

Research Activities at the University of Maribor

Dean Korošak

University of Maribor, Slomškov trg 15, 2000 Maribor, Slovenia
dean.korosak@um.si

1 Introduction

The University of Maribor (UM), established in 1975, is a distinguished public institution, the second largest university in Slovenia and the leading academic institution in Eastern Slovenia region. The university is committed to research excellence [1] and fosters a stimulating environment for remarkable research achievements [2]. The University of Maribor actively pursues new knowledge, collaborates with national [3] and international research organizations [4], engages students in research work and projects, and contributes to society's development and economic progress, both regionally and globally.

From the regulatory perspective, UM research structure and governance strictly adheres to Scientific Research and Innovation Activities Act [5], while also aligning with the Resolution on the Slovenian Scientific Research and Innovation Strategy 2030 [6]. Both national key legislative documents include directives for implementation of open science principles into legal framework of national research institutions and forward research assessment reforms.

The UM ingrains open science principles into its organizational structure by, for example, adopting the Open Access to Research Infrastructure policy [7]. This policy mandates that all researchers, both within and outside the institution, can access the university's high-quality research infrastructure. This open-access approach not only accelerates scientific innovation but also ensures equitable access to vital research tools. By leveraging technology and to support the university's open access to research infrastructure policy, the UM has developed and implemented an application (BriUM) designed as a digital gateway to UM's diverse research facilities and resources. It not only simplifies the process of searching, reserving and utilizing the university's research infrastructure, but also encourages international collaboration and knowledge exchange.

Intertwined with research performed at UM are the efforts of the university to rethink and propose research assessment reforms with the goal to move towards responsible use of metrics like publication count and citation impact together with more comprehensive and

qualitative evaluations. These evaluations consider factors such as societal impact, interdisciplinary collaborations, and researcher contributions to the national and global scientific community, ultimately nurturing a more inclusive and innovative research environment in Slovenia.

UM together with eight other European universities: Hellenic Mediterranean University (HMU), Maria Curie-Skłodowska University (MCSU), Niccolò Cusano University (NCU), Polytechnic Institute of Porto (IPP), University of Orléans (UO), University of Siegen (US), University of Vigo (UV), Vilnius Gediminas Technical University (VGTU) formed ATHENA university alliance [8] to develop and build a new European university from the unique and complementing educational and research potentials of the alliance members. In this contribution to the ATHENA Research Book Volume 2 we first look at UM's research landscape and analyze the fit of UM with other members of ATHENA from a research perspective. We then follow with some observations of ATHENA research potential and discuss the potential of research cooperation of the alliance.

2 The Research Landscape

Over its nearly fifty-year existence, the research efforts at the UM have undergone substantial changes. Initially, the university primarily focused on engineering disciplines. However, over time, research activity at UM expanded into wider and more comprehensive exploration and now includes all major scientific fields. This transition emphasizes the university's dedication to fostering interdisciplinary collaboration and promoting diverse research activities.

In order to analyze the current research landscape at UM and to illustrate some of its key points, we used bibliographic data for UM obtained from Clarivate's Web of Science (WOS) Core Collection database [9].

We gathered data on current highly cited publications from UM (hcUM), the publications that cited these UM's top research papers and the overall research production in the last 15 years (15Y). In Table 1 we show the overlap of most frequent science categories of UM's own publication record between hcUM and the 15Y publication data (Table 1, column Publications). The column Citations in Table 1 shows the most frequent science categories of the overlap between publications that cited hcUM and 15Y UM's research work. These two columns reflect UM's research output and impact, respectively.

Table 1. Intersection between science categories of highly cited papers and all UM's publications in last 15 years in top 30 categories (data: WOS [9]) for UM's research output and impact.

	Publications	Citations
0	Materials Science Multidisciplinary	Materials Science Multidisciplinary
1	Mathematics Applied	Physics Particles Fields
2	Chemistry Multidisciplinary	Environmental Sciences
3	Physics Particles Fields	Engineering Electrical Electronic
4	Environmental Sciences	Multidisciplinary Sciences
5	Physics Multidisciplinary	Chemistry Multidisciplinary
6	Astronomy Astrophysics	Physics Multidisciplinary
7	Multidisciplinary Sciences	Green Sustainable Science Technology
8	Medicine General Internal	Astronomy Astrophysics
9	Energy Fuels	Mathematics Applied

Table 1 shows that engineering and natural sciences are both strong research areas at UM in research output as well as with its impact.

To assess the change in the research landscape and to discover rising research areas at UM, we searched for the science categories in highly cited publication data that do not appear in the list of most frequent science categories for UM in the last 15 years. In table 2 we show the detected rising fields using this approach separately for research output (column Publications) and impact (column Citations).

Table 2. Rising fields in publications and impact: science categories of highly cited works that were not in 30 top categories in overall UM research production in the last 15 years (data: WOS [9]).

	Publications	Citations
0	Physics Mathematical	Gastroenterology Hepatology
1	Engineering Environmental	Immunology
2	Neurosciences	Telecommunications
3	Biology	Medicine General Internal
4	Biophysics	Computer Science Theory Methods
5	Cardiac Cardiovascular Systems	Cell Biology
6	Computer Science Theory Methods	Neurosciences
7	Gastroenterology Hepatology	Nutrition Dietetics
8	Green Sustainable Science Technology	Pharmacology Pharmacy
9	Nutrition Dietetics	Genetics Heredity

Such comparison shows that UM is trending towards Life Sciences, Computer Science, Environmental Engineering in recent years. This is in accordance with the research strategy that UM adopted which lists these non-exclusive research orientations [10]: (1) Advanced Materials and Technologies, (2) Health and Safe Food, (3) Smart Energy and Circular Systems, (4) Artificial Intelligence and ICT.

It is interesting to contrast these with the Research Priorities set by ATHENA university alliance [11]: (1) Sustainable Materials and Energy, (2) Emerging Manufacturing Technologies, (3) Artificial Intelligence, (4) Information & Communication Technologies, (5) Digital society & digital arts, (6) Health & Food Technologies, (7) Assistive technologies.

Although not completely overlapping, UM does seem to fit well with the ATHENA research landscape. An attempt at mapping UM research orientations to ATHENA research priorities could go like this: (UM) => (ATHENA), (1) => (1,2), (2) => (6), (3) => (1), (4) => (3,5).

Besides the well fit of UM research landscape with ATHENA research priorities there are also opportunities for UM research growth with ATHENA. To find complementary research fields of UM and ATHENA members, we looked for research fields in top 20 fields of each ATHENA member that do not occur in top 20 fields of UM. Table 3 shows top two fields for each pair. For example, from the data for the last five years we find these top two complementary fields for UM - UV pair: 'Food Science Technology', 'Biochemistry Molecular Biology'.

Table 3. ATHENA research opportunities for UM. The list of top 20 ATHENA research fields in not found in the list of top 20 UM research fields (data for the last five years: WOS [9]).

	research field 1	research field 2
HMU	Telecommunications	Plant Sciences
UO	Astronomy Astrophysics	Geosciences Multidisciplinary
NCU	Telecommunications	Neurosciences
US	Computer Science Theory Methods	Computer Science Interdisciplinary Applications
MSCU	Biochemistry Molecular Biology	Physics Condensed Matter
UV	Food Science Technology	Biochemistry Molecular Biology
IPP	Computer Science Artificial Intelligence	Computer Science Interdisciplinary Applications
VG TU	Engineering Civil	Economics

3 The vision of ATHENA research-based cooperation

The analysis presented in the previous section and its extension to all pairs of ATHENA universities alliance could inform the alliance on potential opportunities in fostering further mutual research cooperation. Here, to get a first look at the structure of ATHENA research space we constructed two graphs showing links between pairs of ATHENA members: a co-publication graph where two universities are linked if they share joint publications, and a cooperation graph where two universities are linked if they share institutions in their research collaboration. Such an analysis of research data helps us to start to understand the strengths and opportunities of ATHENA research space.

Figure 1 shows the co-publication graph of ATHENA. The links connect pairs of universities that share publications. The structure of the network might tell us something about the current state of ATHENA research collaboration.

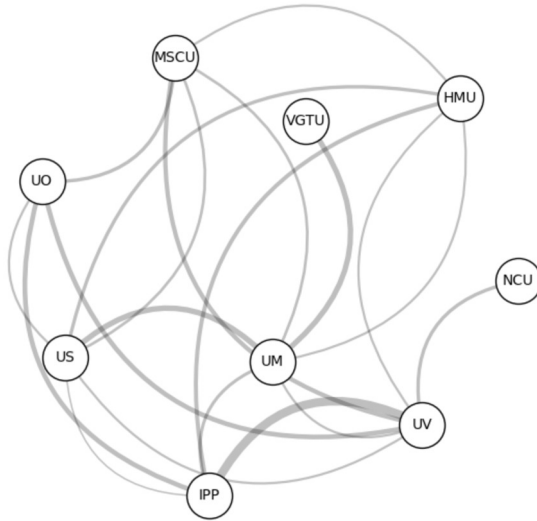


Figure 1. ATHENA university alliance co-publication graph (data from WOS [9]). The thickness of edges between the nodes (universities) indicates the strength of research cooperation as detected from number of joint publications.

Looking at the number of links per node or the degree of the node we notice that NCU and VGTU are connected only to one partner, while other ATHENA members share more links. We also computed the betweenness centrality of each node and explore the triads in the network or 3-node motifs. UV and UM emerge as central figures, with high betweenness centrality values (0.28, 0.29), suggesting they frequently serve as bridges in the shortest path between other universities. This is reinforced by their frequent appearance in various triadic 3-node motifs (12 and 10 out of 21), indicating their participation in numerous triadic collaborations. US, while having a moderate betweenness centrality, is also a common element in many 3-node motifs, suggesting its significant role in multi-institution collaborations. The presence of HMU (9) and UO (5) in a good number of triadic collaborations also shows their integral role in the network despite their lower betweenness centrality. NCU and VGTU, with their betweenness centrality of 0, do not appear in any of the 3-node motifs. This highlights their peripheral role in the network and suggests potential opportunities for them to increase their involvement in multi-university collaborations.

To construct a cooperation graph we mapped ATHENA Research Priorities into following WOS science categories: Green & Sustainable Science & Technology; Engineering, Manufacturing; Computer Science, Artificial Intelligence; Food Science & Technology; Computer Science, Information Systems; Health Care Sciences & Services; Art. We then gathered lists of research partners that collaborated on publications for each ATHENA university in all these science categories. From intersections of the lists of research partners (top most frequent 30 institutions) we finally obtained the cooperation graph shown in Figure 2. In this graph two nodes are linked in they share common research partners. So research partners of alliance members serve as coupling elements between them and indicate towards potential new collaborative research opportunities.

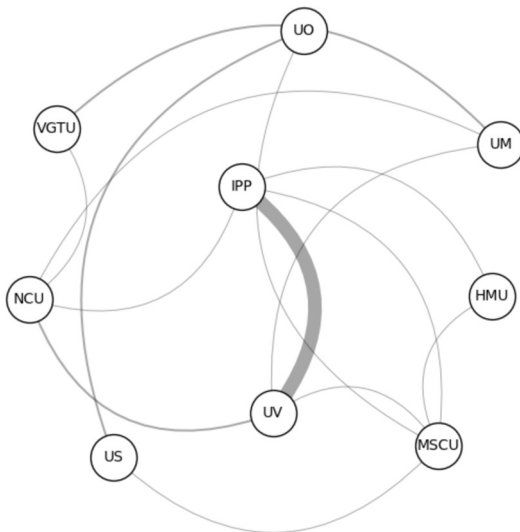


Figure 2. Graph of ATHENA alliance from overlap of top 30 partnering institutions for each pair of members (for example, this corresponds top 3 % of all research partners of UM)

Here, in contrast with publication collaboration graph, MSCU and UV serve as important bridges in the network with highest betweenness centrality. Both institutions are also most frequent in 3-node graph motifs (3 out of 6).

With this couple of examples of research landscape analysis we tried to quickly illustrate how the strengths, opportunities and challenges for research collaboration with ATHENA and wider can be explored using bibliographic data. The development of the methodology to follow and analyze research output of ATHENA alliance and in particular detect missing links that can strengthen the alliance can in our view be one of the important future tasks of the ATHENA Research Board.

References

- [1] <https://www.um.si/wp-content/uploads/2021/11/Strategy-of-the-University-of-Maribor-2021-2030.pdf>
- [2] <https://www.um.si/en/research/>
- [3] <https://www.um.si/en/research/about-research/international-and-eu-projects/ongoing-projects/>
- [4] <https://www.um.si/en/research/about-research/national-research-programmes-and-projects/>
- [5] <http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO7733>
- [6] <http://www.pisrs.si/Pis.web/pregledPredpisa?id=RESO133>

-
- [7] <https://www.um.si/en/research/raziskovalna-infrastruktura/open-access-policy-for-research-infrastructure-at-the-university-of-maribor-2/>
 - [8] <https://athenauni.eu/>
 - [9] <https://www.webofscience.com/wos/woscc/>
 - [10] <https://www.um.si/en/research/about-research/research-orientation/>
 - [11] <https://athenauni.eu/research/rd-roadmap-shared-resources-directory/research-priorities/>

