (10%).

Then we addressed the potential and expected contribution of HEIs' activities in the remaining disciplines to the particular sustainable development goals (SDGs):

- civil engineering – SDG 11: Sustainable cities and communities,
- environmental engineering – SDG 6: Clean water and sanitation,
- medical engineering – SDG 3: Good health and well-being.

Thus the additional criterion, **Contribution to SDGs** (5%), was added for each of the above disciplines, and simultaneously the weights of other criteria were cut: **Research** - to 60%, and **Innovation** - to 25%.

Every indicator in the subject rankings refers strictly to a given discipline. Some indicators in the institutional ranking and in the rankings by subject are based on the same metrics, differing only in the scope of publications or grants considered. Although such indicators from the rankings by subject are indirectly included in the institutional ranking (via the *Engineering and Technology Capacity* criterion) that shouldn't be considered a duplication of the indicators. Note that some HEIs are not classified in all the subject rankings in particular, approximately half of HEIs listed in the institutional ranking are classified in the medical engineering ranking).

Besides, even in case of HEIs classified in all the rankings by subject there are publications and grants not covered by the subject rankings indicators, like the ones in general engineering; nuclear energy and engineering; control and systems engineering; safety, risk, reliability and quality; media technology; bioengineering; other miscellaneous engineering. They are counted in the institutional ranking only.

RESEARCH (60%/64%)

- **Publications (PUB):** number of publications from the years 2018-2022 in the relevant discipline in the Scopus database which are affiliated with the institution. *Source: Scopus/SciVal (15%/16%)*
- **Publications in Top 10% Journals (TOP-10):** percentage of the institution's publications published in the top 10% journals by CiteScore in the relevant discipline in the years 2018-2022. *Source: Scopus/SciVal (15%/16%)*
- **Citations (CIT):** ratio of the number of citations received by the institution's publications from the years 2018-2022 in the relevant discipline indexed in the Scopus database to the number of these publications. *Source: Scopus/SciVal (15%/16%)*
- **Change of Impact (FWCI-C):** dynamic indicator calculated as the ratio of field-weighted citation impact (FWCI) for the institution's publications from the years 2018-2022 to FWCI for the publications from the years 2013-2017 in the relevant discipline. *Source: Scopus/SciVal (15%/16%)*

CONTRIBUTION TO SDGs (0%/5%)

The single indicator criterion. The indicator measures institution's contribution to selected SDGs in defined disciplines by the number of publications.

- **SDG-3: Good health and well-being** (*medical engineering only*): number of publications from 2018-2022 assigned simultaneously to the United Nations Sustainable Development Goal 3: Good health and well-being and to medical engineering (FORD category 2.6). *Source: Scopus/Scival*
- **SDG-6: Clean water and sanitation** (*environmental engineering only*): number of publications from 2018-2022 assigned simultaneously to the United Nations Sustainable Development Goal 6: Clean water and sanitation and to environmental engineering (FORD category 2.7). *Source: Scopus/Scival*
- **SDG-11: Sustainable cities and communities** (*civil engineering only*): number of publications from 2018-2022 assigned simultaneously to the United Nations Sustainable Development Goal 11: Sustainable cities and communities and to civil engineering (FORD category 2.1). *Source: Scopus/Scival*

The indicators' weights in particular subject rankings are summarised in the table below.

Engirank BY SUBJECTS	RESEARCH				INNOVATION		TEACH	SDG		
	Publications	Publications in Top 10% Journals	Citations	Change of Impact	Academic-Corporate Collaboration	Research and Innovation Funding	Accreditations	SDG 3: Good health and well-being	SDG 6: Clean water and sanitation	SDG 11: Sustainable cities and communities
Chemical engineering	16%	16%	16%	16%	16%	10%	10%	-	-	-
Civil engineering	15%	15%	15%	15%	15%	10%	10%	-	-	5%
Electrical eng., electronic eng., information engineering	16%	16%	16%	16%	16%	10%	10%	-	-	-
Environmental engineering	15%	15%	15%	15%	15%	10%	10%	-	5%	-
Materials engineering	16%	16%	16%	16%	16%	10%	10%	-	-	-
Mechanical engineering	16%	16%	16%	16%	16%	10%	10%	-	-	-
Medical engineering	15%	15%	15%	15%	15%	10%	10%	5%	-	-

TEACHING QUALITY (10%)

The single indicator criterion. The indicator is measured by the number of the degree programmes accredited by ENAEE authorised agencies or by ABET (more information on ENAEE and ABET in the frame below)

- **Accreditations (ACCR):** number of engineering degree programmes related to the relevant discipline accredited by the agency authorized by the European Network for Accreditation of Engineering Education (ENAEE) or by the Accreditation Board for Engineering and Technology (ABET) as of 30.06.2023. *Source: databases of EUR-ACE labelled programmes (ENAEE authorised) and of ABET accredited programmes (10%)*

INNOVATION (25%/26%)

The criterion composed of two indicators. The Scopus bibliometric database was the source for calculating the **Academic-Corporate Collaboration** indicator. The values for the **Research and Innovation Funding** are based on information from the CORDIS database.

- **Academic-Corporate Collaboration (ACC):** percentage of publications in the relevant discipline published between 2018 and 2022 that are co-authored by researchers affiliated to an institution outside academia. *Source: Scopus/SciVal (15%/16%)*
- **Research and Innovation Funding (FUND):** value of grants awarded to the university within the EU framework programmes funding research and innovation between 2018 and 2022 to finance research projects in the relevant discipline. *Source: CORDIS database (10%)*

The subject rankings list the following number of HEIs: • Chemical engineering - 167 • Civil engineering - 145 • Electrical engineering, electronic engineering, information engineering - 177 • Environmental engineering - 178 • Materials engineering - 191 • Mechanical engineering - 169 • Medical engineering - 91.

Method of calculation

The *EngiRank* rankings are modelled on the basis on the *Multi-Attribute Value Theory*. According to the theory, it was assumed - firstly - that it is possible to estimate the value, or the aggregate score, of each HEI (as well as the disciplines under consideration) taking into account impacts of the individual criteria as measured by corresponding indicators. Secondly, it was assumed that if the criteria are not equally important, then bringing them to comparability is possible by weighting the corresponding indicators with appropriate coefficients. Thirdly, the additivity of weighted criteria was assumed meaning that the final score is the linear combination of partial scores. Moreover, the indicators with an asymmetric distribution are generally subject to the transformation (square root or cube root) to reduce skewness of the distribution.

The partial scores for every indicator are calculated with reference to the leading institution. The score of 100 is assigned to the HEI with the highest indicator value and for the other institutions a proportional distance to the leader is calculated. The partnership in a European university alliance is a specific binary indicator corresponding - each of 88 universities listed in the institutional ranking that is a member of any European university alliance is assigned a score of 100.

Partial scores for all the indicators obtained by the HEI – both in the subject rankings and in the institutional ranking – are added using appropriate weights. Then the HEIs are ranked according to the weighted sum of scores in the descending order. The leading institution is assigned the final score of 100, and the subsequent institutions receive scores that are equal to the ratio of their weighted sum of partial scores to the one for the leader (in percentage terms). Position of HEIs in a ranking is determined using a discrimination threshold of 1% of the final score. It means that institutions with final scores differing by less than 1% occupy the same position in the ranking.

Warsaw - Brussels
20 October, 2023

Engirank

EUROPEAN RANKING OF ENGINEERING PROGRAMS

Project executed by
Perspektywy Education Foundation (Poland) in partnership with
Foundation for the Development of the Education System FRSE
(Poland's National Agency for the Erasmus+ Programme
and the European Solidarity Corps)

engirank.eu

Ranking Organizers

Perspektywy
Perspektywy Education Foundation

frse
Foundation for the Development of the Education System

Ranking Partner

ELSEVIER