

THEMATIC ANALYSIS
BIBLIOMETRIC EFFECT OF HIGHER EDUCATION INSTITUTIONS
FROM THE REPUBLIC OF SRPSKA

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I INTRODUCTION

In 2021, the Agency for Higher Education of Republika Srpska (the Agency) initiated and, together with the Center for Evaluation in Education and Science (CEON) from Belgrade, Serbia in the period 2021-2022 conducted research on the bibliometric performance of higher education institutions from Republika Srpska (hereinafter: Thematic analysis).

The main objective of the thematic analysis is to improve the higher education system of Republika Srpska by providing an objective and systematic overview of the scientific productivity and bibliometric performance of higher education institutions from Republika Srpska during the period 2011-2020.

In accordance with the legal and sublegal regulations in Republika Srpska, as well as practices in the European Higher Education Area, the Agency periodically conducts external evaluations of higher education institutions/study programs in relation to the Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG)¹. Although this quality assurance mechanism evaluates higher education institutions/study programs in all key areas of work, there are certain areas that are not (or not sufficiently) represented in these procedures. This primarily concerns the bibliometric performance of higher education institutions, which is the foundation for development and achieving international standards in all segments of the institution's work. In addition, the accreditation report of a higher education institution does not contain detailed data on the quality of work of each individual member of the university, which prevents a more detailed overview of relevant indicators at the level of faculties/academies of arts.

The purpose of conducting research on the bibliometric performance of higher education institutions from Republika Srpska is:

- to provide a reliable basis for conclusions about the level and quality of scientific research productivity,
- to provide guidelines for increasing the volume and quality of scientific productivity and bibliometric performance of higher education institutions from Republika Srpska,
- to encourage higher education institutions to continuously develop and improve quality assurance systems,
- to collect and process data for the preparation of strategic documents in the field of higher education and scientific research activities,
- to provide better information about the higher education system to all stakeholders, from students and researchers to decision-makers at the institutional level.

Considering that there is no institution in Republika Srpska dealing with scientometrics and collecting and processing bibliometric data, the Agency conducted a public procurement procedure through a competitive call published on the Public Procurement Portal for the purpose of research on the bibliometric performance of higher education institutions from Republika Srpska. Only one bidder, the Center for Evaluation in Education and Science (CEON), responded to the call and met all the

¹ The Standards and Guidelines for Quality Assurance in the European Higher Education Area

conditions stated in the competitive call for public procurement, with which the Agency concluded a contract for services for the collection and processing of bibliometric data.

II BIBLIOMETRIC PERFORMANCE

The collection and processing of bibliometric data was carried out by CEON, in accordance with the Service Procurement Agreement, concluded between the Agency and CEON after the public procurement procedure.

CEON is an independent scientific and technological institution based in Belgrade. It brings together researchers and experts from several regional research and development organizations who deal with issues of evaluation in science and higher education. A significant part of CEON's activities is dedicated to the development of information systems used for evaluation purposes. CEON is networked with international groups, organizations, and associations dealing with evaluation, scientometrics, and scientific publishing. CEON has national and regional citation databases in which the largest number of journals published by authors employed at universities and colleges of Republika Srpska are indexed.

The scientific (bibliometric) performance has been determined for 9 universities, as well as their 74 faculties, and for 9 higher education institutions of Republika Srpska². The basis for measuring bibliometric performance is the CEON model, which is designed for evaluating scientific entities of small developing countries (middle-income, catching-up, emerging economies/countries). These are countries whose universities cannot be evaluated within well-known evaluation systems (ARWU/"Shanghai List", THE WU Rankings, QS WU Rankings, Leiden Rankings, etc.), due to the insufficient representation of their researchers' papers and citations in the scientific databases used by these systems as sources for determining performance.

2.1 Performance Indicators

The selection and definition of performance indicators, as well as the overall methodology for evaluating scientific performance, are derived from the general doctrine of evaluative bibliometrics, CEON's Principles for Evaluating Science in Small Developing and Transition Countries (SDTC), and relevant guidelines from leading international regulatory institutions, contained in the documents: The San Francisco Declaration on Research Assessment (DORA), the Leiden Manifesto for Research Metrics, and the Berlin Principles on Ranking of Higher Education Institutions.

The following performance indicators have been established for measuring scientific performance:

- Productivity expressed as the absolute number of published papers,
- Productivity expressed as the absolute number of published paper fractions,
- Impact of papers expressed as the absolute number of citations received,
- Impact of papers expressed as the absolute number of citation fractions received.

² The bibliometric performance also included the College for Information Technology, Economics, and Entrepreneurship, which has since ceased operations.

Additionally, the following "normalized indicators" of productivity and impact have been established:

- Cumulative productivity expressed as the number of articles weighted using CEON's standard formula (R_p),
- Cumulative average productivity per researcher expressed as the number of articles weighted using CEON's standard formula (R_i),
- Cumulative impact expressed as the number of citations weighted using CEON's standard formula (C_p),
- Cumulative average impact per researcher expressed as the number of citations weighted using CEON's standard formula (C_i).

Under the term "researcher," each employee holding the title of associate or professor was considered. The number of researchers at a particular faculty (or college) was determined by summing the fractions/portions of employees based on their percentage of employment engagement. Additional information regarding the teaching staff and their engagement fractions at higher education institutions was requested to establish normalized indicators of scientific performance.

The following weighting factors were used for weighting articles/citations:

- In an international journal - 5 points,
- In a regional journal - 3 points,
- In a national journal - 2 points.

Additionally, the following "relative performance indicators" were established:

- Relative citation index - the number of citations per article (C/R),
- Annual productivity growth indicator ($Pu+$).

Although additional indicators were not explicitly provided for in the contract, it was agreed upon by CEON and the Agency to include them, as the data processing revealed that, despite some limitations, they possessed satisfactory measurement characteristics and added utility value.

2.2 Period Covered by the Measurement of Scientific Performance

The measurement of scientific performance covered the period from 2011 to 2020. A thematic analysis defined the observation of this ten-year period not only due to the significance of the data and the tracking of trends for each evaluation entity and the overall higher education system but also due to the insufficient scientific productivity of researchers from Republika Srpska, which complicates adequate statistical data processing and differentiation of higher education institutions.

2.3 Sources for Measuring Scientific Productivity

The following global and regional citation databases were used as sources for measuring scientific productivity:³

- The international database Web of Science Core Collection: SCI, SSCI, A&HCI, and Conference Proceedings, which includes 24,200 scientific journals,
- The regional database SouthEast European Science Advanced through Evaluation (SEESAmE) with 500 journals,
- The regional database SCI Index Plus with 520 journals,
- A sample of 25 national journals in Republika Srpska.

The list of 25 journals published in Republika Srpska was selected according to criteria such as being highly categorized by the ministry responsible for scientific research and being licensed in DOAJ⁴.

2.4 Data Collection and Processing

An article/paper was considered any contribution recorded in any of the citation databases/collections that has an abstract and references, regardless of its editorial classification. A paper authored by someone from a higher education institution in Republika Srpska was considered any paper whose author team includes at least one affiliation from the List of Higher Education Institutions in the Republic of Srpska. The same criterion was used when counting citations. Incomplete affiliations, where only the university was mentioned, were assigned to faculties/colleges through an agreement between the Agency and CEON.

After processing the data, scientific performance data were determined:

- For both dimensions of performance:
 - Productivity expressed as the number of published papers and paper fractions, and
 - Impact of papers expressed as the number of citations received and citation fractions, and
- For three levels of journal excellence from which the data were sourced:
 - Global,
 - Regional, and
 - National level.

After generating raw results for both dimensions of performance and all three levels of excellence, the variables were assigned certain weighting factors, as specified for the weighting of articles/citations in Chapter 2.1, in agreement with the Agency and CEON.

³ The status of the databases used, along with the number of journals covered, is provided in the Help section of CEON's web application.

⁴ The list of these journals is given in Appendix 3 of the Help section of CEON's web application.

2.5. Consolidated Results of Scientific Performance

The consolidated bibliometric performance result encompasses both dimensions: productivity and impact. It is determined as a "composite score of four normalized indicators." All four indicators were previously transformed to a percentile scale. When calculating the composite score as the average percentile, the following weighting factors (weights) were used:

- Rp - weighting factor 2
- Ri - weighting factor 1
- Cp - weighting factor 3
- Ci - weighting factor 2

The weighting factors were determined arbitrarily, based on the general view that citation count is a more important component than productivity and that the number of articles published under a certain affiliation is more significant than that number expressed as an average per researcher.

The consolidated bibliometric performance result is expressed in points obtained by transformation onto a scale ranging up to 35 points. This scoring scale was established to enable comparison and consolidation of bibliometric performance data with data obtained through the accreditation evaluation process of the teaching quality at faculties/higher education institutions. Given the equal contribution of the teaching process and bibliometric performance to enhancing the quality of work at higher education institutions, both bibliometric performance and the evaluation of the teaching process at faculties/higher education institutions were assigned the same weight (35 points). The correlation between bibliometric performance and the evaluation of the teaching process at faculties/higher education institutions was also calculated, amounting to 0.64. Therefore, the upper limit of bibliometric performance was set at 21 points (the maximum number of points in the evaluation of the teaching process at faculties/higher education institutions on a scale of up to 35 points). The lower limit was forcibly set to zero to avoid the artifact that faculties with zero bibliometric performance would have some non-zero number of points.

2.6. Information and Collaboration with Institutions

Higher education institutions were involved in the bibliometric performance research from the very beginning and actively collaborated as partners with the Agency and CEON. At the request of the Agency, higher education institutions regularly provided the requested documentation related to segments of their work that are crucial for measuring scientific performance, primarily regarding the engaged teaching staff (for the presentation of normalized bibliometric performance indicators).

In May 2021, a seminar titled "Bibliometric Foundations of Bibliometric Performance" was held via the Zoom application. The seminar presented the methodology for collecting and processing bibliometric data, the citation databases that would be used for measuring scientific performance, and the dimensions of scientific productivity (productivity and impact)⁵. Representatives from all higher education institutions in Republika Srpska attended the seminar.

⁵ <https://www.avors.org/index.php/sr/ins-i-uci-vis-r-br-v-nj-r-publi-srps/433-drugi-seminar-za-visokoskolske-ustanove-orangiraniu>

Throughout 2021-2022, Agency representatives presented the significance of bibliometric performance in the context of developing and improving the quality assurance system at various seminars and conferences.

2.7. Period of Thematic Analysis

The thematic analysis of bibliometric performance was carried out from March 2021 to July 2022.

2.8. Presentation of Scientific Performance Results

The scientific performance results of higher education institutions in Republika Srpska were delivered by CEON in an Electronic Report (Web application) as well as in a Tabular (Excel) overview.

The Electronic Report is in the form of a PHP MySQL web application. It has an open-source code and an open architecture, allowing for the integration of modules for registration and login, in case of selective access approval for certain user categories. The application is available in both Serbian (Cyrillic and Latin scripts) and English. It includes tabs: Help, Questions and Answers, and Comments (forms for reporting potential errors), as shown in Figure 1.

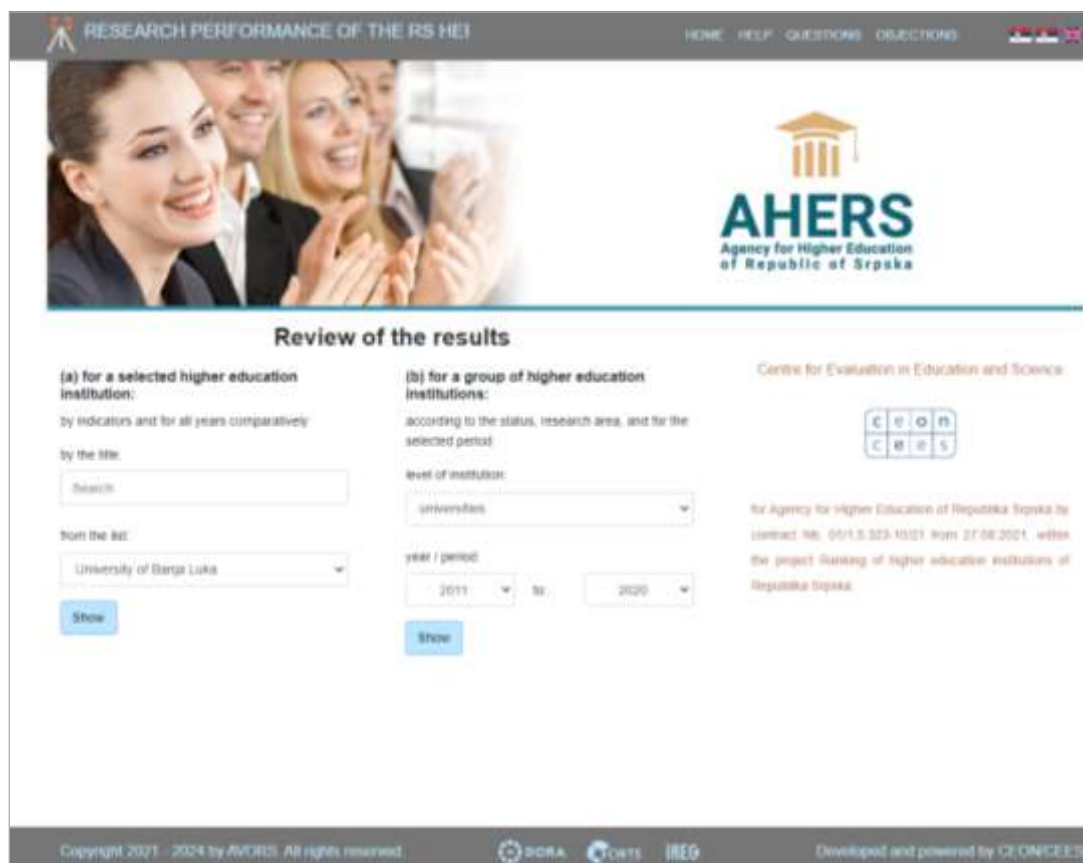


Figure 1. Homepage of the Scientific Performance Web Application of the Republic of Srpska

The review of results can be done for (a) a selected institution individually and (b) for a group of higher education institutions at a chosen level and for a selected period. When the level of faculties/colleges is selected, the display can also be sorted according to their association with a specific Frascati field.

By selecting the institution level and the desired period, a table displaying performance across all bibliometric indicators will appear, as shown in Figure 2.

R	Name of institution	Productivity						Impact						Relative indicators					
		global		regional		national		global		regional		national		productivity		impact		relative	
		Rg	Rgf	Rr	Rrf	Rn	Rnf	Cr	CrF	Cr	CrF	Cr	CrF	Rp	RpF	Ri	RiF	CR	CRF
1	...	148	171.1	33	13.4	178	160.9	421	160.9	48	13.8	36	16.9	1034.0	10.37	1487.0	37.44	3.7	1.67*
2	...	99	21.1	31	31.0	39	39.8	209	111.5	11	13.3	22	27.9	911.0	8.81	1011.0	18.81	2.3	1.87*
3	...	81	41.0	35	10.9	136	160.0	31	20.7	40	10.3	40	16.2	884.0	10.21	889.0	17.51	2.8	1.96*
4	...	75	11.0	31	10.9	31	30.0	136	29.4	9	9.8	37	17.9	422.0	3.98	519.0	6.89	1.8	1.60
5	...	39	11.1	5	3.0	47	21.7	16	13.8	1	1.0	11	1.3	211.0	3.83	491.0	4.38	1.4	1.18
6	...	31	5.8	5	2.3	50	47.0	48	13.0	9	9.9	30	41.7	248.0	4.81	421.0	6.81	1.1	1.31*

Figure 2. Display of Scientific Performance by Universities

Indicators in the table are marked with a code, and their full description is provided in tooltips. Searching across all indicators is supported. Institutions are initially (by default) sorted according to productivity (the number of published articles) in globally significant journals (first column). This table also allows access to the list of articles and citations published under the affiliation of a specific institution (Figure 4).

On the page displaying institutions at the faculty/college level, it is possible to view results by the Frascati field to which they are assigned.

For each observed entity, data on the bibliometric profile of the institution can be obtained. Productivity is shown both in tabular form and graphically, using line charts. Performance achieved in journals of all three levels of excellence is expressed in terms of the number of articles in both absolute and fractional forms, as shown in Figure 3.



Figure 3. Productivity Over the Years for the Selected Entity

Insight into the list of articles published under the affiliation of the higher education institution is provided. The link leading to the list is only set on the numbers with absolute, not fractional, values, i.e., those in rows Rp, Rr, R, and Σ. Articles in the list are presented in abbreviated bibliographic format, i.e., only with the name of the first author, and sorted by the number of citations received. A link to the list of citing works is provided with each citation, as shown in Figure 4. The list is searchable.

Published papers x

1. Skipina i dr. [2011], OPTICAL MATERIALS, 33: 1578 - 1584 Citirano: 16 ▼
2. Jelic i dr. [2011], THERMOCHIMICA ACTA, 521: 211 - 217 Citirano: 15 ▼
3. Jelic i dr. [2011], THERMOCHIMICA ACTA, 526: 252 - 256 Citirano: 15 ▼
4. Vidovic i dr. [2011], POLYHEDRON, 30: 16 - 21 Citirano: 10 ▼
5. Marjanovic i dr. [2011], CROATIAN MEDICAL JOURNAL, 52: 235 - 244 Citirano: 9 ▼
6. Nalesnik i dr. [2011], Medicinski glasnik, 8: 163 - 168 Citirano: 8 ▼
7. Ponorac i dr. [2011], Journal of Medical Biochemistry, 30: 135 - 140 Citirano: 6 ▼
8. Stijak i dr. [2011], ORTHOPEDICS, 34: 431 - 431 Citirano: 6 ▼
9. Spasojevic D. i dr. [2011], SURGICAL AND RADIOLOGIC ANATOMY, 33: 313 - 318 Citirano: 5 ▼
10. Setrajcic P. i dr. [2011], MODTECH 2011: NEW FACE OF T.M.C.R., VOL I AND II, 545 - 548 Citirano: 4 ▼
11. Radmanovic-Burgic i dr. [2011], PSYCHIATRIA DANUBINA, 23: 64 - 68 Citirano: 4 ▼
12. Radovanovic i dr. [2011], ACTA PHYSIOLOGICA HUNGARICA, 98: 449 - 455 Citirano: 3 ▼
13. Sokolova-Djokic i dr. [2011], JOURNAL OF BUON, 16: 170 - 173 Citirano: 2 ▼
14. Nikolic i dr. [2011], ANATOMICAL RECORD-ADVANCES IN INTEGRATIVE ANATOMY AND EVOLUTIONARY BIOLOGY, 294: 1506 - 1510 Citirano: 2 ▼
15. Vujić i dr. [2011], Journal of Medical Biochemistry, 30: 131 - 134 Citirano: 1 ▼
16. Gavric i dr. [2011], CENTRAL EUROPEAN JOURNAL OF MEDICINE, 6: 372 - 377 Citirano: 1 ▼

Figure 4. List of Articles from a Specific Category

The impact is presented in the same way as productivity, as shown in Figure 5."



Figure 5. Impact Over the Years for the Selected Entity

Figure 6 illustrates the performance profile of the academic institution in the form of a radar (spider) diagram. The diagram on the left presents the comparative performance on simple indicators of productivity and impact, while the diagram on the right showcases the performance on complex, normalized indicators."

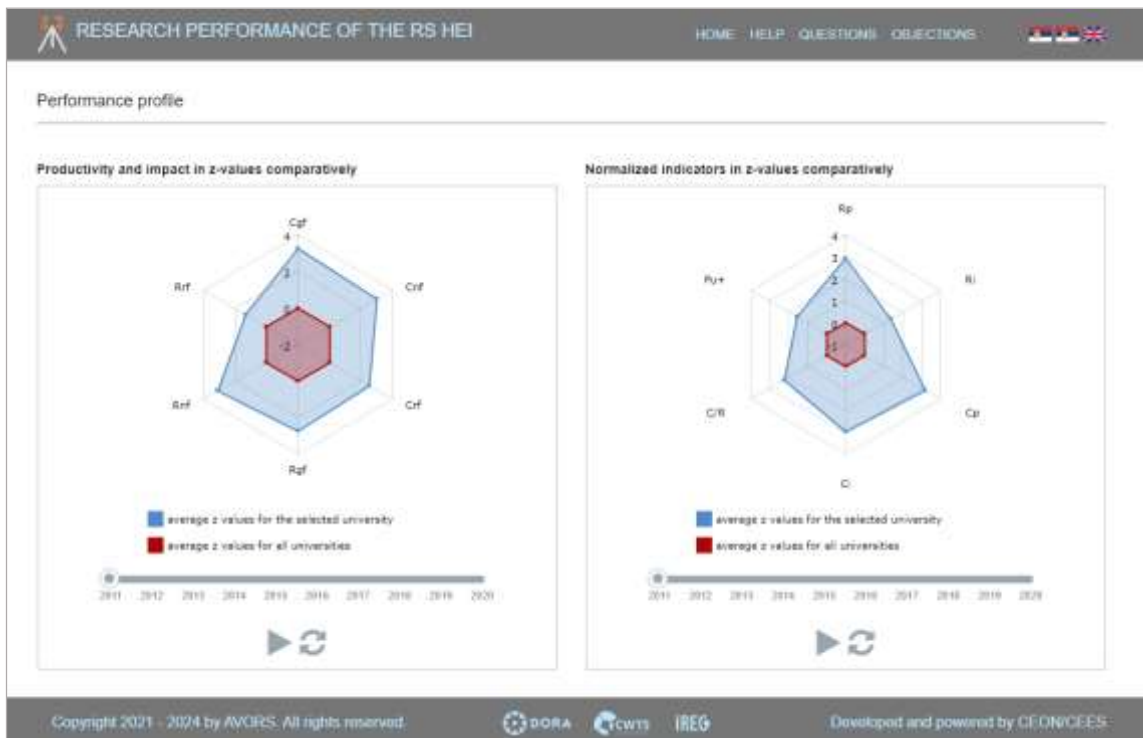


Figure 6. Performance Profile for the Selected Entity

The results are expressed in z-values to enable:

- Comparison of indicators relative to the average of all analyzed institutions ($z=0$, red color), as well as institutions classified in the field to which the institution belongs (green color) and simultaneously,
- Comparison of the results achieved by the institution on individual indicators to identify those where the institution achieves better or worse results.

The institution's performance is better if the points describing its profile are farther away from the intersection of the diagram axes. The diagrams are dynamic and can be activated by clicking the arrow. Additionally, the Agency has been provided with a tabular overview of the results in the form of an Excel file tailored for transfer to the Agency's application and potential integration with the results of the evaluation of the teaching process and other aspects of the work of higher education institutions."

III Conclusion

Thematic analysis of the bibliometric performance of higher education institutions in Republika Srpska has been conducted in line with the principles of transparency and multidimensionality, fulfilling the objectives and purposes of its implementation.

The analysis revealed that scientific publications during the observed period are not at a satisfactory level, both in terms of the number of published papers and their citation impact (expressed by the number of citations). However, an upward trend in the number of papers published in journals of global significance can be observed over the ten-year period, which is certainly related to incentive measures for publishing in indexed journals by the competent ministry and the institutions themselves.

From the outset, higher education institutions have been actively involved in researching bibliometric performance and collaborating with the Agency CEON as partners. Through a detailed insight into the methodology of evaluating scientific research and data on the results of scientific performance over the ten-year period, higher education institutions are further motivated to develop and improve the quality assurance system, increase scientific productivity, and enhance international visibility and recognition.

The obtained bibliometric evaluation data represent valuable sources for identifying, planning, and developing future strategic guidelines for the development of the higher education system and scientific research activities. Thematic analysis has also made a significant contribution to better informing all stakeholders in the higher education system, from students and researchers to decision-makers at the institutional level.

Thematic analysis has demonstrated the exceptional importance of measuring scientific performance and, at the same time, the incompleteness of the higher education system in Republika Srpska due to the lack of an institution or analysts within existing institutes who would be capable of conducting bibliometric searches and monitoring the scientific productivity of researchers from Republika Srpska. Therefore, one of the relevant tasks for the next period should preferably be a systematic approach to training researchers for measuring scientific performance and establishing an institution (or center within existing institutes) responsible for evaluation in science and education.