



**SCIENTOMETRIC ANALYSIS OF THE RESEARCH OUTPUT OF THE
ORGANISATIONS WITHIN THE SLOVAK ACADEMY OF SCIENCES**

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1. Introduction

For the purposes of the upcoming accreditation of the organisations within the Slovak Academy of Sciences (SAS), the Academic Ranking and Rating Agency (ARRA) was asked to develop a scientometric analysis of the research outputs of individual research institutes. This report is based on indicators and methodology similar to those used in the project previously conducted by ARRA for the purposes of the evaluation of individual research teams within SAS, although now only the indicators relevant for each organisation as a whole are applied.

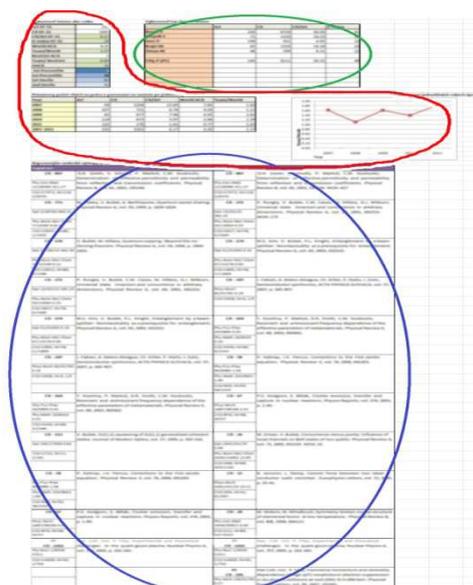
This report is developed only for the institutes of Section I (Physical, Space, Earth, and Engineering Sciences) and Section II (Life, Chemical, Medical, and Environmental Sciences) of SAS. Due to the nature of the most of the organisations within Section III (Social Sciences, Humanities, Arts, and Culture), the scientometric analysis had to be modified in order to accommodate several research-field specificities, and is therefore a subject of separate report.

It is important to bear in mind, that this is a scientometric analysis of the research output. The presented material can ease the process of evaluation significantly, but at a certain point, it needs to be interpreted by a human agent, and additional information should be incorporated into the final performance assessment. For example – the analysis is focused mostly on publications and their citation impact in a given field, but some organisations might be oriented more on applied or local research, which might slightly worsen their publication output. Or, on the other hand, the large multi-national collaborations (most visible, but not limited to the field of particle physics - PF) can ameliorate institute's overall results. Also, some institutes deal with a chronic lack of publication activities indexed in international citation databases (with only several indexed articles per year), and so their average results are easily distorted by few articles in collaboration with institutes abroad (law of small numbers). All these (and few more – additional notes included in some tables) variables need to be taken into consideration in the process of interpretation of the provided data.

The report consists of several parts, from which the first deals with the general methodological remarks, where the background information on evaluation processes and benchmarking are briefly explained. Then, the four main criteria and their respective indicators are outlined. These two parts should serve as a broad methodological framework and instructions on how to better read and understand the final tables. These tables constitute the last parts, where the results of each evaluated organisation are summarised in a comprehensive way and compared with the world, and top universities, benchmarks.

2. Methodological framework and benchmarking

Before we move on to the description of individual criteria used for the analysis, it should be helpful to outline a general methodological framework and benchmarking process first. There are three main parts of the evaluation table of each institute: 1) core scientometric data for the whole organization (red); 2) overall performance of the institute's top researchers (green); and 3) detailed evaluation of institute's top articles (blue).



Core scientometric data regarding the whole organisation are based on the Web of Science (WoS) database. Papers included in the assessment are drawn from institutes' annual reports within the evaluated period (in this case 2007-2011). Papers (or articles) here are defined only as ESI (Essential Science Indicators) compatible publications: scientific articles, review articles, proceeding papers and research notes (letters, editorial material, corrections, abstracts, etc. are **not** included). ESI compatible papers were chosen to be used in the evaluation because the benchmarking in this part is often based on ESI Baselines or at least made according to ESI categories (world's top 35 universities). Benchmarks are tailored for each organisation separately, based on a mini-questionnaire (previously distributed to individual institutes) with an option of choosing institute's proportional research focus from 21 main ESI categories (with 5% accuracy). Also, in order to represent the impact of the multi-author papers (100+ co-authors) on the performance of the whole organisation, two separate tables have been created for institutes with high proportion of multi-author papers (which in this case means only two organisations dealing with particle physics – the Institute of Physics and the Institute of Experimental Physics). This illustrates how the research output of the institutes changes significantly when particle physics multi-author papers are added to the results of the whole institute.

The overall performance of the top researchers is based on the data from accreditation questionnaires of the SAS, where the recently-top-cited scientists from each organisation are highlighted. For these individuals, basic scientometric data were gathered. On the contrary to the core scientometric data for the whole organisation, papers for individuals include all the material available in WoS, (including abstracts, letters, editorial materials, etc.) in order to give a more complex general picture of the individual scientists. This is also due to the fact that it is almost impossible to compare these data with ESI benchmarks, because the benchmarks are made only for a period of max 11 years, and most individual scientists' research careers far exceed such time-period.

Lastly, the evaluation of top articles is again based on accreditation questionnaires, where recently-top-cited articles of each organisation are selected. For every article included, an in-depth analysis based on WoS data is performed. Where there is no WoS assessment possible, other available sources are explored at least for citation counts and basic bibliometric data (SCOPUS, GoogleScholar, SAS Internal Library). Technical remark – concerning the number of selected top-cited articles, there is a small difference between Section I and Section II. Section I accreditation questionnaires comprise of two types of articles – articles published since the establishment of the institute, and articles published only during the 2000-2010 period – whereas Section II includes only the former ones, therefore all the organisation from the Section II have fewer data for this part of evaluation.

3. Description of individual indicators

In the following paragraphs, main criteria and their respective indicators will be described in more detail. For the purposes of the presented analysis, four main criteria were used in this report: 1) publication productivity; 2) overall impact; 3) effectiveness; and 4) relative impact. Some of these criteria are size- and field- dependent, therefore the discretion is required. Others are size-independent, already field-adjusted, and therefore **directly benchmarked to the world average or the average of world's top universities**.

1) Publication productivity

Publication productivity is one of the most basic criteria used for evaluation purposes, as it informs about the amount of papers produced by members of the organisation. It is highly **size- and field-dependent**, as larger institutes have usually produced more articles than smaller ones, and also certain research fields have higher publication productivity than others (although there are no systematic benchmarks in this area). In this report, publication productivity serves mainly as a control criterion – institutes with fewer entries have higher statistical uncertainty, and thus the benchmarks might give a slightly distorted picture (e.g. data for institutes with less than 10 papers per year might contain some unusual average results).

2) Overall impact

Another basic criterion important for the analysis is the overall impact. It deals with the general response of the research community to the papers produced by the organisation. Three main indicators are used here – the total number of citations to the papers published by members of the institute, H-index of the institute within a given period (2007-2011), and H-indexes and citation counts of the top-cited scientists. As in previous criterion, and for similar reasons, this indicator is also a highly **size- and field- dependent** one, although there are higher deviations in citation counts between individual research fields.

3) Effectiveness

The effectiveness criterion consists of several indicators, and (after taking the statistical robustness of the data through the publication productivity control into account) it is probably one of the most important aspects of this analysis. The indicators include the average citation rates of the organisation in comparison to the world averages and the top universities averages, adjusted to the same research-field structure. These are the **size- and field- independent** indicators, as they deal with the averages per paper, and the size of the organisation has no direct impact on it. Also, the benchmarks are modelled to compare the results in the same research-field composition, therefore the research focus should have also no significant impact upon these indicators. The world average citation rates are also compared in each year of the evaluated period, thus it is possible to track the changes in effectiveness

during individual years (this is also a control indicator to some extent – more recent publications have lower citation rates, therefore it is theoretically possible to have disproportionately low/high average citation rates for the whole period if there is disproportionately high/low number of recent publications, which needs to be taken into consideration). There is also one additional indicator in the effectiveness criterion – the percentage of uncited papers – which provides another perspective on the overall performance of the organisation.

4) Relative impact

In order to provide a broader picture of the research output of a given organisation, it is important not only to assess the overall impact of the papers or effectiveness in comparison to the world/top-universities averages, but also to look at the top papers, papers that are most visible and best-known in their fields. For the purposes of checking the status of top articles, several indicators of relative impact were incorporated. All of these indicators are highly **size- and field- independent**, therefore a direct comparison is possible.

On one hand, all the papers that have reached certain percentile thresholds (0.1%, 1%, 10%, 20%) are counted, which means that if a paper is among the top 1% of the most cited papers in its field in the world (WoS), it is assigned to all relevant categories (all thresholds are inclusive, so a paper reaching 1st percentile belongs also into 1st and 2nd decile categories). For illustration – the number of papers in certain percentile category should, in average, have the same value as the proportion that category has on the overall number of institute's papers (e.g. from 270 papers in the organisation, 2.7 (≈3) should be in 1st percentile, 27 in first decile and 54 in second decile, in order to reach average values – the more the better and vice versa).

On the other hand, the accreditation questionnaire includes the list of recently-top-cited papers of the institute, and it is interesting to check their status in more detail. Considering the articles indexed in WoS, it is possible to look at them quite thoroughly and observe several indicators applicable for general analysis. For each of these papers it is possible to calculate their rank within the year of its publication and every research sub-field (more than 250 different sub-fields) it belongs to (for example a paper XY is 20th most cited paper from 5895 papers in a sub-field of 'Physics-Fluids&Plasmas' in 2003, which means that it belongs to 0.34% of the most cited papers). In a similar manner, also its ranking within a journal is calculated, together with the H-index of that journal in a given year, showing not only how influential the journal was, but also whether that particular article contributed to the journal's H-index or not. Last but not least, the number of second-order citations is counted, which signifies the potential reach of information included in the given article. If the article is not in the WoS database, at least some compensatory data are gathered from other available databases like SCOPUS, GoogleScholar, or SAS Internal Library (marked accordingly). However, these data cannot be processed to the same extent as WoS data, therefore mostly only the raw citation counts are included (with exception of SAS Internal Library, where the structure of citations is also observed).

**Appendix: List of the world's top universities used for benchmarking
(combined ranking of ARWU, QS, THE – alphabetical order)**

University	Country
California Institute of Technology	United States
Carnegie Mellon University	United States
Columbia University	United States
Cornell University	United States
Duke University	United States
Georgia Institute of Technology	United States
Harvard University	United States
Imperial College London	United Kingdom
Johns Hopkins University	United States
Kyoto University	Japan
Massachusetts Institute of Technology	United States
McGill University	Canada
Northwestern University	United States
Princeton University	United States
Stanford University	United States
Swiss Federal Institute of Technology Zurich	Switzerland
University College London	United Kingdom
University of British Columbia	Canada
University of California, Berkeley	United States
University of California, Los Angeles	United States
University of California, San Diego	United States
University of California, San Francisco	United States
University of Cambridge	United Kingdom
University of Chicago	United States
University of Edinburgh	United Kingdom
University of Hong Kong	Hong Kong
University of Illinois at Urbana-Champaign	United States
University of Michigan	United States
University of Oxford	United Kingdom
University of Pennsylvania	United States
University of Tokyo	Japan
University of Toronto	Canada
University of Washington	United States
University of Wisconsin - Madison	United States
Yale University	United States