WESTERN BALKANS
RESEARCH AND INNOVATION INFRASTRUCTURE ROADMAP

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* This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence

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4S	•	Smart Specialisation Strategy of Serbia
AL	•	Albania
BA	•	Bosnia and Herzegovina
CEESDA	•	Consortium of European Social Science Data Archive
CEFTA	•	Central European Free Trade Agreement
CERIC	•	Central European Research Infrastructure Consortium
CERN	•	European Organisation for Nuclear Research
CRM	•	Common Regional Market
DARIAH	•	Digital Research Infrastructure for the Arts and Humanities
DIH	•	Digital Innovation Hub
EBAN	•	European Business Angel Network
EBRD	•	European Bank for Reconstruction and Development
EC	•	European Commission
eLTER	•	Long-Term Ecosystem Research in Europe
ENEF	•	Enterprise Expansion Fund
ENIF	•	Enterprise Innovation Fund
EOSC	•	European Open Science Cloud
ERA	•	European Research Area
ERIC	•	European Research Infrastructure Consortium
ESA	•	European Space Agency
ESFRI	•	European Strategy Forum on Research Infrastructures
ESS-ERIC	•	European Social Survey
EU	•	European Union
EUROCC	•	National Competence Centres in the framework of EuroHPC
EuroHPC JU	•	European High Performance Computing Joint Undertaking
HL•LHC	•	High-Luminosity Large Hadron Collider
HPC	•	High-Performance Computing
ICT	•	Information and Communication Technologies
ME	•	Montenegro
MK	•	North Macedonia
NI4OS-Europe	•	National Initiatives for Open Science in Europe
R&D	•	Research and Development
R&I	•	Research and Innovation
RCC	•	Regional Cooperation Council
RI	•	Research Infrastructure
RS	•	Serbia
S3	•	Smart Specialisation Strategy
SEAF	•	Small Enterprise Assistance Funds

SEE	• South East Europe
SEEIIST	• International Institute for Sustainable Technologies in South East Europe
SME	• Small and Medium Enterprises
STP	• Science Technology Park
UK	• United Kingdom
UNICEF	• United Nations Children's Fund
USAID	• US Agency for International Development
VC	• Venture Capital
WB	• Western Balkans
WB EDIF	• Western Balkans Enterprise Development & Innovation Facility
WB6 CIF	• Western Balkans 6 Chambers Investment Forum
WBESS	• Western Balkans ESS Regional Network
WBIF	• Western Balkans Investment Framework
WHO	• World Health Organisation
WITSA	• World Information Technology and Services Alliance

EXECUTIVE SUMMARY

In line with the Common Regional Market (CRM) Action Plan 2021-2024 and the Western Balkans Agenda on Innovation, Research, Education, Culture, Youth & Sport (WB Innovation Agenda), Regional Cooperation Council (RCC) aims to assist the development of Research and Innovation (R&I) infrastructure by creating the first Western Balkans Roadmap of Research and Innovation Infrastructures (WB Roadmap). WB Roadmap is a strategic policy document that sets out an overall vision for research and innovation infrastructure in the Western Balkans (WB) and the major steps needed to achieve it. It identifies R&I capabilities and opportunities for increasing interconnectivity, promotes the WB as a reliable partner in R&I and sets out the key recommendations to reach the long-term vision.

The main purpose of the WB Roadmap is to identify the potential for collaboration between the WB economies in the area of R&I. Given the limited R&I capacities of individual economies, the joint efforts of the Western Balkans economies have the potential to enhance the overall R&I potential of the region and of individual economies. The WB Roadmap highlights existing R&I resources and infrastructure that can support the launch of joint initiatives by the WB economies in R&I.

By encompassing different initiatives undertaken in WB economies, this report focuses on mapping internationally and regionally relevant R&I infrastructures in the WB region and activities that are open to a wide range of users to undertake excellent research and innovation. In addition, WB Roadmap presents a regional bibliometric analysis of the most productive scientific disciplines against the background of existing research infrastructures (RIs) and recommends fields the region should focus on in the future to increase its competitive edge.

Research Infrastructures in the Western Balkan Region

Limited R&D funding common to all WB economies is one of the causes of the non-competitiveness of domestic RIs at the European level and insufficient integration of research institutions in the large pan-European RIs. In most WB economies, existing RI facilities are outdated and mainly used for educational purposes, with limited use for research purposes. WB economies are participating only in a few high-level European RIs: Serbia participates in 5 ESFRI projects, North Macedonia and Bosnia and Herzegovina in 1, while Albania, Kosovo* and Montenegro are the only European economies that do not participate in any of the ESFRI European RIs.

Regarding the current state of RIs in ESFRI thematic areas, the general conclusion is as follows:

- ***Energy:*** WB economies are not participating in ESFRI research projects and landmarks in the area of energy, and have very limited access to other pan-European RIs. They are connected to CERN in different ways.

- ***Environment:*** The WB economies have participated in 63 projects, receiving an EC contribution of 10.68 million euros, which is only 0.34% of the total EC contribution to this thematic priority.
- ***Health and Food Sciences:*** All WB economies generally agreed to participate in the development of the first regional RI: The South East European International Institute for Sustainable Technologies. It is important to highlight the Antares project (worth 28 million euros) implemented by the Biosense Institute, Serbia. The project aims to evolve the BioSense Institute into a European Centre of Excellence for advanced technologies in sustainable agriculture and food security. Montenegro has established the first centre of excellence: BIO-ICT Centre of Excellence. These two projects are proofs of the exceptional potential in the entire region in this thematic area.
- ***Physical Sciences and Engineering:*** Serbia is the only WB economy that participates in the CERN's project of high importance: High-Luminosity Large Hadron Collider - HL-LHC. WB economies have participated in only 3 out of a total of 1,451 H2020 projects within the thematic area of physical sciences.
- ***Social and Cultural Innovation:*** WB economies are well represented in pan-European RIs in this area. Serbia is participating in CESSDA, ESS-ERIC, OPERAS and DARIAH; Bosnia and Herzegovina and Albania participate in RESILIENCE; Bosnia and Herzegovina has recently become a member of DARIAH, while most WB economies conducted at least one Social survey coordinated by ESS-ERIC.
- ***E-Infrastructures:*** *A*ccording to the strategic policy frameworks, the Information and Communication Technologies (ICT) sector represents an absolute priority in WB economies. However, the WB region is lagging behind the EU in terms of using High-Performance Computing (HPC). The WB's research network shows high level of research collaboration between WB economies with the important role of EU and neighbourhood economies.

Innovation Infrastructures in the Western Balkan Region

The innovation ecosystem has been developing rapidly in the last few years in all WB economies. However, it is still in its infancy and more efforts need to be invested to continue this trend. The WB region lacks venture capital on the level of individual economies as well as on the macro-regional level. The future of the region's startup ecosystem lies in the greater availability of venture capital markets.

Innovation infrastructures in the WB region are mainly providing their clients with pre-incubation services, training and education activities, networking, advice on the development of new products and services, etc. The least reported are services related to the venture capital market and business angel networks access services.

There is low cooperation between innovation infrastructures in the WB region. However, given that some innovation infrastructures have reported tight cooperation with universities, their models and approaches should be explored further to identify possible models and space for cooperation between universities and innovation infrastructures in the region.

Based on the analysis of key vertical sectors supported by innovation infrastructures in the WB region, it could be concluded that the ICT and Creative Industries are the most supported areas. Innovation infrastructures are mainly focused on providing support to startups in these sectors.

Research Specialisations in the WB Region: Bibliometric Analysis

Research specialisation of WB economies is placed against the Smart Specialisation Strategy (S3) priorities of WB economies that adopted or have identified priority areas in the process of designing their S3. The WB economies that have identified S3 priorities are Albania, Montenegro, North Macedonia and Serbia. For all WB economies, the first twenty Web of Science (WoS) research areas with the largest stocks of knowledge in the period 2010-2021 are identified, and, in addition, the stock of knowledge is compared to the S3 priorities for those WB economies that have performed the S3.

S3 priorities and most productive scientific disciplines in WB economies:

- ***Albania:*** The largest number of research papers by Albanian authors in WoS in the period 2010-2021 is in the field of environmental sciences, which corresponds to the S3 priority Water and Energy" The second, ICT, and the third S3 priority Tourism and Agritourism correspond to several identified WoS research areas.
- ***Montenegro:*** All S3 priorities directly correspond to the several identified WoS research areas.
- ***North Macedonia:*** The second S3 priority ICT and the fourth priority Electrical Equipment & Machinery Parts directly correspond to the several identified WoS research areas. Other priorities, both horizontal and vertical, can hardly be found among the first twenty WoS research areas.
- ***Serbia:*** All S3 priorities directly correspond to the several identified WoS research areas.

Recommendations for the Development of the Region's R&I Infrastructures

As a result of the analysis of the current situation of RIs in the WB region, the following policy recommendations emerge, aiming to improve the quality of the existing RIs in the region:

R1. Increase investments in research infrastructures:

R2. Ensure funding support measures at the regional level research.

R3. Improve policy research framework of some WB economies.

R4. More active participation in Large European RIs.

R5. Policy makers from the WB economies should address the challenge of lack of access to RIs and a low level of cooperation between sciences and industry.

R6. WB Roadmap should serve as infrastructural support for possible future cooperation in R&I.

R7. Development of the joint R&I Infrastructures in the WB region should be based on already established projects as well as future projects based on cooperation in R&I.

R8. The development of domestic R&I infrastructure in the WB economies should support the implementation of the S3 priorities of each WB economy.

R9. Support from domestic and EU funds for cooperation between R&I in the WB in the S&T areas is identified as the S3 priorities, which correlate with knowledge stocks recorded in WoS and Scopus databases.

R10. To enable further growth of the innovation ecosystem, the WB economies should provide greater access to finance by startups.

R11. Policy measures aimed at fostering cooperation between Innovation infrastructures in the WB region should be introduced.

R12. WB economies should create policies for increasing the internal capacities of Innovation infrastructures.

INTRODUCTION

PURPOSE OF THE DOCUMENT

Western Balkans Research and Innovation Infrastructure Roadmap (WB Roadmap) is a strategic policy document that sets out an overall vision for research and innovation infrastructure and the major steps needed to achieve it. This strategic document aims to offer enormous benefit in increasing our understanding of the Western Balkans (WB) current capability, and in planning for the future. It will identify research and innovation (R&I) capability priorities, identify opportunities for increasing interconnectivity, promote the WB as a reliable partner in R&I, and set out the key recommendations to reach the long-term vision. The WB region includes the following 6 economies: Albania (AL), Bosnia and Herzegovina (BA), North Macedonia (MK), Kosovo* , Montenegro (ME) and Serbia (RS).

Many EU economies develop research infrastructure (RI) roadmaps as tools to support strategic planning and to identify current strengths and priorities. RI Roadmaps ensure transparent, merit-based support for the long-term investments needed to develop RIs not only at economy level, but of macro-regional and EU relevance as well. RIs represent the basic tools for conducting excellent research. Considering that in today's world, these infrastructures are becoming increasingly complex, and therefore increasingly expensive, it is important to ensure that investments in RIs are as effective and efficient as possible. RIs were also found to have strong effects on networking and human capital development in the sense that they catalyse learning processes and knowledge-sharing, help create formal and informal social networks, and they are a strong factor in determining researcher mobility and support capacity building.

The WB region has also undertaken similar exercises. Montenegro was the first WB economy which developed its first RI Roadmap in 2015 and a revised version in 2019. Serbia developed the first RI Roadmap in 2018, while other WB economies have adopted RI roadmaps in 2021 with the support provided by the Regional Cooperation Council (RCC). The need to update and broaden our understanding of the current R&I capability and future needs of the entire WB region has been raised by the RCC. The regional infrastructure roadmap is set as one of the deliverables of the Western Balkans Agenda on Innovation, Research, Education, Culture, Youth & Sport (WB agenda), which indicates the importance of this document for the future of the WB region in the area of R&I.

In line with the WB agenda and in the context of supporting the implementation of the Common Regional Market (CRM) Action Plan, the RCC has undertaken to facilitate the development of R&I infrastructure by creating the first Western Balkans Roadmap of Research and Innovation Infrastructures. The WB Roadmap will contribute to the mobility of researchers, better uptake of innovative practices by businesses in the region, improved scientific cooperation and collaboration in the WB region, and building of functional links between academia and industry to enable the development of existing, and creating new enterprises and encouraging the growth of entrepreneurial universities in the region. It provides an assessment of the current

R&I infrastructure landscape and identifies opportunities for investments, and is intended to guide decision-making and identification of future priorities.

SCOPE AND DEFINITION OF RESEARCH AND INNOVATION INFRASTRUCTURE

The term 'research and innovation infrastructures' is not commonly used in the literature and accordingly, it can be interpreted in many ways. For the WB Roadmap, under research infrastructure, we have adopted the EU definition[1] which defines RIs as a set of facilities, resources and services that are used by the research communities to conduct research and foster innovation in their respective fields. They include major scientific equipment (or sets of instruments), knowledge-based resources such as collections, archives and scientific data, e-infrastructures, such as data and computing systems and communication networks, and any other tools that are essential to achieve excellence in research and innovation.

Innovation infrastructure includes infrastructure aimed primarily at the startup community and industry and set up explicitly to foster and commercialise innovation. Under innovation infrastructure, we understand a variety of business support organisations, including business incubators, science and technology parks, innovation hubs, accelerator programmes, startup centres, etc.

By encompassing the different initiatives undertaken in WB economies, we are focusing on mapping internationally and regionally relevant R&I infrastructures and activities that are open to a wide range of users to undertake excellent research and innovation.

In addition to well recognised R&I infrastructures in the WB economies, we are also seeking to capture the equipment and facilities within universities funded through capital budgets or project-specific grants.

The report consists of 3 chapters and it is organised in the following way: First, an overview and the current state of RIs in the WB region is provided according to thematic areas with a special focus on each economy individually. The second chapter presents the most important Innovation Infrastructures in the WB region for each economy separately. The third chapter provides an analysis of the scientific productivity of WB economies with a focus on identifying the most productive scientific fields. Finally, the last paragraph provides conclusions, implications of key findings and recommendations for improving the R&I infrastructure in the region.

1 The EU uses the definition of Research Infrastructures as specified in Article 2 (6) of the Regulation (EU) No 1291/2013 of 11 December 2013 - Establishing Horizon 2020 – the Framework Programme for Research and Innovation 2014-2020

1. RESEARCH INFRASTRUCTURES IN THE WESTERN BALKANS REGION

METHODOLOGICAL REMARKS

This section is based on the document analysis and systematic evaluation of RI Roadmaps of WB economies. In total, 6 policy documents have been reviewed to identify the most important RIs on the domestic and international levels for each WB economy. Therefore, while 6 RI roadmaps have been the basis for writing this section, additional sources have also been used such as other relevant policy documents in the region (Map of Digital Innovation Hubs,[2] Network of Open Access Research Infrastructures,[3] strategic documents of individual economies, National Peer Review documents, etc.), initiatives, reports and web sources.

THE CURRENT STATE OF DEVELOPMENT OF RESEARCH INFRASTRUCTURES

RI Roadmaps, recently created by all WB economies, set the principles for the future development of RIs and showcase the existing research potential of WB economies. They assist ministries in charge of research on how to better leverage investments in RIs to ensure their domestic and international relevance, as well as to ensure their availability to the entire research and business community in the region.

Research systems in the WB economies are predominantly public-sector oriented with activities concentrated in higher education institutions, public centres and research institutes. While the region lags significantly behind EU27 when it comes to the development of RIs, individual economies are at different stages of the development of RI. Furthermore, research policy frameworks are continuously being improved although at different levels of development.

An important challenge tthe WB region is facing is the low level of R&D investments. According to the Eurostat data, Gross Expenditures on R&D in North Macedonia accounted for 0.38 percent of GDP, 0.49% percent of GDP in Montenegro, and 0.9 percent of GDP in Serbia (Eurostat database, 2021). Official data for other economies are not available.

Figure 1 shows the current state of membership in the European Strategy Forum on Research Infrastructures (ESFRI) projects and landmarks of EU and WB economies. ESFRI Research Infrastructures are facilities, resources or services of a unique nature, identified by European research communities to conduct and support top-level research activities in their domains. ESFRI selects proposals of RIs in strategic areas of research with an adequate level of maturity

2 Digital Innovation Hubs available at: https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool Digital Innovation Hubs (DIHs) and similar organisations operating in the Western Balkans: https://www.rcc.int/pubs/130/mapping-of-digital-innovation-hubs-and-identification-of-needs-within-western-balkans-and-of-prospective-regional-cooperation-actions

3 More information available at: https://www.rcc.int/working_groups/60/open-access-research-infrastructure-in-the-western-balkans-support-programme

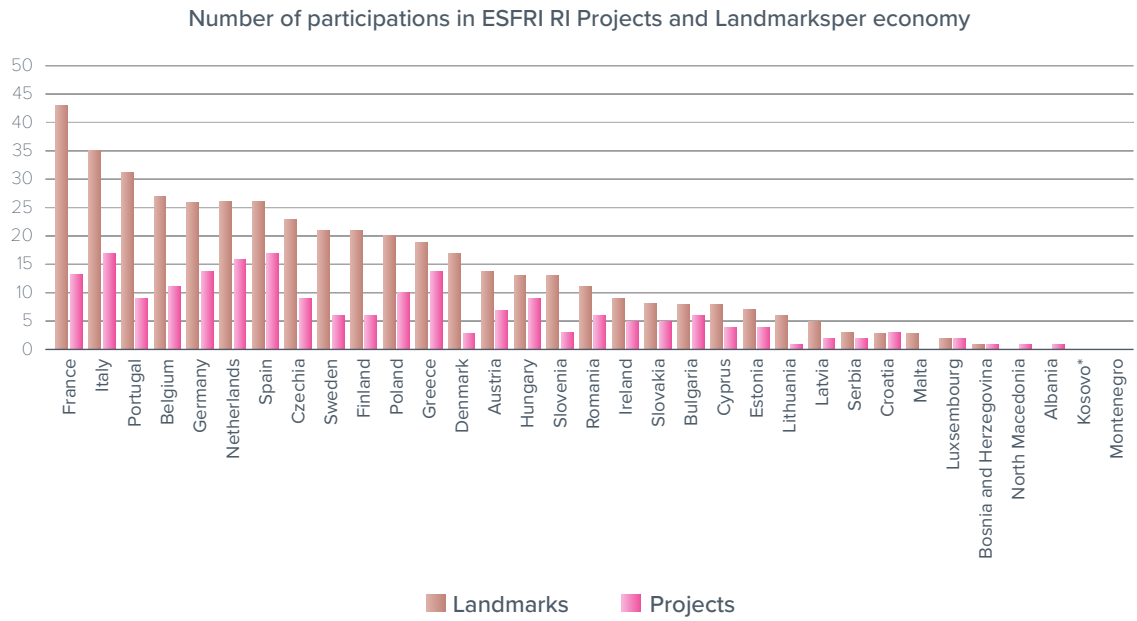
to become ESFRI Projects and identifies successfully implemented RIs to become ESFRI Landmarks

The ESFRI Projects[4] are RIs in their Preparation Phase which have been selected for the excellence of their scientific case and their maturity, according to a sound expectation that the Project will enter the Implementation Phase within the ten-year term. They are included in the Roadmap to point out the strategic importance they represent for the European Research Area (ERA), and to support their timely implementation as new RIs or major updates to existing RIs.

The ESFRI Landmarks[5] are RIs that were implemented, or reached an advanced Implementation Phase under the Roadmap and that represent major elements of competitiveness of the ERA. The Landmarks can be already delivering science services and granting user access or can be in an advanced stage of construction with a clear schedule for the start of the Operation Phase.

One can see from figure 1 that the most developed EU member states are at the forefront, while WB economies are lagging behind, participating only in a few top European RIs. Currently, Serbia participates in two projects and 3 landmarks, Bosnia and Herzegovina in 1 Landmark and 1 project, North Macedonia and Albania in 1 project, while Montenegro and Kosovo* are the only European economies that do not participate in any of the selected top European RIs.

Figure 1: Participations of EU member states and other economies in ESFRI projects



Source: Authors' calculations based on ESFRI Roadmap 2021, Strategy Report on Research Infrastructures

However, WB economies participate in the operations of several large European RIs that are not included in the ESFRI Roadmap, but are of importance for the development of European and regional RIs: GEANT Pan-European Network, European Open Science Cloud (EOSC),

4 ESFRI Roadmap 2018, Strategy Report on Research Infrastructures
5 ESFRI Roadmap 2018, Strategy Report on Research Infrastructures

Consortium of European Social Science Data Archives (CEESDA), EGI: Advanced Computing for Research, The European High Performance Computing Joint Undertaking (EuroHPC JU), etc. It is also worth mentioning that Serbia is one of the founding members of the Central European Research Infrastructure Consortium (CERIC), which provides open access to leading facilities in eight economies for research in materials science, biomaterials and nanotechnology. WB economies also contribute to the development of European e-infrastructures by participating in international projects, international associations and institutions.

The following paragraphs provide an overview of the current state of RIs in the WB economies grouped thematically within the following 6 thematic areas:

1. Energy
2. Environment
3. Health and Food Sciences
4. Physical Sciences and Engineering
5. Social and Cultural Innovation
6. E-infrastructures

It is worth noting that research infrastructures are grouped into 6 broad thematic areas, although many of them are multidisciplinary, covering more than one area.

1.1. ENERGY

THE GENERAL OVERVIEW IN THE WESTERN BALKANS REGION

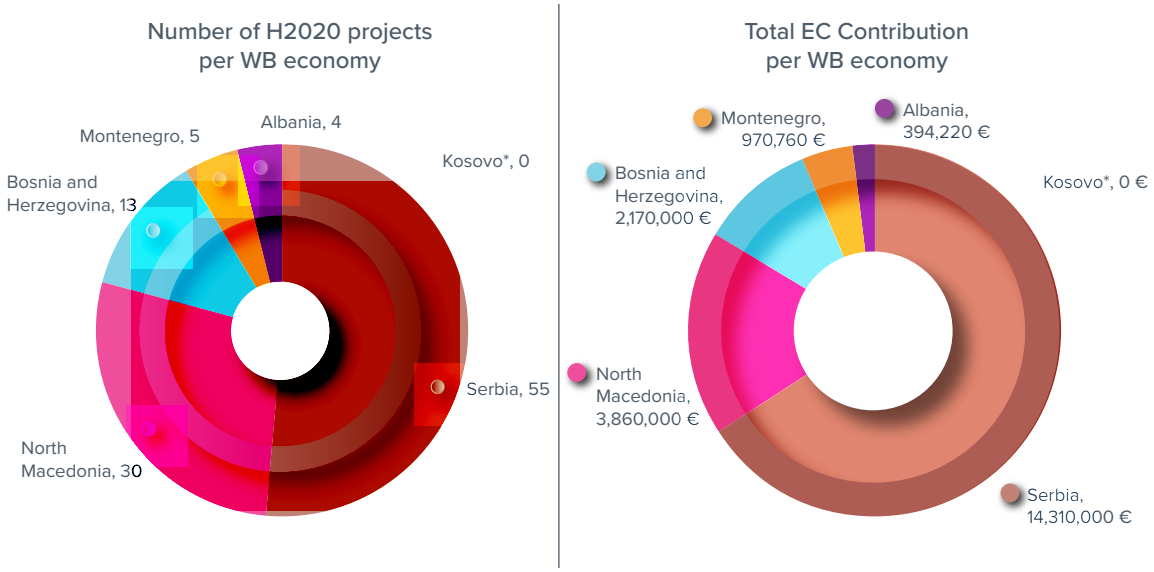
As stated in the WB Agenda, the main challenge of the WB region, excluding Albania, is its heavy reliance on coal which is fundamental to the energy sector, accounting for around 70% of electricity produced in the entire region. According to the official data provided by the International Energy Agency, Serbia accounts for 70% of electricity generated from coal, Bosnia and Herzegovina for 70%, Kosovo* for 96%, North Macedonia for 49%, Montenegro for 44%, while Albania is generating 99% of electricity from hydropower (International Energy Agency).[6] While the share of electricity production from renewable sources in the EU has increased significantly in recent years, the WB region is not making any progress. However, there are certain differences among the economies in the region. Albania is almost exclusively dependent on hydropower, while Kosovo* is almost entirely dependent on lignite-fired thermal power plants. In the context of recent dialogue that has taken place in the process of developing the WB Agenda, WB governments generally agreed to pursue a clean energy transition and sustainable development. This transition should lead to greater use of renewable energy sources, strengthen regional energy security, unlock greater economic growth, and address persistent air and related health pollution challenges.

6 More information available at: https://www.iea.org/fuels-and-technologies/electricity

While it is expected from the WB economies to start with decarbonising the energy sector, it is clear that research projects in the area of energy are needed more than ever. However, research potential is largely concentrated in research laboratories within public universities (faculties and research institutes). Research facilities owned by laboratories within the faculties are mainly used for educational purposes, while research institutes are focused on their research projects with a very limited application in the industry. Most research institutions do not have an official access policy so potential users from the industry are often unaware of the research equipment owned by research institutions.

Concerning the participation in research projects under the Horizon Europe (H2020) programme's thematic priority Secure, Clean and Efficient Energy, the WB region is highly underrepresented compared to other EU economies. The WB economies have participated in 107 projects and received an EC contribution of 21.71 million euros, which is only 0.4% of the total EC contribution in this thematic priority. Serbia and North Macedonia are far ahead of other WB economies, participating in 55 and 30 H2020 projects respectively (Figure 2).

Figure 2: Participation of WB economies in the Horizon 2020 programme's thematic priority Secure, Clean and Efficient Energy

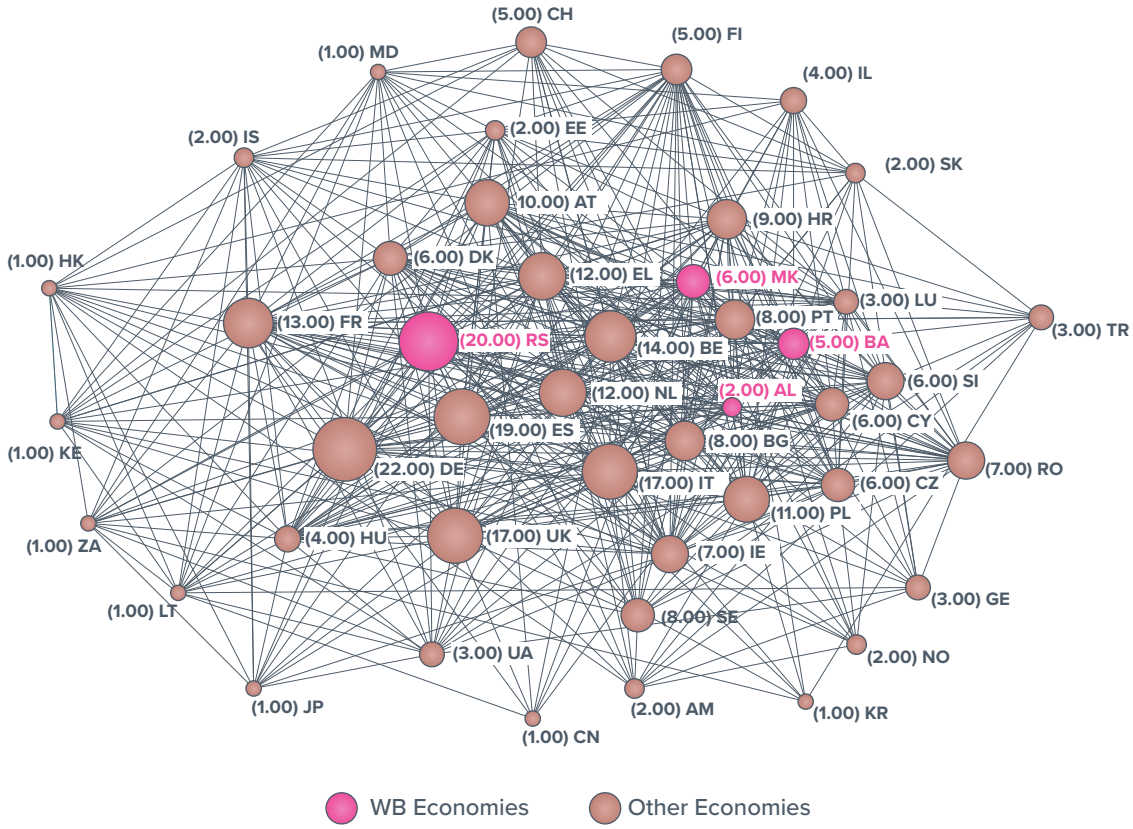


Source: Authors' visualisation based on https://cordis.europa.eu/projects/en

More than 65% of the total EC contribution (14.31 million out of 21.71 million) to the projects from the WB region was implemented by research institutions from Serbia, indicating very low research performance of other WB economies in this area.

Figure 3 shows research collaboration between the WB economies and their project partners from other economies within the H2020 projects with the application in the energy sector. Serbia is the central node in the regional network, the project cooperation between the research institutions in the WB region is rather low, while most of the partners are from Germany, Spain, Italy and the UK.

Figure 3: Research network of WB economies in H2020 projects with application in energy



Source: Authors' visualisation based on https://cordis.europa.eu/projects/en

LARGE RESEARCH INFRASTRUCTURES

Research institutions from the WB economies have very limited access to pan-European research infrastructures in the area of energy. They are not participating in 2 prospective ESFRI research projects and 3 RIs that are in the implementation phase in the area of energy.

Concerning other large pan-European RIs, most WB economies are connected with the **European Organisation for Nuclear Research (CERN)** in different ways. Serbia, as the most advanced WB economy, is an official member of CERN, participating in big projects and experiments conducted in CERN. North Macedonia, Bosnia and Herzegovina, Albania and Montenegro have signed an International Cooperation Agreement with CERN that allows them access to educational content and trainings.

For the **Euratom Research and Training Programme**, WB economies are not eligible to apply for calls under this programme. Euratom programme is important for the energy sector since it aims to pursue nuclear research and training activities with an emphasis on continually improving nuclear safety, security and radiation protection, notably to contribute to the long-term decarbonisation of the energy system in a safe, efficient and secure way. While Ukraine and UK have recently become associated, some of the WB economies are expected

to become associated with this programme shortly, which would undoubtedly enhance the research excellence of the WB region in the area of energy.

THE CURRENT OVERVIEW OF EACH WESTERN BALKANS ECONOMY[7]

Serbia

After being an Associate Member since 15 March 2012, Serbia became CERN's 23rd Member State on 24 March 2019. At the moment, there are four scientific institutions from Serbia actively participating in projects and experiments at CERN:

1. Vinča Institute of Nuclear Sciences, University of Belgrade
2. Institute of Physics, University of Belgrade
3. Faculty of Physics, University of Belgrade
4. Faculty of Sciences, University of Novi Sad

Serbian scientists and engineers have been actively involved in the design, construction and commissioning of the sophisticated CERN experiments used to investigate the fundamental building blocks of nature. As of October 2019, there were 34 scientists and engineers associated with Serbian institutions which are officially involved in CERN experiments and projects. Researchers from Serbia have been involved in the ATLAS and CMS experiments at the Large Hadron Collider (LHC), as well as in the ACE and NA61 experiments. Serbian researchers are also active in the nuclear physics experiments at the ISOLDE facility, and the GRID computing project.

The Institute Mihajlo Pupin (IMP) is one of the most remarkable research institutions in Serbia in the field of energy. It has participated in several H2020 projects in the area of energy. The primary objective of the current H2020 project (Synergy) is to unlock the innovation potential of IMP, transforming it into a macro-regional Centre of Excellence in smart energy management. Once established, as a novel regional excellence centre, IMP will promote the added value of smart energy management technologies, co-ordinate research efforts and unite scarce research resources in this field in the WB region, but also encourage communication with leading external EU parties, aiming at full integration into the European Research Area.

North Macedonia

In the process of developing its Smart Specialisation Strategy (S3), North Macedonia has identified the energy field under the domain Energy for the Future as a horizontal priority due to its strong cross-sectoral relations with other vertical priority areas and its impact on the process of greening the industry and protection of the environment.

Concerning the participation in pan-European research infrastructures in the field of energy, North Macedonia signed an International Cooperation Agreement with CERN in 2009. Within

7 Note that the order of presenting the WB economies in all thematic areas is based on the level of their sophistication rather than on the alphabetical order.

the framework of this agreement, students and high-school teachers are being sent to CERN for training and education activities. However, researchers have not participated in research projects and LHC experiments conducted by CERN.

Research institutions from North Macedonia have participated in a total of 30 H2020 projects under the Horizon programme's thematic priority Secure, Clean and Efficient Energy. This is a considerable number of projects taking into account its size and the total number of H2020 projects.

The most important research institution in the field of energy is the Ss. Cyril and Methodius University in Skopje (UKIM). It is the largest and most prestigious University in North Macedonia. The most relevant faculties in the field of energy are:

- Faculty of Mechanical Engineering, UKIM
- Faculty of Technology and Metallurgy UKIM and
- Faculty of Electrical Engineering and Information Technologies, UKIM

In addition to UKIM, the South East European University is also active in the energy field. The Laboratory for Environment and Health Group, Max van der Stoel Institute operating within South East European University, is equipped with low emissions sustainable testbed that consists of solar photovoltaic plants (100 kWp and 15 kWp), a controlled mechanical ventilation system, geothermal heat pump, solar thermal system and data monitoring system for evaluation of energy performance.

The Institute for Environment and Health leads the environmental efficiency programme at the South East European University and is a promoter and operator of the green energy initiative through the Low Emission Sustainable Campus Testbed. The main services provided are energy production and energy performance evaluation.

Albania

The energy sector is well identified in the strategic and research framework of the Government of Albania. Within the National Strategy of Science, Technology and Innovation (2017-2022), the Government of Albania envisaged the improvement of research infrastructures in the area of energy, recognising research activities in this area as important for future development. Additionally, in the process of developing S3, Water & Energy was identified as a priority area.

Albania has an active community of physicists maintaining collaboration links with various research groups in the CERN Member States. Thanks to these links, in October 2014, CERN and Albania signed an International Cooperation Agreement to establish scientific and technical cooperation in high-energy physics. This formed a base for enhancing scientific and educational contacts with CERN with the view of Albanian participation in experiments and other research projects at CERN.

Important research institutions from Albania in the Energy research area are:

- Polytechnic University of Tirana
  - Institute of Geosciences, Energy, Water and Environment,
  - Faculty of Mathematical Engineering and Physical Engineering
  - Faculty of Geology and Mining
- University of Tirana
  - Faculty of Natural Sciences

Bosnia and Herzegovina

Reviewing the strategic framework of Bosnia and Herzegovina as well as the strategic framework of the Federation of Bosnia and Herzegovina and the Republika Srpska, energy was identified as one of the priority sectors only within the Scientific and Technological Development Strategy of the Republika Srpska (2017-2021).

Bosnia and Herzegovina has recently made progress in international energy cooperation by signing an international cooperation agreement with CERN on 16 February 2021. This agreement ensures long-term opportunities for the scientists, engineers, and technicians from Bosnia and Herzegovina to participate in the research projects at CERN.

According to the RI Roadmap of Bosnia and Herzegovina, the most important research institutions conducting research activities and projects in the area of energy include:

- University of Sarajevo
  - Faculty of Mechanical Engineering (Laboratory for heating, ventilation, air conditioning and renewable energy)
  - Faculty of Electrical Engineering
- University of Tuzla:
  - Faculty of Electrical Engineering
  - Faculty of Mechanical Engineering
- University of Banja Luka
  - Faculty of Electrical Engineering
- University of East Sarajevo
  - Faculty of Electrical Engineering (Photovoltaic Power Plant and High Voltage Laboratory)
- International University of Sarajevo
  - Faculty of Engineering and Natural Sciences

Montenegro

Within its RI Roadmap, the Government of Montenegro has recognised Energy as a promising field in which Montenegro is striving to become a regional energy hub with a high degree of use of energy sources and secondary technogenic raw materials. Montenegro aims to increase the share of energy use from renewable sources, with a focus on the sustainable development of this sector. Energy has been set as a priority field within several important policy strategic documents such as Montenegro Development Directions (2018–2021); Innovation Strategy (2016-2020); Strategy of Scientific Research Activity (2017–2021) and Smart Specialisation Strategy of Montenegro (2019–2024).

Cooperation with CERN is carried out based on the Agreement on scientific and technical cooperation in the field of high-energy physics signed between the Government of Montenegro and CERN on 1 October 2007. However, Montenegro had not joined any of CERN's projects until July 2017, when they got the full membership of the CMS experiment, one of the largest LHC experiments. A research team from the University of Montenegro–Faculty of Natural Sciences and Mathematics and the Faculty of Electrical Engineering are participating in this experiment.

The most important research institutions from Montenegro in the Energy area are

- Faculty of Natural Sciences and Mathematics, University of Montenegro and
- Faculty of Electrical Engineering, University of Montenegro

Kosovo*

The Energy sector was selected as a research priority within the National Science Programme of Kosovo*. Within this strategic document, the Government of Kosovo* is aiming to ensure a better quality of life, a clean and environmentally sustainable environment and future accession to the EU.

According to the list of research infrastructures, facilities and equipment provided in the RI Roadmap of Kosovo*, it follows that research capacities in the field of energy are limited. Research projects conducted at the faculties and research laboratories are mainly oriented toward other research areas and student education.

Kosovo* has neither been involved in Pan-European RIs in the area of energy nor did they participate in H2020 projects related to research activities with the application in the energy research area. The University of Pristina is the most relevant research institution in the field of energy. The highest research productivity is achieved by researchers from the Faculty of Mechanical Engineering and the Faculty of Mathematics and Natural Sciences, University of Pristina.

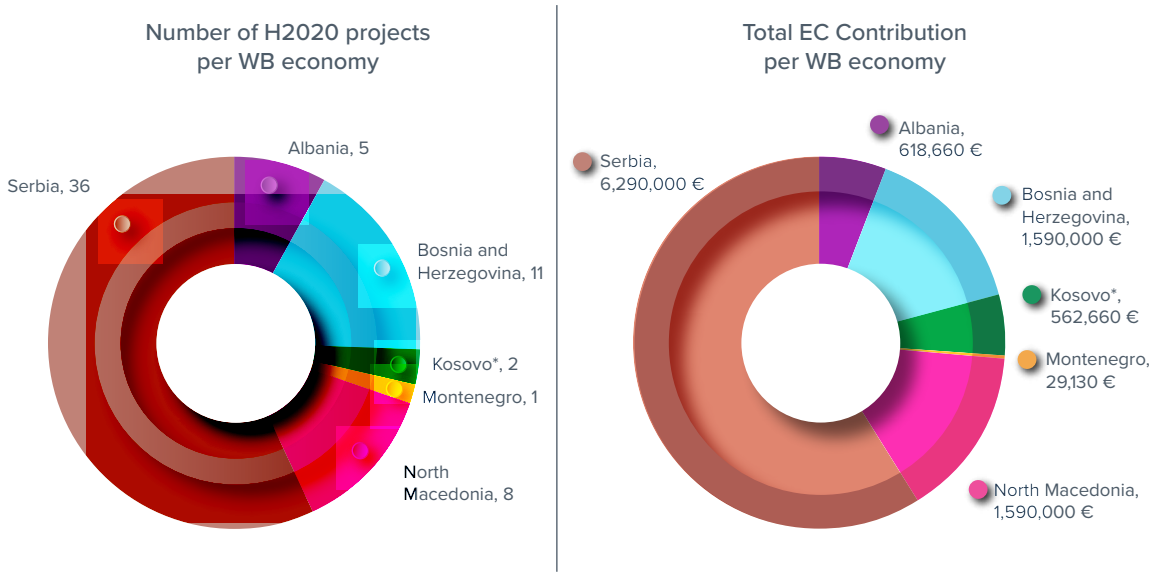
1.2. ENVIRONMENT

THE GENERAL OVERVIEW OF THE WESTERN BALKANS REGION

Global challenges in the area of environment typically require global solutions. Working in an international arena and partnering internationally is a key characteristic of the environmental science community and RIs that support it. Therefore, the high level of cooperation with other international RIs and organisations is a necessary condition for research excellence in this sector.

According to the level of participation of WB economies in the Horizon 2020 programme's thematic priority: Climate Action, environment, resource efficiency and raw materials, it follows that, except for Serbia whose organisations have participated in 36 projects, other WB economies have achieved low participation in this thematic priority (Figure 4). Looking at the entire region, the WB economies have participated in 63 projects, getting an EC contribution of 10.68 million euros, which is only 0.34% of the total EC contribution in this thematic priority.

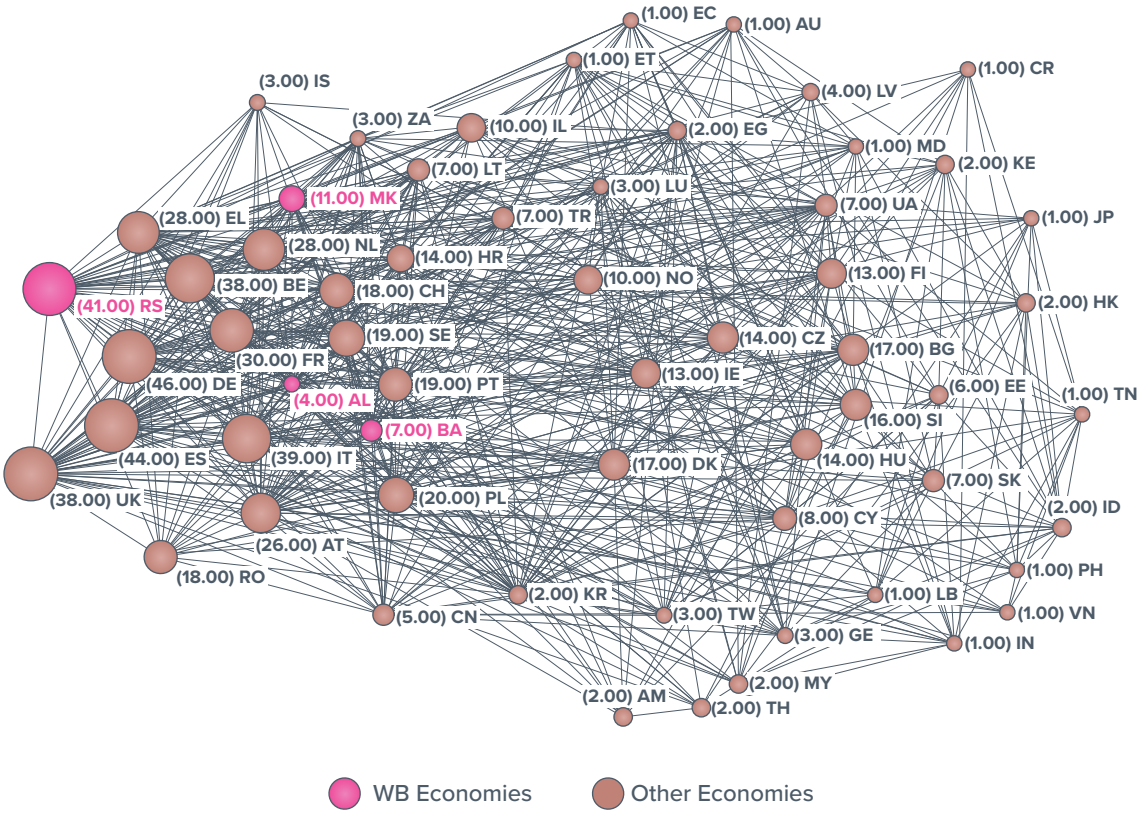
Figure 4: Participation of WB economies in the Horizon programme's thematic priority: Climate action, environment, resource efficiency and raw materials



Source: Authors' visualisation based on https://cordis.europa.eu/projects/en

Figure 5 shows extracted research network that includes H2020 projects with the application in the environment sector with at least one participant from the WB economy. The Research network of WB economies shows that Serbia is the central node in the network while the most important research partners are from Germany, Spain and Italy. Research cooperation within the region is weak with the insignificant role of other WB economies.

Figure 5: Research network of WB economies in H2020 projects in the field of environment



Source: Authors' visualisation based on https://cordis.europa.eu/projects/en

LARGE RESEARCH INFRASTRUCTURES

Concerning Large European RI in the area of environment recognised by ESFRI, Serbia is a member of one distributed RI: **eLTER (Long-Term Ecosystem Research in Europe)**. The text below provides more information on this RI.

eLTER (Long-Term Ecosystem Research in Europe)

The Long-Term Ecosystem Research in Europe (eLTER) is a distributed RI which aims at integrating traditional natural sciences and holistic ecosystem research approaches, including studies of the human component, to better understand ecosystems. Through research and monitoring, eLTER seeks to improve knowledge of the structure and functions of ecosystems and their long-term response to environmental, societal and economic drivers. eLTER will provide indispensable integrated data sets – abiotic, biotic and societal, covering all system structures and functions – for system model development and validation, hence supporting predictions and decision-making in an interdisciplinary framework and collaboration with other in situ, domain-specific RIs.

eLTER is now in the preparatory phase on the way to becoming a fully-fledged RI. The Preparatory Phase Project, funded by the European Commission (2020-2025) will support

this process. eLTER RI will comprise National RIs, and European level Central Services, such as data access, training and harmonised methods and parameters.

LTER-Serbia

Serbia's network for Long-Term Ecosystem Research presents the basis for communication and coordination of scientists and institutions that actively contribute to the long-term research of ecological systems. It is a network of several research institutions and LTER infrastructure. On the economy level, it has been established since December 2008. It was accepted as a member of the global LTER network in August 2009, provided that it proves its operational capability within two years. At the moment, 3 of 13 LTER Serbia sites are active.

THE CURRENT OVERVIEW OF EACH WESTERN BALKANS ECONOMY

Serbia

Unlike ICT and agricultural sciences, which are usually prioritised in many strategic documents, Serbia has neglected the environment sciences and environment sector in general in its strategic documents for many years. However, although this area is not particularly recognised and supported by the Government, the research performance is not negligible. With 6.017 papers published in the period 1996-2021 and an H-index of 97 (Scimago Country Rank), Serbia is the leading economy in the WB region and competitive with EU members in the region such as Bulgaria, Croatia and Slovenia.

By joining the Pan-European RI eLTER, Serbia is expected to improve its knowledge of the structure and functions of the ecosystem and its long-term response to environmental, societal and economic drivers. Participation in pan-European RIs is important because of the acquisition of new knowledge and improvement of research performance through cooperation with the most eminent European researchers in this field.

In terms of the total number of published papers in the area of environmental sciences, the most important research institutions in Serbia are:

- Faculty of Technical Sciences, University of Novi Sad
- Faculty of Architecture, University of Belgrade
- Faculty of Geography, University of Belgrade
- Geographical Institute Jovan Cvijić of Serbian Academy of the Sciences and Arts
- Institute of Architecture and Urban & Spatial Planning of Serbia
- Faculty of Forestry, University of Belgrade
- Faculty of Transport and Traffic Engineering, University of Belgrade

North Macedonia

Reviewing the current strategic framework of North Macedonia, it could be concluded that the environment is not among the prioritised sectors. With only 686 research papers published by researchers from North Macedonia in the area of environmental sciences, it belongs to the group of low-performance economies compared to the EU average and even compared to the WB economies (Scimago Country Rank). Research institutions from North Macedonia are not integrated into large pan-European RIs operating in the area of environment which indicates limited research excellence, including research productivity as the number of publications per researcher. Therefore, much more effort is needed in the period ahead to improve the existing indicators.

According to the RI Roadmap of North Macedonia, the following research institutions stand out in this area:

- Faculty of Natural Sciences and Mathematics, University St Cyril and Methodius, Skopje
- Faculty of Agricultural Sciences and Food, University St Cyril and Methodius, Skopje
- The Public Scientific Institution: Hydrobiological Institute Ohrid
- Institute for Environment and Health
- Faculty of Natural and Technical Sciences, Goce Delchev University

Bosnia and Herzegovina

Research institutions from Bosnia and Herzegovina are not participating in large pan-European RIs in the area of environment. At the same time, they have participated in 11 international projects within the Horizon 2020 programme's thematic priority: Climate action, environment, resource efficiency and raw materials. The main type of institutions in these projects from Bosnia and Herzegovina are NGOs, associations, foundations, municipalities and regional agencies, with no participants from the universities. It shows that H2020 projects in which Bosnia and Herzegovina has participated are mostly coordination and support actions, while the participation in research and innovation actions is missing.

Researchers from the main universities in Bosnia and Herzegovina are mainly oriented toward educational and publishing activities. Researchers from Bosnia and Herzegovina published 781 papers in the area of environmental sciences from 1996 to 2021, achieving the H-index of 41 (Scimago Country rank). Although these are modest results, Bosnia and Herzegovina is the second-ranked WB economy in terms of the number of published papers in this area.

According to the RI Roadmap of Bosnia and Herzegovina, the following research institutions are engaged in research activities in the area of environment:

- Faculty of Science, University of Sarajevo
- Faculty of Forestry, University of Sarajevo
- Faculty of Technology, University of Tuzla,
- Biotechnical Faculty, University of Bihać,

- Faculty of Mine Engineering, University of Banja Luka
- Faculty of Natural Sciences and Mathematics, University of Banja Luka
- Institute for Protection and Ecology of the Republika Srpska, Banja Luka,
- Agricultural Institute of the Republika Srpska, Banja Luka,
- Institute for Applied Geology and Water Engineering IPIN, Bijeljina.

Albania

The environment sector was selected as one of the priority sectors for the evaluation and improvement of the domestic research infrastructures in Albania within the National Strategy of Science, Technology and Innovation (2017-2022). While this could be a good basis for the future development of the environment sector, according to the current state, research performance in this sector is modest. Research institutions from Albania are not members of large pan-European RIs and research activities are mainly oriented toward educational activities. Researchers from Albania have published 690 papers in international peer-reviewed journals in the area of environmental sciences in the period 1996-2021, achieving the H-index of 33 (Scimago Country Rank).

Albanian entities participated in only 4 H2020 projects within the thematic priority: Climate action, environment, resource efficiency and raw materials, receiving 319,660 euros of direct EU contribution.

According to the RI roadmap of Albania, the most important research institutions in this area are:

- Faculty of Natural Sciences, University of Tirana
- Faculty of Agriculture and Environment, Agricultural University of Tirana
- Polytechnic University Tirana

Montenegro

With a relatively low absolute number of researchers, it is clear that Montenegro's research capacity in the field of environmental sciences is limited. Like most other WB economies, Montenegro does not participate in Large RIs at the European level. Geological Survey of Montenegro is the only institution that has participated in one H2020 project in the area of environment. Concerning publication productivity, researchers from Montenegro have published 455 papers in international peer-reviewed journals and achieved an H-index of 26 (Scimago Country rank).

In terms of the research institutions that have the highest number of published research papers in international peer-reviewed journals in the area of environment, the main research potential of Montenegro lies within the University of Montenegro, particularly:

- Institute of Marine Biology, University of Montenegro,
- Faculty of Natural Sciences and Mathematics, University of Montenegro
- Faculty of Technology and Metallurgy, University of Montenegro

Kosovo*

Looking at the current research priority areas identified in the National Science Programme, the Natural Resources, Energy and Environment thematic priority has been recognised as one of the priority areas by the Government of Kosovo*. However, while this could be a good sign for the future development of this sector, current research performance is poor.

Institutions from Kosovo* have been engaged in 2 H2020 research projects related to the environment sector. Their collaboration with the other institutions from WB economies is weak.

The University of Pristina accounts for the largest share of research activities and research facilities in the area of environment. However, researchers are mainly oriented toward educational activities.

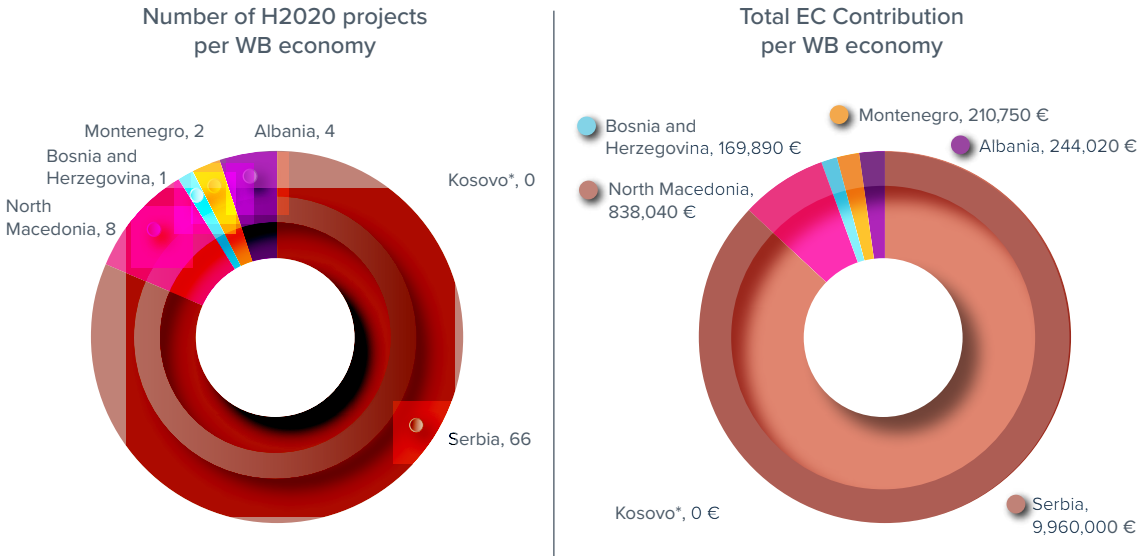
1.3. HEALTH AND FOOD SCIENCES

THE GENERAL OVERVIEW OF THE WESTERN BALKANS REGION

Health and Food Sciences are one of the most prioritised research fields in WB economies. Strategic framework and policy instruments in the region are in favour of these two areas (although they are treated together here, health and food are often treated as two separate areas in most strategic documents). As a result of the great potential of this sector in the region, all WB economies generally agreed to participate in the development of the first regional RI: the South East European International Institute for Sustainable Technologies. More information on this initiative is provided in the paragraph below.

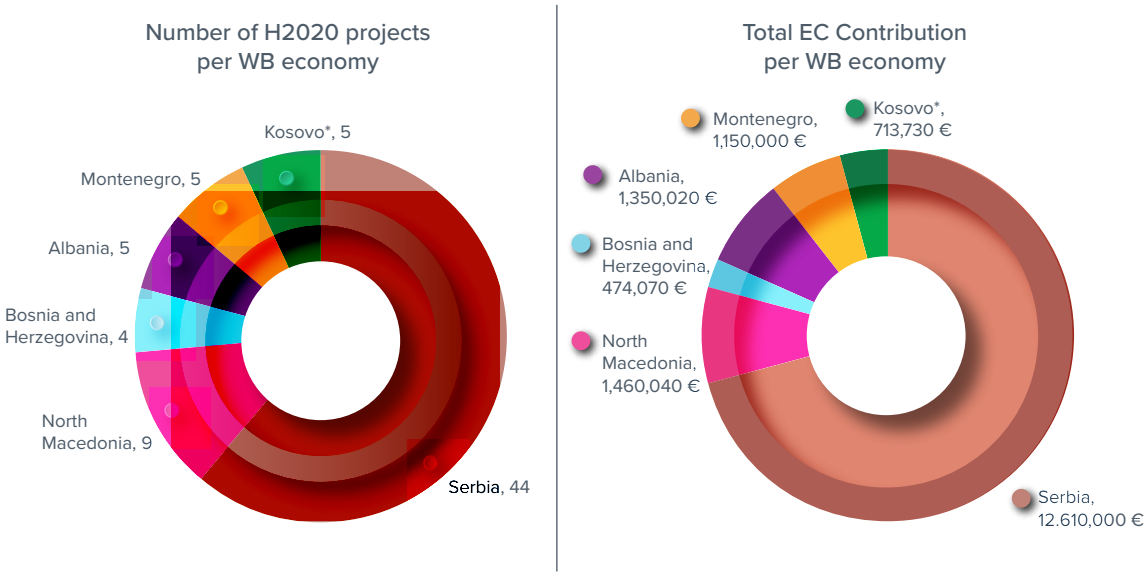
With regard to the participation of the WB economies in Horizon 2020 projects within the thematic priority Food Security, Sustainable Agriculture and Forestry, Serbia is the leading WB economy with significantly higher participation in H2020 projects compared to other WB economies. (Figures 6 and 7).

Figure 6: Participation of WB economies in the Horizon 2020 programme's thematic priority Food Security, Sustainable Agriculture and Forestry



Source: Authors' visualisation based on https://cordis.europa.eu/projects/en

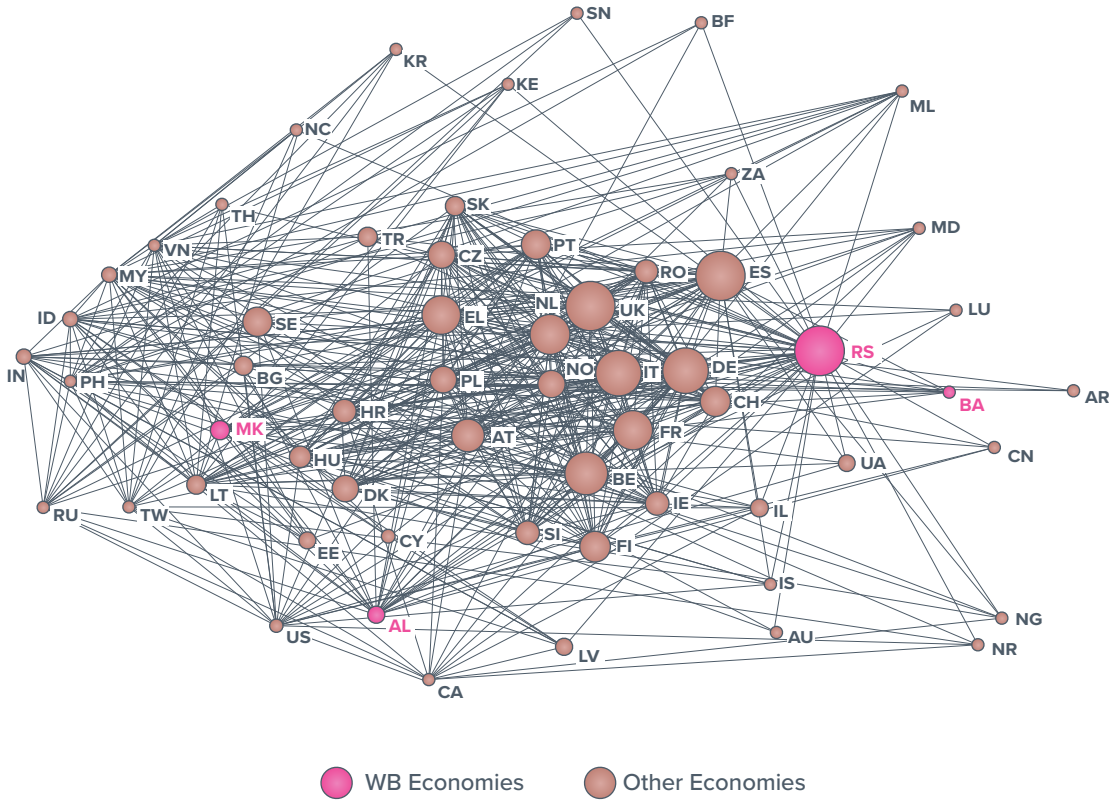
Figure 7: Participation of WB economies in the Horizon 2020 programme's thematic priority Health, Demographic Change and Wellbeing



Source: Authors' visualisation based on https://cordis.europa.eu/projects/en

Figure 8 shows extracted research network that includes H2020 projects with the application in the health and food sector, with at least one participant from the WB economy. The WB economies' research networks show a similar pattern as other areas: Serbia holds the central node in the network while the most important research partners are from Germany, Spain, Italy, France and the UK. Research cooperation within the region is weak with the insignificant role of other WB economies.

Figure 8: Research network of WB economies in H2020 projects in the field of health and food



Source: Authors' visualisation based on https://cordis.europa.eu/projects/en

LARGE RESEARCH INFRASTRUCTURES

When it comes to Pan-European RIs, WB economies are participating in one ESFRI project: **Infrastructure for Promoting Metrology in Food and Nutrition (METROFOOD-RI)**. Particularly, North Macedonia is a member of this RI with high scientific potential and international relevance.

Additionally, WB economies are cooperating on the development of the regional project: **the South East European International Institute for Sustainable Technologies** which is in the design phase and is supposed to have a great regional impact.

More information on the two projects is provided below.

Infrastructure for Promoting Metrology in Food and Nutrition - METROFOOD-RI

METROFOOD-RI is an ESFRI approved (2021) distributed European RI for promoting metrology in food and nutrition. Supported by the H2020 INFRADEV-02-2019 CSA METROFOOD-PP project (GA 871083), METROFOOD-RI moves towards its preparatory phase. It provides high-quality metrology services in food and nutrition, comprising an important cross-section of highly interdisciplinary and interconnected fields throughout the food value chain, including agrifood, sustainable development, food safety, quality, traceability and authenticity, environmental safety, and human health.

METROFOOD-RI consists of physical infrastructure and electronic infrastructure to coordinate and integrate existing networks of plants, laboratories, experimental fields/farms for crop production/animal breeding, small-scale plants for food processing and storage, and kitchen labs for food preparation.

The project consortium involves 48 institutes from 18 European economies (15 member states and 5 associated economies). Italy is the leading partner. The Institute of Public Health of North Macedonia is one of 20 beneficiaries and Ss. Cyril and Methodius University, North Macedonia is one of 28 linked parties that make a consortium.

The South East European International Institute for Sustainable Technologies

The South East European International Institute for Sustainable Technologies (SEEIIST) is a regional project formalised through the Declaration of Intent on 25 October 2017, signed at the Ministerial Conference held at CERN, Geneva, by eight signatories from the South East Europe (SEE) region.

After the signing of the Declaration of Intent in October 2017 at CERN, the Initiative was transformed into a regional project gathering the following Parties: Albania, Bosnia and Herzegovina, Bulgaria, Kosovo*, North Macedonia, Montenegro, Serbia and Slovenia.

After analysing common regional social and economic challenges and needs for high technologies, Steering Committee members decided to support the Hadron Cancer Therapy and Biomedical Research with Protons and Heavy Ions as the main research area for the Institute.

The main missions of the SEEIIST Project include the following: science for peace; scientific excellence; international collaboration; sustainable development of society; education; technology transfer; development of a powerful digital network; and high-performance computing and Big Data handling.

Project members:

- Albania, Ministry of Education Sport and Youth
- Bosnia and Herzegovina, Ministry of Civil Affairs
- Bulgaria, Ministry of Education and Science, Sofia University St. Kliment Ohridski
- Kosovo*, Ministry of Education and Science
- North Macedonia, Ministry of Education and Science, Ss. Cyril and Methodius University Skopje, Faculty of Natural Sciences and Mathematics, Institute of Physics
- Montenegro, Clinic for Oncology and Radiotherapy, Clinical Centre of Montenegro, Ministry of Science
- Serbia, Ministry of Education, Science and Technological Development
- Slovenia, Ministry of Education, Science and Sport

Observers:

- Croatia, Ministry of Science and Education
- Greece, Division of International and Transnational Organisations, Directorate of International Science and Technology Cooperation, General Secretariat for Research and Technology, Ministry of Education, Research and Religious Affairs

The SEEIIST project is currently entering the next phase of implementation - the design study development phase. The final implementation of the project is not certain, however, if it gets implemented, it will offer numerous opportunities for technological transfer to the WB economies.

THE CURRENT OVERVIEW OF EACH WESTERN BALKANS ECONOMY

Serbia

Serbia has remarkable research results in the fields of health and food even at the European level. One of the most important research institutions in the field of health and food sciences in Serbia is BioSense Institute, University of Novi Sad. BioSense is Serbia's centre of excellence and the most successful institution in the H2020 programme in Serbia. Besides the number of relevant research projects, one current H2020 project of particular importance is Antares.

Project Antares

Antares (2017-2024) project, worth 28 million euros, aims to evolve the BioSense Institute, Serbia into a European Centre of Excellence for advanced technologies in sustainable agriculture and food security. The project is developing smart sensors and big data technologies that could help farmers produce more food in a way that is sustainable for society, farm incomes and the environment. The massive amount of data is interpreted using artificial intelligence and an app, which is being developed, will help make the findings accessible to farmers.

It is also worth noting that the Government of Serbia has taken preparatory actions for the construction of a new Institute: Biofor. Preparations are already underway, and a detailed regulation plan is being drafted. As part of the new institute, there will also be a technology park. A new RI is intended exclusively for biomedical research related to the production of drugs, vaccines, and diagnostics. The new scientific institution will gather young scientists from higher education institutions that deal with these scientific fields: Faculty of Medicine, Faculty of Pharmacy, Faculty of Biology, Faculty of Mechanical Engineering, Faculty of Technology and others.

North Macedonia

North Macedonia has not had an actual strategic policy document in the field of research and science since the last version of the National Programme which expired a few years ago. However, the Government of North Macedonia is currently in the process of developing S3

and according to the results of the entrepreneurial discovery process (EDP), food processing with high added value is recognised as one of the priorities of the Strategy. S3 process has confirmed that the food sector is the priority domain in which North Macedonia should create its competitive advantages on the macro-regional and global markets. With regard to the participation of the entities of North Macedonia in the H2020 programme, they have participated in 8 projects in the Food priority area and 9 projects within the Health priority area, which places North Macedonia in the second place in the WB (Figures 6 and 7).

As it was presented in the previous paragraph, North Macedonia is the only WB economy that participates in one ESFRI project in the thematic area of health and food sciences. The Institute of Public Health of North Macedonia is one of 20 beneficiaries, while Ss. Cyril and Methodius University of North Macedonia is one of 28 linked parties that make a consortium. The participation in this RI will enable the Institute of Public Health of North Macedonia to provide high-quality metrology services in food and nutrition, including agrifood, sustainable development, food safety, quality, traceability and authenticity, environmental safety, and human health.

According to the RI Roadmap of North Macedonia, the most important research institutions in this area are:

- Faculty of Agricultural Sciences and Food, Ss. Cyril and Methodius University of Skopje
- Faculty of Technology and Metallurgy, Ss. Cyril and Methodius University of Skopje
- Faculty of Agriculture, Goce Delchev University
- Institute of Public Health
- Faculty of Medicine, Ss. Cyril and Methodius University of Skopje
- Faculty of Pharmacy, Ss. Cyril and Methodius University of Skopje
- Faculty of Medical Sciences, Goce Delchev University
- Albania

Food safety and Public health are the two priorities that have been recognised by the National Strategy of Science, Technology and Innovation (2017-2022) of Albania. The strategy aims to improve research infrastructures in these areas. However, while the Action Plan of the Strategy is still ongoing, RIs do not seem to have improved so far. RIs are mainly based on research equipment and instrumentation that is outdated. Albania has not participated in the large pan-European RIs, while research entities from Albania have participated in 4 H2020 projects in the area of food, and 5 H2020 projects in the area of health.

The University of Medicine, Tirana is the most important research institution in the field of health. It is also the most successful research institution in the international context receiving the highest level of EC contribution (1.03 mil. EUR). According to the RI roadmap of Albania, the most relevant research institutions in the area of health and food sciences are:

- University of Medicine, Tirana

- Institute of Public Health
- Mother Teresa University Medical Centre of Tirana
- Agricultural University of Tirana
- Faculty of Natural Sciences, University of Tirana

Bosnia and Herzegovina

Within its research strategic framework, Bosnia and Herzegovina aims to create prerequisites for the improvement of the research sector generally and this refers to the Food and Health sciences too. Policy measures are created to reduce the discrepancy between Bosnia and Herzegovina and developed countries, and to enable Bosnia and Herzegovina to keep pace with European science. Researchers from Bosnia and Herzegovina have participated in only 1 H2020 project within the Food thematic priority, and in 4 projects within the Health thematic priority. Researchers mainly come from the faculties, and their activities are mostly those related to student education.

According to the RI Roadmap of Bosnia and Herzegovina, the following research institutions are important in the area of food and health sciences:

- Faculty of Agriculture and Food Sciences, University of Sarajevo
- Faculty of Pharmacy, University of Sarajevo
- Biotechnical Faculty, University of Bihać,
- Faculty of Agriculture, University of Banja Luka
- Faculty of Medicine, University of Banja Luka
- Faculty of Medicine in Foča, University of East Sarajevo

Montenegro

Health and food areas are among the prioritised sectors within the strategic framework of Montenegro. While research entities from Montenegro participated in only 2 H2020 projects in the area of food, they have participated in 5 H2020 projects within the thematic priority Health, Demographic Change and Wellbeing. Moreover, it is the thematic priority for which Montenegro has received the highest level of EC contribution (1.15 mil. Euros).

It is important to emphasise the development of RIs in the domestic context that is currently happening in Montenegro. Within the third component of the INVO project: Establishing a competitive environment for research, the establishment and operation of the first pilot centre of excellence in Montenegro called Centre of Excellence in Bioinformatics - BIO-ICT was funded.

BIO-ICT Centre of Excellence, Montenegro

BIO-ICT Centre of Excellence is the first centre of excellence in Montenegro, implemented as a three-year research programme at the University of Montenegro, led by the Faculty of Electrical Engineering and financed by the Ministry of Science of Montenegro through a World Bank loan from June 2014. Besides the Faculty of Electrical Engineering, partners on the project are 3 leading research institutions: Biotechnical Faculty, Institute for Marine Biology, Institute of Public Health; 2 international universities: St. Petersburg Scientific Research Centre for Ecological Safety and Centre for TeleInFrastruktur; and 2 successful SMEs from Montenegro: COGI and Green House Jovovic. It is focused on the development and implementation of novel bioinformatics technologies. BIO-ICT has been exploiting its capacities towards unlocking and utilising the potential of the Montenegrin South Adriatic Sea and inland rural areas, bringing innovative ICT based solutions in various bioeconomy sectors, related to food security, blue growth, bio-based innovation for sustainable goods and services.

Kosovo*

Even though agriculture is one of the most important economic sectors in Kosovo*, research activities in the field of agricultural sciences and food safety are not prominent. Significant support for research in the field of health in Kosovo* has been provided by international organisations such as WHO, UNICEF, USAID, etc.

According to the RI roadmap of Kosovo*, there is a need for better-equipped research laboratories. Currently, the most important research institutions are:

- Faculty of Medicine, University of Pristina
- Faculty of Agriculture and Veterinary Medicine, University of Pristina
- Faculty of Food Technology, University Isa Boletini in Mitrovica

1.4. PHYSICAL SCIENCES AND ENGINEERING

THE GENERAL OVERVIEW OF THE WESTERN BALKANS REGION

Out of a total of 1,451 H2020 projects implemented within the thematic area of physical sciences, the WB economies have participated in only 3 of them. In particular, project partners in the 3 projects are from Serbia, with no participation from other WB economies. While this could be rated as low participation of institutions from Serbia, non-participation by other WB economies reflects the limited research, excellence and capacities in the field of physical sciences.

Generally speaking, the WB region lacks large RIs in the area of physical sciences and the level of integration into pan-European RIs is extremely weak. Research activities in the area

of natural sciences are mainly oriented toward producing research papers in domestic and international peer-reviewed journals.

LARGE RESEARCH INFRASTRUCTURES

Out of a total of 4 projects and 12 landmarks identified by the ESFRI consortium in the field of physical sciences and engineering, the WB economies currently participate in only 1 Landmark. Serbia is the only WB economy that participates in the CERN's project of high importance: High-Luminosity Large Hadron Collider (HL-LHC).

High-Luminosity Large Hadron Collider - HL-LHC

The Large Hadron Collider (LHC) at CERN is the highest-energy particle collider in the world. The breakthrough discovery of the Higgs boson by the ATLAS and CMS experiments in 2012 marked the start of a major programme to measure this particle's properties with the highest possible precision to test the validity of the Standard Model and search for new physics at the energy frontier. To extend its discovery potential, the LHC will be upgraded to the High-Luminosity LHC.

The HL-LHC is currently in its Construction Phase (2017-2025) and it is envisaged to start operating in 2026. The full exploitation of the LHC, including the HL-LHC, was identified as the highest priority for European particle physics in the update of the European Strategy for Particle Physics approved by the CERN Council in May 2013. The HL-LHC project is considered a high-priority component in the national roadmaps of many societies across the world as well. The high luminosity upgrade of the existing LHC will allow full exploitation of its scientific potential and will map out the scientific programme until 2035 and possibly beyond.

Serbia, as a member of CERN, is a participating partner in this RI. Many young physicists and engineers from Serbia trained during the project will transfer their expertise to society and industry. Whether in the field of accelerators, detectors or computing, the HL-LHC is a major undertaking that will impact many technologies that are of relevance for other RIs and the big data and computing paradigm.

THE CURRENT OVERVIEW OF EACH WESTERN BALKANS ECONOMY

Serbia

As it was concluded above, although not sufficiently represented, Serbia is the most advanced WB economy in the area of physical sciences and the only one participating in pan-European RIs in this area. Serbian institutions have participated in 3 H2020 projects in the area of physical sciences. Considering its publication performance and participation in international RIs projects, important research institutions in the field of physical sciences are:

- Institute of Physics, University of Belgrade
- Faculty of Physics, University of Belgrade

- Institute of Nuclear Sciences Vinča, University of Belgrade
- Faculty of Science, University of Novi Sad
- Faculty of Science, University of Niš,
- Faculty of Science, University of Kragujevac

North Macedonia

Research activities of North Macedonian researchers in the field of physical sciences are mainly based on domestic research projects, and the main results of the research process are presented in the form of research papers. Therefore, there were no research projects with international relevance nor research institutions that are members of pan-European RIs.

According to the RI Roadmap of North Macedonia, the main research instruments and research activities in this field are from the following research institutions:

- Physics Laboratory, Faculty of Electrical Engineering and Information Technologies, Ss. Cyril and Methodius University of Skopje
- Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University of Skopje
- Institute of Earthquake Engineering and Engineering Seismology
- Faculty of Natural and Technical Sciences, Goce Delchev University

Albania

Physical sciences are not among the prioritised fields of sciences recognised by the National Strategy for Science, Technology and Innovation (2017-2022) of Albania. Since the criteria for identifying research priorities were related to the current research base and performance, it follows that physical sciences are not visible at the economy level. Since Albania is not participating in pan-European RIs nor international H2020 projects in this field, research results are modest and are mostly based on published papers in domestic journals and much less in top international journals.

According to the RI Roadmap of Albania, the main scientific base in the field of physical sciences is within the University of Tirana, particularly at the following institutions:

According to the RI Roadmap of Albania, the main scientific base in the field of Physical sciences is within the University of Tirana, particularly at the following institutions:

- Faculty of Natural Sciences, University of Tirana and
- Institute of Applied Nuclear Physics, University of Tirana

Bosnia and Herzegovina

As stated in the Strategy for Development of Science in Bosnia and Herzegovina (2017-2022), the economy confronts a serious brain drain and the main challenges are related to the lack of researchers in all fields of sciences. The lack of researchers in physical sciences

and other natural sciences is emphasised the most. Considering the current state, Bosnia and Herzegovina could not be expected to improve its research excellence in the physical sciences without an increase in human resources. Researchers in the field of physical sciences are mainly conducting educational activities, and the core researchers are coming from the following research institutions:

- Faculty of Natural Sciences and Mathematics, University of Sarajevo
- Faculty of Natural Sciences and Mathematics, University of Banja Luka

Montenegro

The Strategic Research Framework of Montenegro has not recognised Physical sciences as a research field of importance on the economy level due to the limited number of researchers and current research results. Research institutions from Montenegro neither participate in RIs of international importance, nor in international associations. However, according to the RI Roadmap of Montenegro, the Government of Montenegro has taken the first steps toward establishing cooperation with the European Space Agency (ESA) in 2018. The ESA's main mission is to shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world.

An important research institution in the field of physical sciences in Montenegro is the Faculty of Natural Sciences and Mathematics, University of Montenegro.

Kosovo*

Physical and Engineering Sciences are not recognised as a priority research area in Kosovo*. Research results in this area are not represented to a sufficient extent. Physical sciences are mainly conducted within the Faculty of Natural Sciences and Mathematics, University of Pristina. However, these activities are mainly educational with insufficient time spent on research activities.

1.5. SOCIAL AND CULTURAL INNOVATION

THE GENERAL OVERVIEW OF THE WESTERN BALKANS REGION

Research infrastructures in the area of social and cultural innovation comprise surveys, different types of data collections, laboratory experiments, longitudinal studies, administrative data records, as well as large-scale databases and repositories. Research infrastructures are referred to as the services needed to make that data usable. The most popular existing RIs in the area of social sciences are databases (catalogues, reference indexes, bibliographies, etc.) as well as: digitised texts, objects, sound, film, etc.

Except in Kosovo*, Social and Cultural Innovation is not recognised as a priority area by other WB economies. A review of strategic documents gives the impression that most economies in the WB have not recognised the importance of social research and little attention has been

paid to RIs in the social sciences. On the macro-regional level, the Common Regional Market's (CRM) Regional Industrial Area has Creative industries as one of the five industrial priorities. The adopted CRM's Action Plan (2021-2024) supports the development of creative industries in the region. Particularly, the agreed measures are aimed at increasing the contribution of the film industry to the overall growth and job creation, investing in the creative industry's infrastructures, and increasing the number of regionally-based business suppliers able to provide quality services to the industry, etc.

According to the current state, Serbia, North Macedonia and Bosnia and Herzegovina have their domestic infrastructures/data centres providing long-term preservation and distribution of research data in the social sciences. While Serbia is the most advanced, the general conclusion is that all three economies are in the infancy phase. The other three WB economies have not yet established their data centres, however, they are planned for the future.

As social sciences are not distinguished as a separate thematic priority within Horizon 2020, it is not possible to provide comparative statistics as presented for other areas.

LARGE RESEARCH INFRASTRUCTURES

Some of the most important research infrastructures in Europe in the area of social sciences and humanities include:

- CESSDA - Council of European Social Science Data Archives
- ESS-ERIC - The European Social Survey
- SHARE - Survey of Health, Ageing and Retirement in Europe
- CLARIN - Common LAnguage Resources and Technology INitiative
- DARIAH - DigitAl Research Infrastructure for the Arts and Humanities
- EROHS - European Resource Observatory for the Humanities and Social sciences
- SERISS - Synergies for Europe's Research Infrastructures in the Social Sciences

WB economies are partly represented in these RIs. Serbia, as the most advanced WB economy in the field of research and innovation, is participating in CESSDA, ESS-ERIC and DARIAH. Bosnia and Herzegovina has recently become a member of DARIAH RIs, while other WB economies are not members of pan-European RIs. However, it is important to note that most WB economies conducted at least one Social survey coordinated by ESS-ERIC.

Additionally, it is important to note that within the 11 proposals that have been scored high for their science case and maturity for implementation and included as new Projects in the ESFRI 2021 Roadmap Update, WB economies are participating in 2 of them, both in the thematic area of Social and Cultural Innovation:

- OPERAS
- RESILIENCE

More information on the pan-European RIs participated by WB economies is provided in the paragraphs below.

CESSDA

CESSDA is a Consortium of the European Social Science Data Archives. As one of the most important pan-European RIs for the development of social sciences, CESSDA provides large-scale, integrated and sustainable data services to the social sciences. It brings together social science data archives across Europe, to promote the results of social science research and support domestic and international research and cooperation.

The CESSDA Consortium is currently composed of 22 members and one observer. Several European economies are in the process of becoming CESSDA members or observers. CESSDA also has partners in several economies outside of the consortium.

Serbia and North Macedonia are the full members of the CESSDA, while Bosnia and Herzegovina, Albania, Montenegro and Kosovo* are the potential partners currently outside the consortium.

DARIAH ERIC

The Digital Research Infrastructure for the Arts and Humanities (DARIAH) aims to enhance and support digitally-enabled research and teaching across the arts and humanities. DARIAH is a network of people, expertise, information, knowledge, content, methods, tools and technologies from its member economies. It develops, maintains and operates infrastructure in support of ICT-based research practices and sustains researchers in using them to build, analyse and interpret digital resources. By working with communities of practice, DARIAH brings together individual state-of-the-art digital arts and humanities activities and scales their results to a European level. It preserves, provides access to, and disseminates research that stems from these collaborations and ensures that best practices and methodological and technical standards are followed.

DARIAH was established as a European Research Infrastructure Consortium (ERIC) in August 2014. Currently, DARIAH has 20 members and 1 Observer. Serbia and Bosnia and Herzegovina are the only 2 members from the WB region.

ESS – European Social Survey

The European Social Survey (ESS) is an academically driven cross-national survey that has been conducted across Europe since its establishment in 2001. Every two years, face-to-face interviews are conducted with newly selected, cross-sectional samples. The European Commission regularly uses the ESS data to monitor social phenomena and formulate practical policies at the EU level. The ESS was awarded ERIC status on 30th November 2013.

The majority of the WB economies participated in at least one round of the ESS. Serbia and Montenegro have participated in the last two rounds of surveys conducted in 2018 and 2020; North Macedonia participated for the first time in the 2020 round; Albania participated in two

rounds (2012 and 2016); Kosovo* participated in Round 6 that was conducted in 2012; Bosnia and Herzegovina is the only WB economy that has not conducted ESS survey yet.

Western Balkans ESS Regional Network - WBESS

The Western Balkans European Social Survey Regional Network is convened by the Institute for Social Science in Belgrade for promoting European Social Survey in the Western Balkans. This project is part of the broader Horizon 2020 project – SUSTAIN 2. SUSTAIN 2 is a 36-month project funded by the European Commission, due to be implemented from January 2020 until December 2022.

The focus of the project is on organising workshops, meetings, promotional activities, as well as advocacy towards relevant government ministries. Through appointed National Focal Points, the efforts are concentrated on maximising the likelihood that as many economies as possible are granted guest or membership status for ESS.

RESILIENCE

RESILIENCE is a unique, interdisciplinary and invigorating research infrastructure for all Religious Studies, building a high-performance platform, supplying evolving tools and big data to scholars from all the scientific disciplines crossing religions in their diachronic and synchronic variety. It primarily serves the academic community, and at the same time its impact extends significantly to the non-academic community: it offers the tools for an innovative approach to Religious Studies which can be used to build a European response to the challenge of religious diversity.

The main representatives from the WB region are:

- Albanian University and
- University of Sarajevo.

The Albanian University in Tirana is among the first privately founded institutions of higher education in Albania. It has been operating for more than a decade, currently organised into three faculties: Faculty of Social Sciences, Faculty of Applied and Economic Sciences and Faculty of Medical Sciences.

The University of Sarajevo is a leading research institution in Bosnia and Herzegovina by the amount of received research funding. The University of Sarajevo is striving toward becoming an equal partner in all aspects of research and artistic activities within the international university network. Within the University and in the framework of this project, two institutions will take the lead: the Faculty of Islamic Studies and the Faculty of Catholic Theology.

OPERAS

OPERAS is the European distributed RI dedicated to open scholarly communication in the social sciences and humanities. Its mission is to coordinate and federate resources in Europe to efficiently address the scholarly communication needs of European researchers in the field

of SSH. OPERAS is however fully European with its 53 members from 16 economies, and the commitment of its Core Members from France, the UK, Germany, Italy, the Netherlands, Poland, Greece, Croatia, Slovenia and Portugal to establish OPERAS' strategy.

The WB region is represented in the project by the Centre for Evaluation in Education and Science (CEES) from Serbia. CEES is an independent non-governmental, not-for-profit organisation, that specialises in building digital infrastructures for Open Access journal publishing and evaluation, with a special focus on metadata quality, implementation of PIDs, open citations, the integrity of editorial policies, legitimacy of citations, and interoperability. It has also developed a complex journal evaluation framework relying on sound and sustainable journal quality and impact indicators.

THE CURRENT OVERVIEW OF EACH WESTERN BALKANS ECONOMY

Serbia

Through membership in some of the most important European RIs in the area of social and cultural innovation, research institutions from Serbia have access to state-of-the-art research methods and practices in this field. As a result of the membership in these RIs, Serbia has made significant progress and the main result of this advancement is the development of one of the most important RIs in the area of social sciences in Serbia: the Data Centre Serbia for Social Sciences.

Data Centre Serbia for Social Sciences

The Data Centre Serbia for Social Sciences (DCS) is an organisational unit of the Institute of Economic Sciences in Belgrade. Supported from 2012 by international funds through projects such as SEEDS and CESSDA, DCS was formally established in 2014. However, it is still in the infant phase. Currently, DCS can preserve and disseminate all types of data, both quantitative and qualitative, through FORS data portal SEEDSbase and Dataverse platform.

DCS collects data and information across a range of social science disciplines: economics, education, employment and labour, environment, conservation and land use, health, history, industry and management, law, crime and legal systems, media, communication and language, political science, psychology, sociology, society and culture, social welfare policy and systems.

Taking into consideration the international visibility and participation in pan-European RIs, the most important institutions in the area of social sciences and humanities in Serbia are:

- Institute of Economic Sciences
- Centre for Evaluation in Education and Science
- Institute of Social Sciences
- Belgrade Centre for Digital Humanities
- Mathematical Institute of the Serbian Academy of Sciences and Arts
- Institute for the Serbian Language of the Serbian Academy for Sciences and Arts

- National Library of Serbia
- University Library Svetozar Markovic

North Macedonia

As a full member of CESSDA, the main benefits for the scientific community in North Macedonia are:

- Access to the CESSDA data catalogue (21000 studies in English language and 9000 in other languages from across Europe);
- Participation in the CESSDA training activities;
- Monitoring and implementation of international standards;
- Participation in international projects

Also, within the project, the Macedonian Social Science Data Archive (MK DASS) is planned to be developed. MK DASS will be an economy-level infrastructure and a public service providing long-term preservation and distribution of research data in the social sciences. It will be hosted by the Institute for Sociological, Political and Juridical Research at Ss. Cyril and Methodius University in Skopje, one of the oldest public university research institutions in the social sciences in North Macedonia. The Ministry of Education and Science is a crucial institution for establishing MK DAS as part of the domestic scientific infrastructure.

North Macedonia joined the ESS for the first time in the 10th Round. This initiative was supported by the main public and private universities with social science departments in the economy, which appointed their representatives for the National Network of ESS in North Macedonia. Participation in the ESS is of great importance for the research community in social sciences, enabling them to have open access to a database of comparable data on a large number of social science topics in European economies. Round 10 of ESS in North Macedonia is being conducted by the Institute for Sociological, Political and Juridical Research in Skopje.

According to the RI Roadmap of North Macedonia, the most important research institutions in the area of social sciences and humanities are:

- Institute for Sociological, Political and Juridical Research in Skopje
- Institute of National History, Ss. Cyril and Methodius University of Skopje
- Institute of Macedonian Literature, Ss. Cyril and Methodius University of Skopje
- Institute of Macedonian Language Krste Misirkov, Ss. Cyril and Methodius University of Skopje
- Institute of Folklore Marko Cepenkov, Ss. Cyril and Methodius University of Skopje
- PRI Institute of Old Slavic Culture–PRILEP

Albania

Social sciences are not recognised among the priority areas within the National Strategy of Science, Technology and Innovation (2017-2022). However, research institutions from Albania are active in pan-European RIs in the social sciences thematic area.

Although not a full member of ESS-ERIC, Albania has participated in two rounds of surveys implemented within the ESS. The first survey round was implemented in 2012 and the second one in 2018. It was implemented by the European University of Tirana.

Albania is a full member of the RESILIENCE project. RESILIENCE is a pan-European RI that was selected by ESFRI and will be included as a new Project in the ESFRI 2021 Roadmap Update. Albanian University in Tirana is a representative of this project. The project will offer the tools for an innovative approach to religious studies which can be used to build a European response to the challenge of religious diversity.

Albania is a partner economy to CESSDA RI. As a partner economy, Albania has committed itself to establish the Albanian Data Archive for Social Science (ADAS). ADAS will be an economy-level research infrastructure that provides long-term preservation and distribution of research data in the social sciences in Albania. The Ministry of Education, Sports and Youth and the National Agency for Scientific Research and Innovation will define the host institution for ADAS and coordinate its establishment. Several potential institutions could serve as host institutions for the domestic data service.

According to the RI Roadmap of Albania, important research institutions in the area of social sciences and humanities are:

- Albanian University in Tirana
- European University of Tirana
- University of Tirana (Faculty of Economics, Faculty of Social Sciences and Faculty of History and Philology)

Bosnia and Herzegovina

Bosnia and Herzegovina has made recent progress in the area of social sciences, arts and humanities when it comes to the process of integration into European RIs. As of June 2021, Bosnia and Herzegovina has become a full member of DARIAH-ERIC. This is a result of joint efforts made by the Council of Ministers of Bosnia and Herzegovina and the Ministry of Civil Affairs. This initiative is expected to enhance individual state-of-the-art digital arts and humanities activities of Bosnian researchers and scale their results to a European level. Accession of Bosnia and Herzegovina to DARIAH was possible thanks to research institutions in the fields of humanities and arts that hold invaluable cultural archives (documents, audio archives, etc.) that are important for research in humanities, arts, and social sciences.

Bosnia and Herzegovina is also active in two more RIs: CESSDA and ESS but not as an official member. Bosnia and Herzegovina is represented in these RIs by the Centre for Research Education and Development Investigations (CREDI). The initiative to join two RIs is launched and

is currently under consideration. According to the information from the Ministry of Civil Affairs, in the next 2-5 years, Bosnia and Herzegovina will mainly focus on getting full membership in these two RIs as the procedure is underway.

Following the development of open science and initiatives in the ESFRI, CREDI has developed the Data Archive for Social Sciences in Bosnia and Herzegovina and established a network of universities and other research institutions with which it cooperates to strengthen the research infrastructure in the economy and open access to data and science. These activities aim to promote the principles of open science in Bosnia and Herzegovina and to contribute to meeting one of the conditions for inclusion in EOSC flows and growing requirements for long-term data storage and reuse.

Data Archive for Social Sciences in Bosnia and Herzegovina

Data Archive for Social Sciences in Bosnia and Herzegovina (DASS-BiH) is the economy-level service whose role is to ensure the long-term preservation and dissemination of social science research data. The purpose of the data archive is to provide a vital research data resource for researchers, teachers, students, and all other interested users. The collected data are those from social science research in the following disciplines: economy, education, employment and labour, political science, psychology, sociology, society and culture, social welfare policy and systems.

DASS-BiH is entitled to provide the following services for its depositors and users: collection, validation, data conversion, distribution of data collections; administration of network/system specialised in collecting, storing, and distributing data; assuring quality and safety of data collections within data management activities; permanent monitoring of international standards in data management systems and improving infrastructure when needed; mediation between the demand of data users and supply of data providers; customer support; activities related to web portal development and maintenance; providing services to third parties and user trainings.

Montenegro

The Social and Cultural Innovation is not among the prioritised areas within the Montenegrin Research Policy Framework. RI Roadmap of Montenegro has not identified this thematic area among the important research infrastructure on the domestic level. However, Montenegro has participated in one ESS round so far. Field research for the 9th cycle of the ESS in Montenegro was conducted by the Centre for Social Research, Faculty of Political Science, University of Montenegro.

Although not a full member, as a partner economy to CESSDA, Montenegro has committed itself to establishing the Montenegrin Social Science Data Archive (MSSDA). The MSSDA will be an economy-level data service infrastructure for the long-term preservation and distribution of social science research data produced by Montenegrin researchers. MSSDA could be hosted by the Centre for Monitoring and Research (CeMI) as a service of the Ministry of Science and the Ministry of Education of Montenegro. CeMI is a non-governmental, non-profit organisation, whose main goal is to provide infrastructural and expert support for continuous monitoring of

the overall process of transition in Montenegro. CeMI is well integrated into existing domestic networks, with links to universities, research institutes, NGOs and other institutions.

The University of Montenegro is the most important research institution in the area of social sciences. In particular, the following institutions: Institute of History, Faculty of Economy, Faculty of Philosophy, Faculty of Philology and Faculty of Political Sciences.

Kosovo*

Due to the lack of research capacity in the field of social sciences, publications of authors from Kosovo* in reputable journals are rare and are mainly the result of cooperation with international institutions or joint research during their visits to foreign research institutions.

At an institutional level, the research infrastructure which would ensure sustainability and continuity of cultural studies in Kosovo* is insufficient. Necessary research infrastructure for archaeological expeditions, restorations and revitalisations, archiving of documents and museum materials is missing.

Within the CESSDA RI, it was stated that Kosovo* should establish a Social Sciences Data Centre (KSSDC). Once established, it will be an economy-level infrastructure for social sciences and humanities, providing long-term preservation and distribution of research data. The data centre should be housed within a larger existing organisation, but its services will be available to the whole community, both domestic and international. The main purpose of KSSDC will be to provide curation of research data produced by the research community and access to these data for researchers and general public. The KSSDC could be established by the Centre for Political Courage (CPC) within the Institute for Social Studies and Humanities, at the Faculty of Philosophy, University of Pristina.

The most important research institution in this area is the University of Pristina.

1.6. E-INFRASTRUCTURES

THE GENERAL OVERVIEW OF THE WESTERN BALKANS REGION

The analysis of research strategic frameworks in WB economies has shown that the field of information and communication technologies (ICT) represents an absolute priority:

- Serbia, North Macedonia and Montenegro have identified the ICT sector as a priority domain within their S3 process, ensuring significant support for further development of this sector in the next few years.
- Albania has selected the ICT sector as one of the priority areas within the National Strategy of Science, Technology and Innovation.
- Increasing the digitisation of the economy is one of the priorities of the Development Strategy of the Federation of Bosnia and Herzegovina (2021-2027).

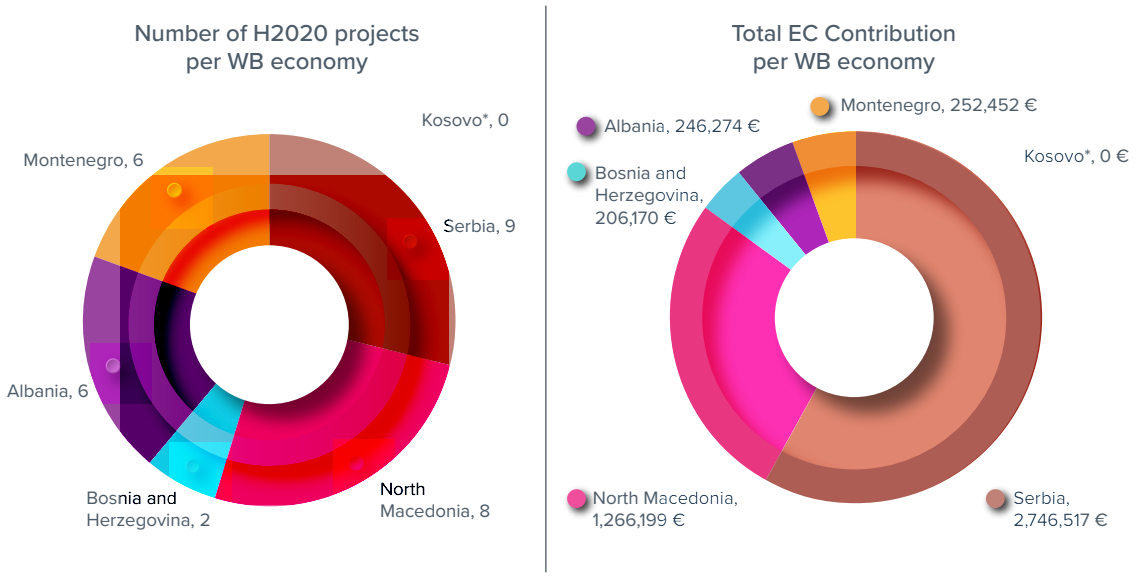
- Within the National Science Programme of Kosovo*, the ICT sector is considered a cross-cutting priority that permeates the other 5 vertical research priority areas.

The WB region is lagging behind the EU in terms of using High-Performance Computing (HPC). However, the diversity among WB economies is evident. While Serbia and North Macedonia have the HPC infrastructures and distinguished research organisations appointed to represent them in European HPC-related projects and infrastructures, other WB economies do not have HPC infrastructures in their economies. Regardless of the current level of development, it is evident that more efforts are needed to promote HPC, familiarise decision-makers with the importance of HPC as well as increase the use of HPC services by the industry. Also, substantial efforts are to be allocated to creating a high-speed communications network of grid infrastructure.

In the last decade, there were several SEE e-infrastructure initiatives (VI-SEEM, NI4OS-Europe, EGI-ACE, EUROCC, GN4-3 and others) aimed at creating conditions for equal participation of the less-resourced economies of the WB region in European networking and Grid computing trends by providing e-infrastructure resources, application support and training. The close collaboration of domestic research and education networks and economy-level grid initiatives in the WB region was crucial in materialising this aim. The above initiatives have also raised awareness of line ministries of the necessity of local programmes and financial support for e-Infrastructures

Regarding the participation of the WB economies in Horizon 2020 projects within the thematic priority E-infrastructures, Serbia and North Macedonia have participated in 9 and 8 projects respectively, followed by Montenegro and Albania with 6 projects. Serbia has received the highest EC contribution (2.7 million euros), followed by North Macedonia (1.2 million euros) (Figures 9).

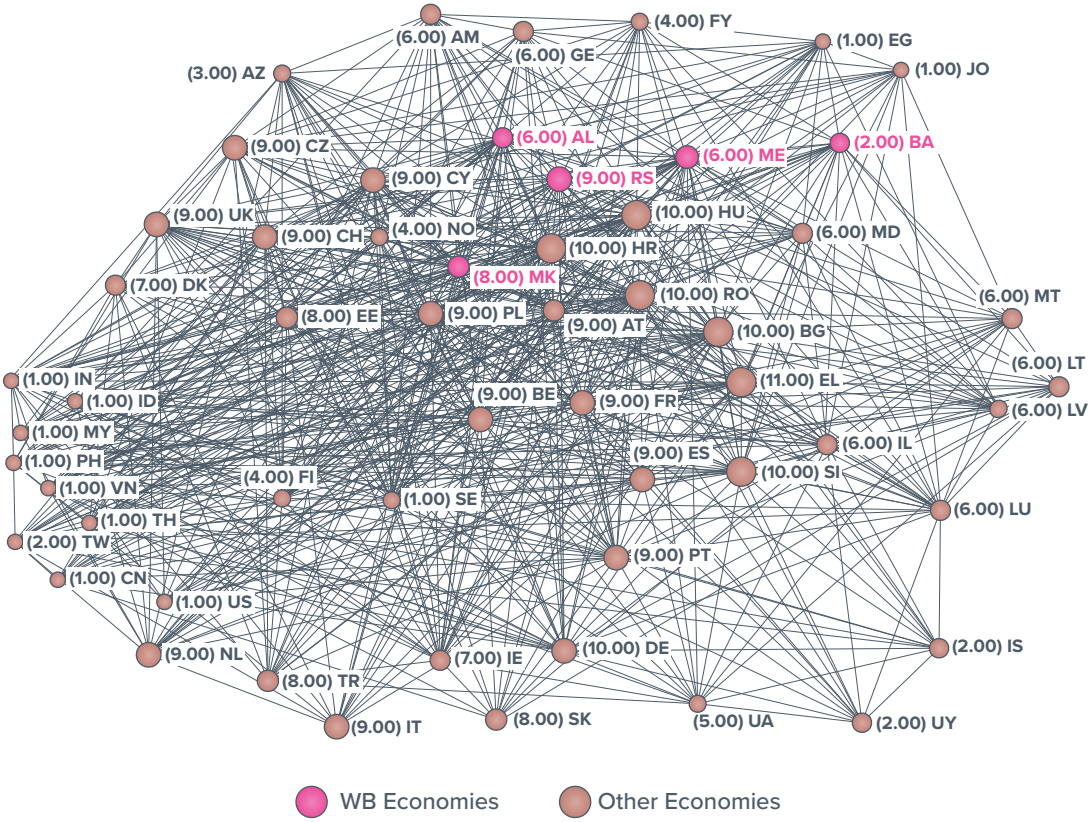
Figure 9: Participation of WB economies in Horizon programme: E-infrastructures



Source: Authors' visualisation based on https://cordis.europa.eu/projects/en

Figure 10 shows extracted research network that includes H2020 projects in the area of e-infrastructures, with at least one participant from the WB economy. The Research network of WB economies shows high research collaboration between WB economies with the important role of EU and neighbourhood economies.

Figure 10: Research network of WB economies in H2020 projects in the area of e-infrastructures



Source: Authors' visualisation based on https://cordis.europa.eu/projects/en

LARGE RESEARCH INFRASTRUCTURES AND INTERNATIONAL PROJECTS

Although not as core and most advanced partners, WB economies are participating in important EU projects, initiatives and associations related to e-infrastructure, high-performance computing and open science initiatives. More information on the projects is provided below.

GEANT

Except for Bosnia and Herzegovina, the other 5 WB economies are participants of pan-European GEANT e-infrastructure. GEANT is the high bandwidth pan-European research and education backbone that interconnects 42 economy-level research and education networks, reaching over 50 million users in 10,000 institutions across Europe, and more than 100 countries worldwide through links with other regions. The network is essential to Europe's e-infrastructure strategy, supporting open science and offering the highest level of capacity and security that users need.

GEANT Project GN4-3 (January 2019 - December 2022)

The GN4-3 is a pan-European collaboration between 39 partners aiming to help take European research to the next level, promoting scientific excellence, and access and re-use of research data. The following organisations from the Western Balkans are partners in the project:

1. Academic Network of Albania (RASH), www.rash.al
2. Academic Network of Serbia (AMRES), www.amres.ac.rs
3. Macedonian Academic & Research Network (MARnet), www.marnet.mk
4. Montenegrin Research and Education Network (MREN), www.mren.ac.me

The importance of participation in the GEANT's projects is reflected in supporting substantial use of the pan-European and world research networks by WB's researchers and students, as well as in facilitating the integration of WB's educational, and research and cultural resources in the international information space. Benefits are particularly notable within large projects which use GÉANT infrastructure, such as the Large Hadron Collider in CERN and similar.

High-Performance Computing (HPC)

WB economies are not members of the European High Performance Computing Joint Undertaking (the EuroHPC JU). The EuroHPC JU is willing to coordinate the WB economies' efforts and pool their resources to deploy world-class exascale supercomputers, and to assist developing innovative supercomputing technologies and applications.

EUROCC - National Competence Centres in the framework of EuroHPC

The Faculty of Computer Science and Engineering, University of Ss. Cyril and Methodius from North Macedonia and the University of Donja Gorica from Montenegro are members of the EuroCC project that brings together the necessary expertise to set up a network of National Competence Centres (NCCs) in HPC across Europe with over 30 participating members and associated economies, to provide a broad service portfolio tailored to the respective domestic needs of industry, academia and public administrations.

The goal is to support and strongly increase the domestic strengths of HPC competencies as well as high-performance data analytics and artificial intelligence capabilities and to close existing gaps, increase the usability of these technologies in the different economies and thus provide a European excellence baseline. Half of the EuroCC project is funded through H2020 (EuroHPC Joint Undertaking [JU]) while the rest is matched through domestic funding programmes within the partner economies.

The European Open Science Cloud

The European Open Science Cloud (EOSC) is an environment for hosting and processing research data to support EU science. The ambition of the EOSC is to provide European researchers, innovators, companies and citizens with a federated and open multi-disciplinary

environment where they can publish, find and re-use data, tools and services for research, innovation and educational purposes.

EOSC Association

The EOSC Association is the legal entity established to govern the EOSC. It was formed on 29th July 2020 with four founding members and has since grown to over 200 members and observers. The EOSC ecosystem is being co-created in a series of funded projects and initiatives from member states and associated economies.

Members from the WB economies are:

- Institute of Physics Belgrade, Serbia
- University of Banja Luka, Bosnia and Herzegovina
- Faculty of Computer Science and Engineering, University Ss Cyril and Methodius in Skopje, North Macedonia

NI4OS-Europe: National Initiatives for Open Science in Europe (September 2019–February 2023)

The NI4OS-Europe project is funded by the European Commission. The NI4OS-Europe project intends to support the development of domestic open science cloud schemes in 15 EU Member States and associated economies. It will design, analyse and categorise the Open Science environment in these economies to create domestic OSC structures to support general EOSC governance.

Members from the WB economies are:

- Institute of Physics Belgrade, Serbia
- University of Belgrade, Serbia
- RASH, the Academic Network of Albania
- Ss. Cyril and Methodius University in Skopje, North Macedonia
- University of Banja Luka, Bosnia and Herzegovina
- University of Montenegro, Montenegro

The EGI Federation

The EGI is a federation of computing and storage resource providers united by a mission to support research and development. The federation is governed by the participants represented in the EGI Council and coordinated by the EGI Foundation. The EGI federated e-infrastructure is publicly funded and provides compute and storage resources to support research and innovation.

EGI resources are provided by:

- The EGI Federated data centres

- The EGI Federated Cloud providers

The EGI Federation comprises hundreds of data centres offering computing and storage resources to researchers. Concerning the Western Balkan region, the EGI data centres are located at 3 research institutions in Serbia:

- Scientific Computing Laboratory, Institute of Physics, Belgrade, Serbia
- Laboratory for Electronic Design Automation, Faculty of Electronic Engineering, University of Niš, Serbia
- Belgrade University Computer Centre (RCUB), Serbia

EGI-ACE: Advanced computing for research

The Ss. Cyril and Methodius University in Skopje, North Macedonia is a project member of the EGI-ACE project. EGI-ACE is a 30-month project coordinated by the EGI Foundation with a mission to empower researchers from all disciplines to collaborate in data- and compute-intensive research through free-at-point-of-use services.

Building on the distributed computing integration in the EOSC-hub project, EGI-ACE will deliver the EOSC Compute Platform and will contribute to the EOSC Data Commons through a federation of cloud compute and storage facilities, PaaS services and data spaces with analytics tools and federated access services. The consortium of the project builds on the expertise and assets of the EGI federation members, key research communities, data providers and collaborating initiatives.

THE CURRENT SITUATION IN EACH WESTERN BALKANS ECONOMY

Serbia

The Government of Serbia has set the digitalisation of public administration as one of the Government's priorities, which has led to the provision of integrated, secure and reliable electronic services for citizens. The Office for IT and e-Government has established the State Data Centre, which is one of the most modern in the region in terms of technology and security standards. It has 5,000 square meters and the value of the project was 30 million EUR.

The Data Centre meets the Tier 3+ standard, and the services are provided under the ISO 27001 security standard, ISO 9001 quality standards and the ISO 20000 service quality. Resources in the Data Centre are offered to the public authorities according to the IaaS (Infrastructure as a Service) model - virtual server resources are issued at the user's request. This model assumes that all infrastructure or hardware components, including the virtualisation layer, are hosted in the State Data Centre.

Serbia is the most advanced WB economy concerning the current state of e-infrastructure development. **The Institute of Physics is the referent institution for grid computing and HPC in Serbia**. It is the focal point of the development of HPC in the entire WB Region. The Institute represents Serbia in European HPC-related projects and research infrastructures. It

coordinates the Academic and Educational Grid Initiative of Serbia (AEGIS) and has participated in pan-European (EGI-Inspire) and regional Grid projects, and it represented Serbia in the Partnership for Advanced Computing in Europe (PRACE).

The Scientific Computing Laboratory at the Institute of Physics provides high-performance computing and storage facilities. In total, more than 1000 CPUs and 50 TB of storage capacity are divided into three Grid sites (AEGIS01-IPB-SCL, AEGIS07-IPB-ATLAS, and AEGIS08-IPB-DEMO) and one local cluster. The local cluster consists of several nodes based on the new computing architectures: IBM POWER6, PowerXCell, and the latest Intel, and AMD Opteron CPUs. The hardware is located in one IBM BladeCenter, and several separate 1U rack-mount servers. In terms of storage resources, a local cluster has a 20 TB storage capacity interconnected with 10 Gigabit Ethernet.

North Macedonia

Faculty of Computer Science and Engineering, Ss. Cyril and Methodius University in Skopje (FCSE) is the largest e-Infrastructure provider in North Macedonia. Through participation in many international e-Infrastructure projects and membership in the large pan-European research infrastructures, the FCSE has developed a strong technical and human potential to support the academic and research community. FCSE is an economy-level centre for high-performance computing and the cloud. The overall e-infrastructure of the FCSE is based on

- HPC cluster (1000 CPU cores, 2TB memory, InfiniBand QDR interconnection)
- GPGPU cluster (27648 GPU cores, 3456 tensor cores, 432 RT cores, 192 GB GPU memory)
- Cloud cluster (384 CPU cores, 1.5 TB memory, 24TB SSD storage, 144TB HDD storage)
- Servers (>1200 CPU cores, >3TB memory)
- Storage (290TB HDD, 230TB SSD)
- Optical network of the UKIM, spanning 30km in the city of Skopje

Bosnia and Herzegovina

There are no HPC centres in Bosnia and Herzegovina, so there are no institutions to mention in the present document. Furthermore, within the existing legal framework, there is no adequate legislation in place to regulate in detail the specifics of the HPC.

There is an extremely low level of awareness and knowledge about HPC technologies in the business sector. Since there is no relevant legal or strategic framework, it is necessary to work on building an environment that will be stimulating to intensify the application of HPC technologies. Cooperation between industry and science could improve the application of HPC technologies. These are clear indicators that concrete support mechanisms for implementing HPC technologies are needed.

Albania

In Albania, there are no HPC centres and there is no actual infrastructure available that allows local researchers and innovators to analyse Big Data. In this case, a local solution of HPC in Albania would facilitate cross-border/boundary collaboration, centred on regional research groups. In line with this need, the WBIF is financing the preparation of the project: Regional HPC Infrastructure, Interconnection of **Regional University Campuses via WB NREN to the Infrastructure and Upgraded HPC-hosting Data Centre** that should be implemented in Albania through:

- WBIF Grant - € 400,000
- EIB Loan - € 15,000,000
- Own Contribution - € 1,300,000
- Other Sources (WBIF possible future TA grant) - € 3,000,000
- Other Sources (Possible future WBIF investment grants if it becomes available. If not, other sources of funding will be explored) - € 5,000,000

The implementation of this project in Albania will help research and academic communities to enhance their capacity to participate effectively and in a solid way in the European research framework, increasing the level of Metadata calculations. HPC is a research infrastructure that has been missing from research and academic institutions for years, and this project can offer it to them. HPC infrastructure offers new opportunities to enhance the collaboration of universities and industry as well as SMEs, as it gives the universities the possibility to offer their expertise and know-how for the development of middleware for the calculation of Big Data.

The project is currently in the preparation phase.

Montenegro

Currently, Montenegro does not have HPC infrastructures. Within the EuroCC project, the **University of Donja Gorica**, together with the other project partners, is establishing a single National Competence Centre (NCC) in the area of HPC. The NCC will coordinate activities in all HPC-related fields at the domestic level and serve as a contact point for customers from industry, science, HPC experts, and the general public.

Kosovo*

Kosovo* has very limited resources for the development of HPC infrastructures. Kosovo* has recently (November 2020) become an associate member of GEANT. As a member of GEANT, Kosovo* Research and Education Network (KREN) is also an active member in different meetings organised for the EOSC.

KREN is following European initiatives related to European RIs such as EuroHPC, EOSC etc., and will consider participation in large RIs soon.

KREN has its network, hardware and software infrastructure dedicated to Higher Education Institutions. However, as a prerequisite for further development of the infrastructure, there is a need to expand it and cover primary and secondary schools. Also, there is a need to increase the overall capacities within the existing HEI infrastructure.

2. INNOVATION INFRASTRUCTURES IN THE WESTERN BALKANS REGION

INTRODUCTION

Innovation Infrastructure encompasses a variety of business support organisations, including business incubators, science and technology parks, innovation hubs, accelerator programmes, startup centres, venture capital funds etc. They play an important role in the success of new ventures as they provide a wide range of support in the form of advice, networking, finance, physical space, etc. The concentration of specific types of innovation infrastructure varies between different economies and depends on many factors. The success of such an infrastructure depends on a good administrative framework, the existence of markets for technology and a suitable intellectual property system that can strengthen the infrastructure's contributions to the successful performance of innovators. Public policy can help innovative entrepreneurs by providing financing for innovation infrastructure.

While Innovation infrastructure encompasses a wide variety of activities and institutions, the focus here is on infrastructure that relates to innovation (as opposed to more general business support activities) and on integrated activities based around a specific location (as opposed to, for example, specific consultancy services). In this context, under innovation infrastructure, we understand innovation centres, technology transfer offices, digital innovation hubs, science and technology parks, accelerators, business incubators, venture capital funds, and so on.

While the majority of the above-mentioned types of organisations are well known, Digital Innovation Hubs (DIH) is a relatively new organisation type firstly introduced by the European Commission: "*A digital innovation hub, in its essence, is an organisation that provides companies with the required technological expertise, equipment and tools (software and hardware) to digitalise their products and/or businesses. Apart from startups, DIHs offer their services to SMEs, scale-ups, midcaps and public administration. DIHs also help companies in finding access to finance, foster an innovation ecosystem, offer training and skills development, and network building and test their ideas and products before bringing them to market.*"[8]

A business incubator is an institution that provides physical space and services to startups, helping them through the early stages of their development, while Science and Technology Parks are the most advanced innovation infrastructures seeking to increase the wealth of the community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. Compared to business incubators, science and technology parks tend to be larger, often spanning large territories and housing various entities, ranging from corporate, government and university laboratories to private companies.

This chapter is organised as follows: the next paragraph provides the research methodology and data collection method, and the second paragraph presents the general state of development

8 See: https://ec.europa.eu/digital-single-market/en/european-digital-innovation-hubs-digital-europe-programme-0

of innovation infrastructures in the WB region as well as the availability of financial instruments in the region. The last paragraph of this section provides an overview of the current situation in each WB economy.

2.1. RESEARCH METHODOLOGY

The mapping of innovation infrastructures in the WB region draws on information gathered from self-reported questionnaires, supplemented by the knowledge gleaned from interviews and desk research. A questionnaire was designed to interact with existing innovation infrastructures in the WB region at all stages of their lifecycle (see the questionnaire in Appendix IX). Sending out a questionnaire to the innovation infrastructure community started at the beginning of November 2021 and the process of gathering and collecting completed questionnaires lasted until the end of November 2021.

A combination of methods was used to identify and target innovation infrastructures for the questionnaires: desk research, nominations by reached innovation infrastructures and consultations with the line ministries from the WB economies. Identified Innovation Infrastructures were invited directly via email to fill in the questionnaire.

By implementing the questionnaire approach, we were able to reach a broad audience in the region. However, the response rate was not as expected. Out of 82 innovation infrastructures in the WB region that were directly invited to fill in the questionnaire, 27 responded, making the response rate 32.9%. There were also differences in the motivation of different WB economies to engage and complete our questionnaires which resulted in the varied completion rates among the WB economies. The table below shows the number of Innovation Infrastructures that responded to the questionnaire.

Table 1: Number of Innovation Infrastructures addressed and reached by survey questionnaire

WB economy	Number of Innovation Infrastructures addressed	Number of completed questionnaires	Response rate
Serbia	28	8	25%
North Macedonia	13	5	38%
Albania	15	5	33%
Bosnia and Herzegovina	14	5	36%
Montenegro	4	2	50%
Kosovo*	9	2	22%

Additionally, taking into account that all questionnaires are subject to limitations and bias, to minimise the risk of variation in the quality or quantity of data causing a bias in the analysis of the WB ecosystem, we have implemented the alternative research methods:

- desk research that involved the collection of data from existing resources (websites of innovation infrastructures, government reports, strategies and other research studies), and

- Short online interviews with the innovation infrastructure managers to get the additional information that was not possible to gather through desk research.

By implementing additional research methods, more than 80 innovation infrastructures were addressed in this report. It should be taken into account that WB's Innovation Infrastructures at this scale have never been conducted before and the data we have obtained should provide appropriate information for this report. However, no approach will ever engage every Innovation Infrastructure and this report, whilst broad, cannot represent the WB landscape in its entirety.

2.2. CURRENT STATE OF DEVELOPMENT OF INNOVATION INFRASTRUCTURES IN THE WB REGION

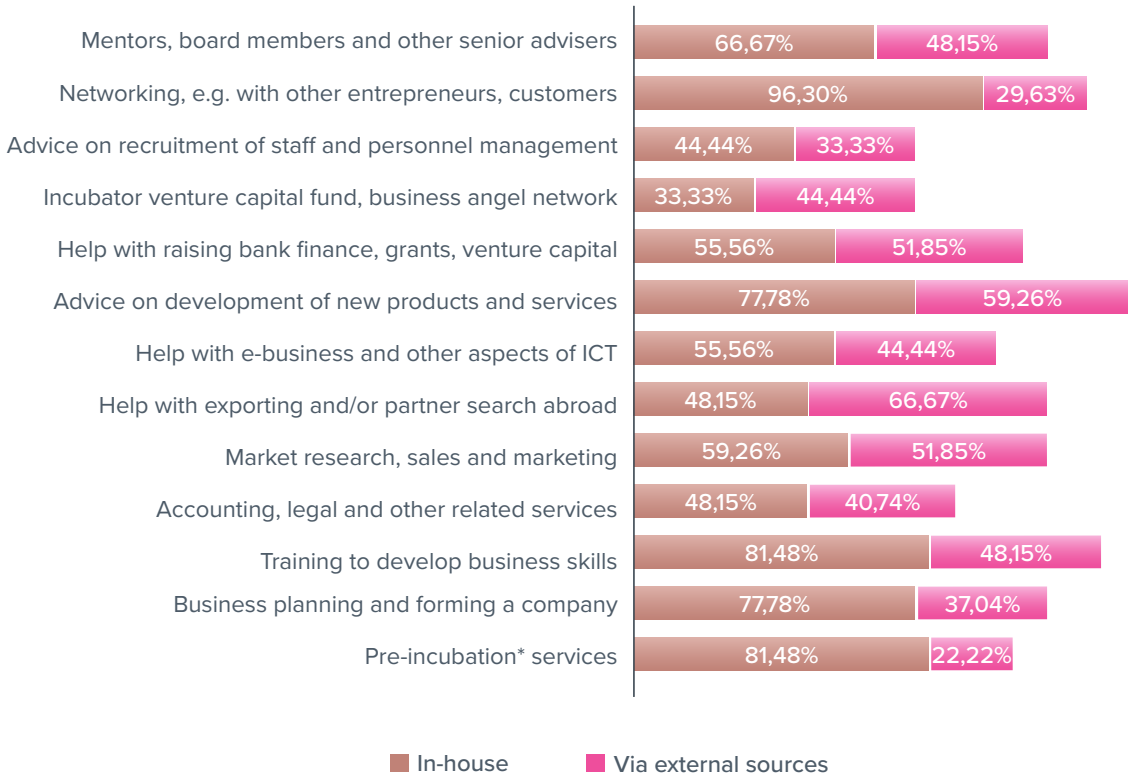
While there are certain differences between WB economies, the general impression is that the development of innovation infrastructures in the WB region is still in its infancy. Results of our research showed that the average age of innovation infrastructures in the region is about 7 years. In recent years, significant progress has been made in innovation infrastructures in most WB economies.

The top five ranked services overall that are provided by innovation infrastructures in the WB region are:

1. Networking with other entrepreneurs, and customers;
2. Training to develop business skills;
3. Pre-incubation services;
4. Business planning and forming a company, and
5. Advice on the development of new products and services.

These services are delivered through a mixture of in-house and outsourced services as shown in Figure 11. The least commonly reported services that are provided in-house are services related to venture capital funds and business angel networks. This is in line with the key challenges the region is facing, namely limited access to finance, and more specifically: the lack of venture capital funds and alternative sources of financing in the entire WB region.

Figure 11: Types of business support services provided by Innovation Infrastructures from Western Balkan



Source: Authors' visualisation based on the conducted research

Cooperation with universities was reported in only a few cases. Given that some of the most advanced innovation infrastructures (such as ICT Hub, Belgrade) have reported tight cooperation with universities, their models and approaches should be explored further to identify possible models and space for cooperation between universities and innovation infrastructures in the region.

Close connection between the University of Niš and Science and Technology Park Niš

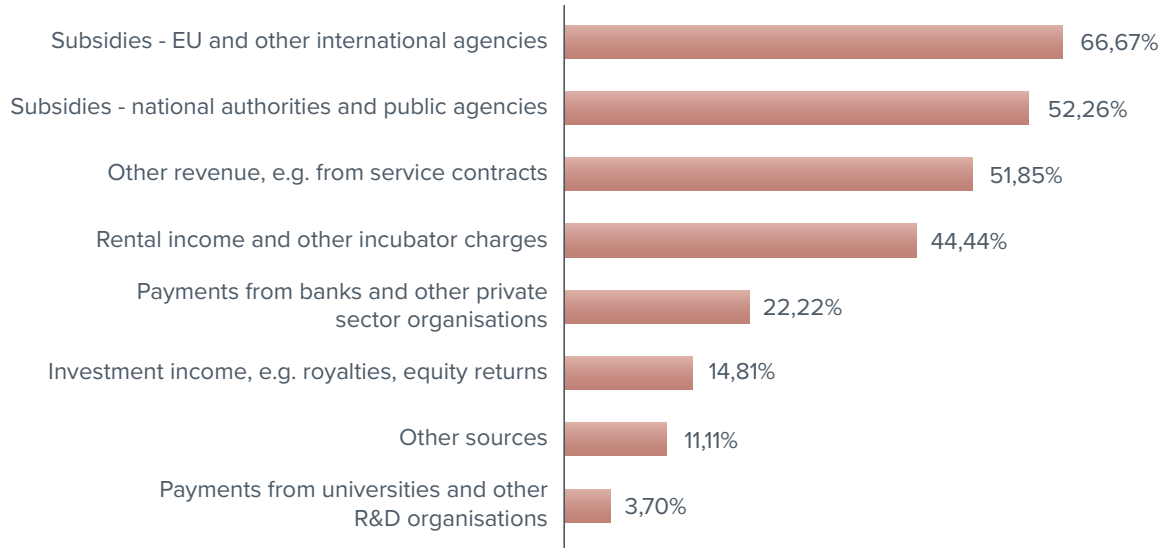
A good example of cooperation between innovation infrastructures and universities is that between the University of Niš and Science and Technology Park Niš. The University of Niš provides support to STP Niš by creating conditions for joint research through laboratory testing for STP Niš members at lower prices; mobilisation of researchers to solve specific technological and development problems; adjustment of the curriculum for the needs of the STP Niš members, and so on. It is also important that the resources of the Multipurpose Laboratory Lamella of the Faculty of Electronics at the University of Niš will be made available for developing the STP Niš members' projects.

Cooperation with other innovation infrastructures is based mostly on the sharing of resources and exchange of experiences and good practices, while joint projects are rare. This

demonstrates an overall low level of cooperation amongst innovation infrastructures and an obvious area for future improvement.

More than 66 percent of innovation infrastructures from the WB region are financing their operating costs from EU and other international agency subsidies, including EU projects and tenders. On the other side, financing from universities, R&D organisations and private companies is the least represented – only 3.7 percent of innovation infrastructures have used these sources of financing (Figure 12).

Figure 12: Sources of financing operating costs



With regard to capital equipment/technical infrastructure, about 48% of innovation infrastructures have reported that they own equipment that is offered to tenants/clients for use. Some of the most common research equipment reported by respondents include:

- 3D printers
- Equipment for 3D scanning and printing with software for professional 3D modelling
- Laser cutting and engraving equipment, UV printing equipment
- CNC Machines
- VR Headsets, Immersive Glasses & Equipment
- Microsoft HoloLens
- Soldering Station
- Dual-arm collaborative robot
- Licensed software for production planning, industrial robot programming
- etc.

2.2.1. IMPORTANT REGIONAL INITIATIVES AND INVESTMENT OPPORTUNITIES

The Western Balkan region has traditionally been financed by commercial bank lending, which has limited both the size and general availability of lending. The current presence of private equity funds in the WB region is inadequate due to the small market size for larger equity investments, lack of local market knowledge, and an unstable political and economic situation. Therefore, untapped market opportunities exist in the WB, capable of providing significant investment returns.

However, despite the generally unfavourable situation, when it comes to the availability of venture capital funds and other support initiatives, it is important to point out two initiatives that are of regional importance and have achieved notable results in the WB region in recent years:

- Western Balkans Enterprise Development and Innovation Facility
- South Central Ventures

Western Balkans Enterprise Development and Innovation Facility

The Western Balkans Enterprise Development & Innovation Facility (WB EDIF), funded by the EU, aims at improving access to finance for SMEs in the Western Balkans. The WB EDIF addresses the needs of SMEs by providing enhanced access to finance and by creating a more favourable financing environment for SMEs and a sustainable equity market in the long run. This includes the promotion of policy reforms to create the necessary political framework which supports SME financing. Financial Instruments under WB EDIF consist of four different pillars:

1. SME Equity Financing
2. SME Loan Guarantee
3. SME Lending
4. Support Services

The table below shows the number of SMEs supported by WB EDIF instruments.

Table 2: WB EDIF economies supported

WB Economy	Provided in financing to SMEs (million euros)	SMEs financed (total number of SMEs)
Albania	36,9	561
Bosnia and Herzegovina	34,9	209
North Macedonia	36,5	141
Kosovo*	72,6	584
Montenegro	28,1	943
Serbia	202,6	1.199

Source: http://www.wbedif.eu/about-wbedif/

WB EDIF is the first regional initiative focusing on SMEs which is channelled through the Western Balkans Investment Framework (WBIF). WBIF supports socio-economic development and EU accession across the Western Balkans by providing finance and technical assistance for strategic investments, particularly in infrastructure, energy efficiency and private sector development.

WB EDIF's Equity instrument pillar consists of Enterprise Innovation Fund (ENIF) and Enterprise Expansion Fund (ENEF). WB EDIF consists of Enterprise Innovation Fund (ENIF) and Enterprise Expansion Fund (ENEF). ENIF is a venture capital fund focusing on an investment portfolio consisting of innovative SMEs at various stages of business development, from the seed to expansion phase, in the Western Balkans. ENIF aims at reinforcing the financial structure of innovative SMEs resulting in a strong and bankable balance sheet. The fund is set up as an independent entity and is managed by South Central Ventures. By December 2020, ENIF's portfolio was composed of 28 active companies, out of which 4 are growth, 17 are startups and 7 are seed capital. The portfolio is mostly composed of high technology sectors with a focus on ICT. ENIF's aggregate capital commitment invested in portfolio investments stands at 72% of the committed capital. According to the data available on the website (http://www.wbedif.eu/for-entrepreneurs/enterprise-innovation-fund-enif), ENIF has supported seven companies from Croatia, while out of 20 supported companies from the WB region, 14 are from Serbia. Five companies from North Macedonia received the ENIF's support, two from Montenegro, one from Kosovo*, and none from Albania and Bosnia and Herzegovina since its inception.

ENEF finances the established SMEs in the WB region with high growth potential to support the development and expansion of their businesses. In particular, ENEF aims to identify local and regional champions – market leaders with good growth prospects – and provide them with the financing they need to take them to the next level. It is managed and advised by the European Bank for Reconstruction and Development (EBRD). Until 2021, ENEF has invested 53.6 million euros in 14 SMEs from the region.

South Central Ventures

With offices in Ljubljana, Zagreb, Belgrade and Skopje, South Central Ventures (SCV) is a venture capital fund that, through Enterprise Innovation Fund (ENIF), focuses on tech companies in South-East Europe. Its investment strategy is targeted primarily at early-stage and growth investments in technology companies. The main purpose of the invested capital is to facilitate the international business expansion and growth of the most promising tech startups that can show traction and prove their potential to "make it big". It invests in seed and early growth startups. Seed investments are up to 500,000 €, while early to growth-stage investments are up to 5 million euros per company. Within the WB region, the primary geographic focus is on Belgrade and Skopje. South Central Ventures is supported by WB EDIF.

Apart from the regional funds and programmes, an important challenge for the region is the lack of venture capital funds at the level of individual economies. However, even in that sphere, things have begun to change. Namely, in 2021, the first corporate VC fund was established in Serbia (more information in the text box below). So, following the examples of good practice, progress in this area is expected in the coming period.

First Corporate Venture Capital Fund in the Western Balkans

TS Ventures Fund, founded in 2021 by Telekom Serbia, as the first Corporate Venture Capital Fund in this part of Europe established with the aim of investing in startups and innovative entrepreneurs which are in the initial phase of development of their businesses and, on the other hand, possess high potential for fast global growth of their business. The Fund of Telekom Srbija a.d. was modelled after the largest world companies, which will help it ensure further improvement and growth of its business in the forthcoming period. Telekom Serbia will invest 25 million Euros in the Fund in the next 5 years.

2.3. KEY INNOVATION INFRASTRUCTURES IN THE WB ECONOMIES

SERBIA

Innovation Ecosystem

Considering the composite indicators provided by prestigious European and world organisations, Serbia is usually ranked better than the other economies in the WB region but is often positioned worse than the EU average. According to the European Innovation Scoreboard report (2021), Serbia is an Emerging Innovator. Over time, the performance relative to the EU has increased. The improvement in innovation performance in the last two years is the result of improved performance related to broadband penetration, venture capital, product and business process innovators, design applications, and employment in innovative enterprises.

There have been many initiatives in Serbia, both top-down and bottom-up, targeted at providing support to startup and scale-up activities of newly established innovative companies. According to the research and innovation policy framework, Serbia considers the development of startups, SMEs and entrepreneurs as an important factor in the development of an innovation-led and knowledge-based economy. This policy is reflected in several policy instruments and measures aimed at supporting SMEs and startups. In addition, the Government of Serbia has been making significant efforts to promote Serbia as an innovation destination (http://srbijastvara.gov.rs).

Massive promotion of startups and entrepreneurship was particularly intensified in the last 5 years. It started in 2016 when Serbia declared the Year of Entrepreneurship and continued with the development of numerous strategic documents such as the Strategy for Supporting the Development of Small and Medium-Sized Enterprises, Entrepreneurship and Competitiveness (2015-2020), Intellectual Property Development Strategy (2018 – 2022), Strategy for Development of Information Technology Industry (2017-2020), Smart Specialisation Strategy (2020-2027), Strategy for the Development of Artificial Intelligence (2020-2025), Industrial Policy Strategy (2021-2030), etc.

The Startup Genome report (2019) identified Serbia, particularly Belgrade and Novi Sad, amongst the most promising startup locations globally. This was the result of the analysis of more than 150 cities and 54 startup ecosystems around the world. This report emphasises growth of the overall number of startups, growth of investments in local startups and availability of high-quality engineering staff. When it comes to the startup community, it is also worth noting that gaming and blockchain have been identified as the most dynamic and most promising sub-sectors in Serbia.

Innovation Infrastructure: key stakeholders

Two key institutions aiming to provide financial support for innovation activities at the economy level are: Innovation Fund and Science Fund. The former does so, primarily through R&D investments, while Innovation Fund is primarily aimed at raising innovation in private entities.

- Innovation Fund

  The Innovation Fund of Serbia (IF) was established in 2010 by the Law on Innovation Activity, in order to provide funds for innovation activities. The IF is directly focused on supporting and transforming ideas and inventions into commercial products, services, and processes, fostering university-business cooperation. From its start in 2011, the IF has disbursed over €31 million through its programmes until September 2020. Currently, the IF provides support through many different programmes.

  Innovation Fund activities are highly integrated with the Smart Specialisation Strategy of Serbia (4S) and rely on the priority areas identified by 4S. In 2020, the Innovation Vouchers scheme disbursed RSD 60 million to 118 projects, 72% of which came from priority areas identified under this strategy. The other two programmes, Mini Grants and Matching Grants, disbursed €5.3 million to 35 projects, of which 34 came from priority areas of the 4S.

  In the period ahead, intensive engagement of the IF and growth of activities to support innovative actors in the innovation ecosystem are expected. According to the Strategy of Scientific and Technological Development of Serbia, the annual funding capacity will increase by € 1.7 million in 2022 and € 2.56 million in 2023.

Long-term investment in the startup ecosystem of Serbia: Serbia Ventures Program

- On 15 March 2022, the Innovation Fund launched a new support scheme: the Serbia Ventures Programme. The programme is designed to incentivise private investors, high net worth individuals and institutions to engage in financing startups with high growth potential by incorporating venture capital funds in Serbia. Through this programme, the Innovation Fund will invest into newly established venture capital funds in Serbia in the role of a limited partner and help these funds generate a significant market impact on Serbia's innovation ecosystem.
- Amount of financing: up to EUR 5,000,000 per individual venture capital fund, provided the mandatory precondition that the selected VC fund has already

commitments from its limited partners/investors to raise, at least the same amount of capital within 12 months of achieving its first close

Funds for the public call were provided from the budget of Serbia, the Ministry of Education, Science and Technological Development, and the programme design was created by Digital Serbia Initiative through the Swiss Government support programme.

- Science Fund

  Science Fund (SF) was founded in March 2019 as an institution that provides support to scientific research activities through the implementation of scientific, technological and development projects. Its programme activities have so far been implemented through 5 programmes mainly aimed at research institutions.

  The most relevant SF programme for innovation activities, Innovation, is in the preparation phase. Once it is prepared, it will be based on 4S, and it will further stimulate research contracts in priority areas of 4S between research institutions and research users. The programme aims at the implementation of projects with the participation of partners from the business sector and with the obligatory direct application of research results. This will expand the availability of financial resources to industry, but also directly raise the applicative character of the research.

  As the most advanced WB economy, Serbia has a large number of institutional actors to support innovative activities. Unlike other WB economies, which are still lacking the most advanced innovation infrastructures such as Science and Technology Parks, in the last few years, Serbia has significantly improved its innovation infrastructure.

  The establishment of Science and Technology Parks (STP) in Serbia started a few years ago. STP in Belgrade has successfully started its operations in 2015. Following this successful example, investments and the construction of STPs continued in other regional centres of Serbia: Novi Sad, Niš and Čačak. This was an important step toward the creation of successful innovation ecosystems with a large number of different stakeholders that jointly create solutions for different challenges in the future.

- Science and Technology Park Belgrade

  The Science and Technology Park Belgrade (STP Belgrade) is the first science and technological park in the WB region established in 2015 through a partnership between the Ministry of Education, Science and Technological Development on behalf of the Government of Serbia, the City of Belgrade and the University of Belgrade. STP Belgrade has a key impact to shaping the development of Serbia's innovation ecosystem. STP Belgrade hosts more than 70 tenants in 16.446 square meters. Since its formation, STP Belgrade has supported the accelerated development of more than 100 companies. STP Belgrade premises currently host the Business Technology Incubator of Technical Faculties Belgrade and Innovation Fund of Serbia. The knowledge and experience acquired by STP Belgrade are being transferred to Niš and Čačak, to speed up the

development of STPs in those two cities, and to facilitate the accelerated development of new export-oriented tech companies in these regions.

- Science and Technology Park Niš

STP Niš was founded in 2020 through a partnership between the Government of Serbia, the City of Nis and the University of Nis. In the first year, 66 companies responded to the public invitation for membership. STP Niš currently assists 40 members in 14,000 square meters. The University of Nis, as one of the founders, supports STP Niš by hiring researchers, teachers and associates employed at the faculties of the University of Niš; creating conditions for joint research, through laboratory testing, for STP Nis members at lower prices; mobilisation of researchers to solve specific technological and development problems; adjustment of the curriculum to the needs of the STP Nis members and other. The Faculty of Electronics, Faculty of Mechanical Engineering, Faculty of Civil Engineering and Architecture, whose staff and students and laboratories are the primary research base, are located near the STP Niš.

- Science and Technology Park Čačak

STP Čačak was initially established in 2011. The founders were: the Government of Serbia, City of Čačak, Business Association Gradac 97, Business Association of Employers - Union Čačak 2000, Faculty of Technical Sciences, Faculty of Agriculture, Čačak, and Institute of Fruit Growing. However, the full capacity was achieved recently through the expansion of capacities. A new complex of STP Čačak was opened in 2020. Innovative companies have about 4,500 m2 at their disposal; and there is also a production plant within the building. There are 7 tenants so far. STP Čačak aims to enable collaboration between industry, science, and research through the development of new ideas to increase the competitiveness of the regional economy. It provides the infrastructure, management, and technical assistance to innovative startup businesses, enabling their further growth and development through professional support and technology transfer from the academic and research sectors. Some of the goals include the recruitment of young university-educated people and reducing the brain drain.

- Science and Technology Park Novi Sad

STP Novi Sad is a newly established entity (31,350 m2) founded by the Autonomous Province of Vojvodina in 2019. It was officially opened at the beginning of 2020 and it currently hosts 9 innovative companies and 8 startups. In 2022, it expects additional 7 startups to become full members. STP Novi Sad is strongly connected to the University of Novi Sad since it is located within the Campus of the University of Novi Sad. Many of the STP Novi Sad member companies are spin-offs created by University's staff and students. Furthermore, one-third of the space capacity is dedicated to the Department of Electrical Engineering and Computing of the Faculty of Technical Sciences which makes this connection strong.

The first business incubator initiatives in Serbia appeared in 2004, supported by international donor organisations. According to the report on business incubators in Serbia (2020) [9], in 2006 there were only 6 business incubators in Serbia, and around 40 functional business incubators were identified in 2020.

In the Serbian ecosystem, hubs are also recognised as extremely important for the innovation and startup ecosystem. According to the Law on innovation activity, hubs are recognised as business and technological incubators, launched as private or civic initiatives. Hubs are usually initiated with the support of donors and are financed mostly through project activities or the commercial provision of services.

Appendix 2 presents a comprehensive list of innovation infrastructures in Serbia that have been reached within the mapping activities. Innovation infrastructures that have the greatest impact on the innovation ecosystem in Serbia are:

- ICT Hub
- SEE ICT (StartIT)
- Business incubator Novi Sad
- Business Technology Incubator of Technical Faculties Belgrade
- Vojvodina ICT Cluster
- Serbian Games Association
- Serbian Blockchain Initiative

In addition to the above-mentioned innovation infrastructures that have had a significant impact on the innovation ecosystem of Serbia for many years, in the last few years, several innovation infrastructures have been established that have the potential to significantly impact the future such as Belgrade Robotics Hub, Health Tech Lab, KGCODE. These and similar initiatives are not presented in detail but are mentioned in Appendix 2.

- ICT Hub

  ICT Hub is a centre for technology entrepreneurship and innovation. Founded in 2014, in a very short time, it positioned itself as one of the key stakeholders in the local and regional innovation ecosystem. It brings together individuals, startup teams, companies and various organisations, experts and institutions, by providing them with consulting services, training, education and overall support on their innovation journeys.

  ICT Hub comprises a team of individuals dedicated to empowering innovation, both in smaller business systems that are fighting for their marketplace, as well as in corporations that are making significant efforts to understand the needs of the ever-changing market and improve their current industrial positions. Through a series of educational, mentoring and consulting activities, ICT Hub provides professional support

9 Karl-Heinz J., Černevičius , T., Batstone S., Mandić V., Marinković M., Uus I. & Kovačević M (2020). Study on the current situation of BIs in the Republic of Serbia, GFA Consulting Group GmbH, Belgrade 2020

in the strategic approach to innovation, improvement of the organisational culture and development of technological entrepreneurship, both to partners in Serbia and the WB region. Four key service segments for ICT Hub are:

1. Consultancy in the field of innovation and business development
2. Inception, development and implementation of donor-funded projects
3. Office and workspace solutions
4. Investments in early-stage tech startups - ICT Hub Venture

- SEE ICT

SEE ICT is a grass-roots non-profit organisation established in 2010, with the mission to provide meaningful, deep support to the Serbian technology and startup scene to foster higher employment and economic growth. Its activities have reached more than 100,000 people in Serbia and 70% of all investment rounds in tech startups in Serbia were raised by startups from their projects.

SEE ICT provides relevant knowledge, skills, networking and employment opportunities to Serbian youth, entrepreneurs and IT professionals, through courses, conferences, meetups and festivals, hackathons, as well as the leading local tech and entrepreneurship website – Startit.rs, which is read by 50,000 people every month. It has been steadily growing for the last three years and its programmes were supported by GIZ, USAID, the US Embassy, German Embassy, Embassy of Israel, IEEE, Erste Foundation, AmCham and many tech companies such as Microsoft, Nordeus, Seven Bridges, SAP, Endava Technologies, etc.

- Business incubator Novi Sad

Business incubator Novi Sad helps young companies to find their way to the market. Its focus is on supporting projects based on knowledge and new technologies whose potential market has the high scalability potential. The Incubator is specialised in working with teams in the field of ICT and creative industries. On a total of 840 square meters, there are 18 private offices based on the 'plug and play' model.

Business incubator Novi Sad provides the following services:

- Administrative services,
- Bookkeeping and legal consulting services,
- Consulting and mentoring service with a special focus on business planning and training, support in accessing funding sources and promotion of business ideas,
- Networking, connecting with researchers from universities, connecting with potential strategic partners,
- Finding new employees, etc.

Business Technology Incubator of Technical Faculties Belgrade (BITF)

BITF is Serbia's first business technology incubator that provides comprehensive support to young, educated people in developing innovative ideas and starting their businesses. It was founded in 2006 by the University of Belgrade School of Electrical Engineering, City of Belgrade-Municipality Palilula, Faculty of Civil Engineering University of Belgrade, Democratic Transition Initiative, Faculty of Mechanical Engineering University of Belgrade and Faculty of Technology and Metallurgy University of Belgrade. It is located within the premises of STP Belgrade.

Its services include:

- Preparation of young people, final year students and graduates of technical faculties, for starting their own business, both through education and training programmes and permanent consulting and mentoring programmes;
- Development of innovations through the final stages of research processes in the development and commercialisation of new products, services, technologies and prototypes in the process of knowledge and technology transfer from the faculty;
- Support to small, newly established innovative companies - members of BITF, to overcome difficulties in the initial stages of their development and to successfully develop their business with the services of incubators (economic, legal, accounting) and continuous training, consulting and mentoring.

Vojvodina ICT Cluster

Vojvodina ICT Cluster is a business association founded through a bottom-up initiative of ICT companies and several supporting institutions. It is a fast-growing organisation, the strongest in its field in Serbia. The companies from this cluster exhibited strong growth in recent years, regardless of the global recession. Vojvodina ICT Cluster gives institutional support to this trend, mobilising players from the triple helix business–education–government. Strong support from the University of Novi Sad adds to the strength of the cluster.

The cluster has its own Academy, organising courses, presentations and lectures according to the needs of the members, as well as a separate project office that grows its projects portfolio and revenues every year, making Vojvodina ICT Cluster leader in excellence among organisations of this type in Serbia.

Serbian Games Association

The Serbian Games Association (SGA) is a non-governmental, non-profit organisation dedicated to the development of the Serbian gaming industry. Its members are teams, companies and individuals engaged in the production of video games in Serbia. Founded in March 2018 in Belgrade, it delivers educational programmes, helps establish new partnerships, conducts research and participates in numerous processes that support

the quality, development, growth and internationalisation of Serbian gaming products and companies.

SGA gathers 44 full and 60 associated members out of about 120 teams and companies in Serbia that are actively working on the development of games and other services closely related to the gaming industry. Within just a few years, the landscape of Serbia's gaming ecosystem has significantly improved with the immeasurable impact of the SGA.

Serbian Blockchain Initiative

The Serbian Blockchain Initiative (SBI) is a non-profit, non-government organisation, created to support blockchain adoption in Serbia and enhance the ability of Serbian blockchain businesses to compete globally. SBI promotes the comprehensive adoption of blockchain technology across the public and private sectors in Serbia and globally. It connects relevant industry players to advance the understanding, acceptance, and application of blockchain technology. The main initiatives include:

- Knowledge-sharing and assisting startups and companies
- Fostering the exchange of ideas and facilitating co-operation via events
- Enhancing blockchain education and deepening the Serbian talent pool
- Providing access to different local and foreign grants and funds
- Analysing and monitoring the behaviour of different jurisdictions
- Following the regulations that economies around the World bring
- Communication with representatives from the Serbian government and regulators
- Communication with legal experts in Serbia and abroad
- Global Advisory Network - Its Committees are exceptional business executives
- International Partnerships with similar blockchain associations around the World
- Business Networking events to increase the awareness of the Serbian ecosystem
- SBI's Yearly Conference as a flagship event for all our members and partners

Belgrade Robotics Hub

Belgrade Robotics Hub (BRH) is a Digital Innovation Hub, founded in 2019 by 2 faculties, 1 institute and 4 companies:

- Robotics Lab, School of Electrical Engineering, University of Belgrade
- Centre for Robotics, Institute Mihajlo Pupin, University of Belgrade
- Laboratory for robotics and artificial intelligence, Faculty of Mechanical Engineering, University of Belgrade
- Servoteh d.o.o.

- ABB d.o.o.
- TipTeh d.o.o.
- Gimatic d.o.o.

The main mission of BRH is to provide companies, students, investors, innovators, policymakers, and the general public with high-quality robotics-related services in education, technology, and business. It aims to make a continuous contribution to robotics innovations, companies' productivity and competitiveness, opening new opportunities for young engineers in Serbia, and stimulating interaction in the regional robotics community.

BRH's vision is to be a focal point, initiator, creator and the biggest support of robotics research, education, and applications in Serbia and wider in the region of South-East Europe.

In the last 2 years, BRH has supported about 20 clients, mostly SMEs.

Health Tech Lab

Health Tech Lab (HTL) is a non-profit organisation that was created in 2018 to meet the real need of building an impactful health-tech ecosystem in Serbia. The core mission of HTL is to identify health challenges and create and support innovative, technological solutions with the patient always being at the core. Some of the key achievements during the first two years are the following:

- Enabling a total of 8 health-tech meet-ups from which 5 were part of partnering conferences
- One self-orchestrated conference marking the partnership and membership within the European Connected Health Alliance
- 1 educational workshop on data protection – GDPR in Health
- Co-organisation of health-tech startup competition Startup Jerusalem, together with the Israeli embassy in Serbia and Friedrich Naumann Foundation for freedom
- Co-organisation of the pre-acceleration programme for health startups in collaboration with the Innovation Forum Cambridge, UK and the Science and Technology Park Belgrade
- Active collaboration with government officials to address key legal and bureaucratic barriers for health tech startups
- Membership with the European Connected Health Alliance-ECHAlliance since June 2018
- Becoming local expert and international jury at the United Nations based World Summit Awards in February 2019

- Distinguished as one of four finalists of the Science & Research for Women In Tech programme in Paris, France.

After Serbia, the Health Tech Lab model is planned to be reproduced in other developing countries in Africa, South America and Asia.

KGCODE

KGCODE is a non-profit organisation established to initiate an IT scene in the city of Kragujevac. The main focus is on exchanging experiences and knowledge, developing new IT projects, establishing new startups and creating conditions for Kragujevac to become one of the main centres of IT and creative industries in Serbia. Their services are oriented toward the organisation of IT events, trainings and workshops and networking services. It also supports the work of freelancers across Serbia.

While most innovation infrastructures are located in bigger cities (Belgrade, Kragujevac, Novi Sad and Niš), there are also many innovation infrastructures in smaller places, and some are very successful. It is also worth remarking that most of the identified innovation infrastructures are relatively young, established only a few years ago.

Government-led Startup Centres

Guided by the idea of unleashing the innovation potential of local startups, the Cabinet of the Minister without Portfolio in charge of Innovation and Technological Development initiated the development of a network of regional innovation startup centres across Serbia. The Ministry launched the Programme for the establishment of regional startup centres in the period 2018-2020. As a result of this programme, 9 regional startup innovation centres were established throughout Serbia. This call was targeting local municipalities to establish startup centres in cooperation with other business support organisations. The table below shows the list of startup centres established.

Table 3: The list of regional innovation startup centres established in Serbia in the period 2018-2020 supported by the Ministry of Innovation and Technological Development

Name of Innovation infrastructure	City	Founders
Startup Centre Niš	Niš	City of Nis Faculty of Electronics, University of Niš
Startup Centre of the Science and Technology Park Cacak	Čačak	City of Cacak Science and Technology Park Cacak
Regional Innovation Startup Centre Gornji Milanovac	Gornji Milanovac	Municipality of Gornji Milanovac ICT Hub, Belgrade
Innovation Startup Centre Stara Pazova	Stara Pazova	Municipality of Stara Pazova Regional Development Agency Srem d.o.o.
Regional Innovation Startup Centre of Rasina District	Krusevac	City of Kruševac Business Incubator, Kruševac

Name of Innovation infrastructure	City	Founders
Regional Innovation Startup Centre Subotica	Subotica	City of Subotica Faculty of Economics, University of Novi Sad
Startup Centre Pirot	Pirot	City of Pirot Zip Centre-business incubator from Pirot
Serbian Innovation Network - StartIT Centre Zrenjanin	Zrenjanin	City of Zrenjanin SEE ICT Startit, Belgrade
Regional Innovation Startup Centre Valjevo	Valjevo	City of Valjevo Business Incubator, Valjevo

Source: Ministry of Innovation and Technological Development, https://inovacije.gov.rs/

Support to the newly established startup centres has continued in 2021. The second call to support the work of regional innovation startup centres was launched in 2021. The goal of the new call was the systematic improvement of the innovation ecosystem by providing support to the work of regional innovation startup centres established through programmes implemented in the period 2018-2020. The ultimate goal of the Programme was to provide the necessary conditions and equal opportunities for development and implementation of innovative entrepreneurial ideas in all parts of Serbia.

Most of the above-mentioned startup centres receive cash operating subsidies. If this funding was stopped, the incubator activities would have to be reduced significantly or the incubator activity would stop altogether. This leads to the conclusion that most of the startup centres established within the government programme are dependent on subsidies and that they are still far from developing sustainable models of operations.

NORTH MACEDONIA

Innovation Ecosystem

According to the last European Innovation Scoreboard report (2021), North Macedonia is an Emerging Innovator. Over time, performance relative to the EU has increased. Recent performance improvements are the result of increased performance for tertiary education, lifelong learning, international scientific co-publications, digital skills, government support for business R&D, ICT specialists, medium and high-tech goods exports, and knowledge-intensive services exports.

Based on the review of strategic documents of the Government of North Macedonia in the area of innovation policy, it can be concluded that the strategic framework does not keep pace with the recent developments on the startup scene. The previous Innovation Strategy (2012-2020) expired a year ago and the innovation strategy for the coming period was not adopted until January 2022.

According to the research conducted by the Startup Europe Central and Eastern Europe Network, North Macedonia is recording a rising number of startups in the last few years. While a decade ago, the startup society mainly consisted of IT outsourcing companies offering low-cost developers, today, new IT companies are dotting the startup ecosystem with more and more product-focused companies. ICT, particularly software solutions, is the most attractive sector for new startups. Most concretely, digital media, fintech, gaming, blockchain, the Internet of things, and tech in Agriculture are the most represented areas within new startups.[10]

According to the research conducted by Startup Macedonia (2021)[11], startups from North Macedonia are in general satisfied with the support they are getting from the innovation infrastructure. Startup founders are actively participating in the programmes provided by innovation infrastructures, either as a participant eager to learn, improve, or connect with others, or as a mentor sharing their experiences. There are areas for improvement, but overall, there is a positive signal of an ecosystem working closely together compared to the previous years. The same report also stated that North Macedonia is witnessing growing interest from international founders and startup teams to set up headquarters there. However, while Skopje has come very far, equal access to services has to be provided to other cities as well. As the ecosystem is progressing towards the growth stages, the majority of innovation infrastructures go towards promoting access-to-finance services as well as business and sales skills.

Innovation Infrastructure: key stakeholders

The key institution for supporting startups and innovative companies in North Macedonia is the Fund for Innovation and Technology Development (FITD).

- #### Fund for Innovation and Technology Development

  FITD is the main institution for supporting startups and innovative companies in North Macedonia. It is a leading seed investor in North Macedonia. Operating as a government entity, the FITD has been co-financing a substantial number of startups and SMEs over the past years. FITD is currently a driving force behind seed and early-stage funding. The majority of startups have applied to its funding calls, and the majority of those have received some funding. By the end of 2021, the Fund supported 782 projects with a joint investment of 88 million euros.

  In addition to the support provided to startups, FITD also supports talented elementary, high school and college students as well as supporting organisations. With almost 1.5 million euros, together with the World Bank, FITD supported the development of three accelerators in North Macedonia: X Factor, Seavus Accelerator and Business Technology Accelerator UKIM.

  There are also other important actors in the ecosystem providing financial support to startups and innovative companies in North Macedonia such as South Central

10 Startup Europe Central and Eastern Europe Network (2021), retrieved from: https://startupeurope.network/ecosystems/mk

11 Connecting Macedonian Startup Ecosystem (2021), retrieved from: https://fitr.mk/wp-content/uploads/2021/11/ECOSYSTEM-REPORT-2021-PDF-Web.pdf

Ventures, CEED Macedonia Business Angels Club, Crimson Capital, Business Angel Network – I2Ban, etc. However, their impact on the development of the startups in North Macedonia has not been strong so far.

The South Central Ventures is focused on tech companies in the Western Balkans and has supported around 30 startups from the entire region.

CEED Macedonia Business Angels Club was formed in November 2013. Currently, 20 entrepreneurs are Club members who are willing to invest in business ideas or existing businesses, if they identify the potential for growth or innovation. The network's three main activities consist of: matchmaking of startups and investors, sharing of best practices and representation of the private investors' interests. Since January 2016, CEED Macedonia Business Angels Club is officially a member of the European Business Angel Network (EBAN).

The Crimson Capital is an international investment bank and management consulting firm established in 1991 to provide privatisation and restructuring expertise to emerging markets in Eastern Europe. Through its Skopje office, it provides loans to local SMEs and startups.

I2Ban was the first official Business Angel Network (BAN) in North Macedonia established in March 2011. However, they are not active anymore.

The most important innovation infrastructures in North Macedonia are:

- Startup Macedonia

Startup Macedonia, headquartered in Skopje, is a grassroots umbrella association founded in 2016 by a group of Macedonian startup enthusiasts, founders, experts, and investors, who have one common goal: to connect the Macedonian startup community through a data-driven approach and encourage and help create a favourable work environment for startups and scale-ups in North Macedonia. The development of the ecosystem is happening at a fast pace thanks to the cooperation of all stakeholders coordinated by Startup Macedonia, especially with the development of their digital platform. Their activities include:

- Strengthening the startup & innovation eco-system;
- Influence mindset change by raising awareness and creating opportunities;
- Facilitate collaboration and synergies among eco-system factors;
- Encourage local and international investments;
- Bridge the gap between the startup community and policy makers;
- Create a data-driven eco-system in order to grow;
- Support startups scale their business globally;
- Provide promotion and media coverage to success stories;
- Support events, hackathons, demo days, conferences, bootcamps;

- Warmly welcome international founders and Entrepreneurs-In-Residence;
- Working on positioning the economy as a startup hub in New Europe.
- The Chamber of Commerce for Information and Communication Technologies (MASIT)

MASIT represents the ICT industry of North Macedonia and promotes and represents the business interests of ICT companies to promote and develop the ICT industry and business environment. The Chamber represents companies operating a wide range of ICT products and services in North Macedonia and since its establishment in 2000, as a non-profit and voluntary institution, it has provided its member companies with access to information, education, legal advice, cooperation, networking and promotion at domestic, regional and international levels, to advance and develop the ICT industry.

MASIT cooperates regionally with all ICT Associations in the WB region and is a member of the Balkan and Black Sea Cluster Network. Internationally, MASIT has been a member of the World Information Technology and Services Alliance (WITSA) since May 2005.

Seavus Accelerator

Seavus Accelerator is a programme co-funded by the FITD and led by Seavus Education and Development Centre, which is an active player in the international startup community. Along with its investments, Seavus Accelerator offers an intensive 6 + 6-week mentorship-driven programme and connects startups with more than 1000 tech experts globally.

Business Technology Accelerator UKIM

Accelerator UKIM is a business-technology accelerator established to identify and support the growth of the most promising technology entrepreneurs, startups, spin-offs and scale-ups in North Macedonia. The support includes tailored pre-acceleration and acceleration programmes, early-stage investments and access to international markets, networks and communities. It mainly supports investment opportunities in ICT, SaaS, Deep Tech, AI, Cleantech, Fintech, IOT, Cloud Services, Industry 4.0 Technologies, Digital Security, and others. The support programmes are in line with the expertise of the technical faculties of Ss. Cyril and Methodius University in Skopje, including advanced R&D.

X Factor Accelerator

X Factor, together with Business Accelerator UKIM and Seavus Accelerator, is one of the three accelerators in North Macedonia, supported by FITD through the World Bank, which received financial support of 2 million euros through the public call for financing technological accelerators. X Factor Accelerator aims to support the faster development of innovative ideas, market validation and building of scalable and

sustainable business models for the startup community. In 2021, X Factor Accelerator made three investments in startups in the total amount of 300 thousand euros.

- YES Incubator

  The Youth Entrepreneurial Service (YES) Foundation offers access to services for accelerating growth and development. It does this through its main component, a business incubator, which supports micro, small and medium enterprises in the ICT field. It also offers mentorship, courses related to entrepreneurship, and resources via its website.

- Centre for Technology Transfer and Innovations (INNOFEIT)

  Having recognised the need for tighter cooperation between academia and industries, the Faculty of Electrical Engineering and Information Technologies, Ss. Cyril and Methodius University opened the INNOFEIT. INNOFEIT is currently an important cornerstone in the innovation ecosystem, a co-founder of the Accelerator UKIM and a selected candidate by the European Investment Bank (EIB) to become a Centre-of-Excellence in its fields of interest.

- Social Innovation Hub

  The Social Innovation Hub, founded by the Faculty of Computer Science and Engineering, Ss. Cyril and Methodius University and United Nations Development Programme (UNDP), aims to make the most of technology to advance young people's development by encouraging innovative solutions to social and economic problems. It also provides a space for them to work and incubate their ideas.

- Social Impact Lab

  Operating in Skopje, the Social Impact Lab focuses on solving global problems, creating impact, and influencing society, by strengthening and reshaping the ecosystem of social entrepreneurship in North Macedonia. To achieve this, the Social Impact Lab runs several programmes and projects dedicated to fostering social entrepreneurship and re-establishing cooperation with all relevant players.

- Brainster Space

  Brainster Space is a tech centre, co-working space, and a continuously growing community. Located in the centre of Skopje, this new tech hotspot is built on a single mission – to build and nurture connections between creative industries and tech companies.

- SEEUTechPark

  SEEUTechPark is a technology park located on South East European University campus in Tetovo. It was established in 2013 by the board of South East European University to create conditions to stimulate the creation of new startup companies, creating a

synergy between the companies, and encourage the growth of existing SMEs which in the long term provides new job opportunities.

- Ceed Hub Skopje

  Ceed Hub Skopje offers access to co-working spaces, events and educational programmes, and finance and mentorship support. CEED Hub Skopje acts as the central root of a fast-moving community. Overall, it is creating a bridge to take early-stage startups to the stage of the mature venture. It offers the following services:

  - Co-working space
  - Event organisation: space, logistical support and support in the implementation of events
  - Different programmes for startups and business ideas through expert input sessions and workshops, one on one mentor sessions, pitch trainings and networking events.
  - Newman's Business Accelerator

  Established as the first startup accelerator in North Macedonia, the Newman's Business Accelerator currently runs the majority of interconnected programmes in the area of education, entrepreneurship, corporate innovations, and investments. Over the last 5 years, Newman's accelerator has hosted over 160 startup events and has organised high-tech training for over 6500 participants.

BOSNIA AND HERZEGOVINA

Innovation Ecosystem

According to the European Innovation Scoreboard (2021), Bosnia and Herzegovina is an Emerging Innovator. Over time, performance relative to the EU has decreased, in particular in the last two years. Innovation performance has decreased in the last two years due to reduced performance on tertiary education, public R&D expenditures, design applications, and environment-related technologies. On the other side, performance improved for medium and high-tech goods exports.

The innovation policy framework of Bosnia and Herzegovina reflects the organisation of the economy defined by the Constitution of Bosnia and Herzegovina, and the Constitutions of the Entities and cantons. There is no harmonised and efficient innovation system appropriate to the social needs of Bosnia and Herzegovina. The economy lacks Innovation Strategy, while the S3 is in the preparation phase without enough political will to carry out the process to its end. However, in February 2021, the Development Strategy of the Federation of Bosnia and Herzegovina 2021-2027 was adopted covering a wide range of areas including measures in the area of innovation. The strategy aims to increase the digitalisation of the economy and one of the main measures is establishing the Federal Fund for Technology Development, Research and Innovation. Furthermore, the Strategy stresses the importance of supporting innovation

activities in the private and public sectors and creating an environment that enables and encourages cooperation between the economy and the research community.

It is important to note the actual public call Digital Innovation HUBs in Bosnia and Herzegovina that aims at supporting the formation of 3 digital innovation hubs in the Federation of Bosnia and Herzegovina. The public call is part of the EU4DigitalSME project, a Multi-Donor Action co-financed by the European Union and the Federal Ministry of Economic Cooperation and Development. This and similar initiatives are a positive sign of the future development of the innovation ecosystem in Bosnia and Herzegovina.

Despite insufficient support from the Government, the startup ecosystem in Bosnia and Herzegovina is growing, but it is still underdeveloped. The number of innovation infrastructures and different programmes for startups is expanding, which is especially visible in bigger cities such as Sarajevo, Mostar, Banja Luka, Tuzla, and Zenica. International organisations aiming to support development of startup ecosystem in Bosnia and Herzegovina, like the Swiss Entrepreneurship Programme, are also growing. Concerning venture capital, except for the regional South Central Ventures fund, there are not that many funding opportunities for innovators in Bosnia and Herzegovina.

Innovation Infrastructure: key stakeholders

The most important innovation infrastructures are located in Sarajevo, Mostar and Banja Luka. A short description of the key innovation infrastructures that have been most active and reaped some results and outcomes in the past 5 years is presented below.

- INTERA Technology Park

  INTERA Technology Park is a non-profit and non-governmental organisation founded in 2011 to encourage and support the development of economic processes in the region of Herzegovina. The initiative to establish the foundation came from the entrepreneurial community of the city of Mostar. It arose as a result of the need for developmental technological and innovative projects and a quality and educated workforce that will be competitive in domestic and foreign markets.

  Implementing more than 20 different projects of domestic and foreign donors, INTERA Technology Park has gained experience and has become a reliable partner in creating a better business environment for all citizens of Bosnia and Herzegovina.

  INTERA's portfolio of services includes:

  - Business incubator (pre-incubation and incubation services) - currently operates as a non-equity incubator, and does not take ownership of the teams going through the startup programme. Mentoring and consulting in the development of business models and plans in key areas (technology/services, partners, customers, competition, finance, time frame, barriers).
  - Business Premises – working and co-working space for startups

- Training and education - practical knowledge and skills in handling CNC machines, technological preparation of CNC programmes, construction using CAD tools or model making on 3D printers
- Support to Internationalisation through Enterprise Europe Network
- Support programmes for women's entrepreneurship

Innovation Centre Banja Luka

Innovation Centre Banja Luka (ICBL) is the first well-equipped centre for entrepreneurship development in Banja Luka and the Republika Srpska. ICBL was founded by the Ministry of Science and Technology, City of Banja Luka, University of Banja Luka, University of East Sarajevo and the Republika Srpska Agency for Development of Small and Medium Enterprises.

The ICBL incubator provides a range of business services to customers whose endeavours are knowledge-based. In this sense, ICBL serves users who are at the beginning of their idea or want to develop their venture, expand international cooperation and placement in the international market. Services include:

- pre-incubation services,
- incubation services and
- virtual incubation services.

The pre-incubation programme is intended for teams and individuals who aim to develop a business idea based on the principles of innovation and knowledge.

The incubation programmes (regular or virtual) are intended for companies that aim to develop existing or new products based on innovation and knowledge, hire new workers, or intend to export their products/services to foreign markets.

Some of the most potential areas of interest of ICBL are information and communication technologies, creative industry, energy efficiency, electronics, biotechnology, chemical industry, pharmaceutical and cosmetic industries, agriculture, organic and food production, manufacturing, education, tourism, ecology, etc.

ONEX Banja Luka

ONEX is a digital innovation hub created to support the development of startups and scale-ups in the Republika Srpska. The hub provides business competencies in digitalisation, AI, internationalisation, access to finance, IPR, innovation, etc. The hub targets a wide spectrum of businesses: food processing, wood, machinery and equipment, tourism, logistics, trade, IT, textile industry, chemicals, plastics, etc. Presenting a strong network of partner organisations, the hub's scope is well aligned with the relevant strategies of the SMEs development in the Republika Srpska and the new Industrial Strategy for a globally competitive, green and digital Europe.

The portfolio of services includes:

- Business support services (assessment of business ideas, feasibility studies, business plans, intellectual property protection, tax consulting, etc.)
- ICT Support services
- Group and individual trainings
- Learning and sharing knowledge

BIT Centre

Business Innovation and Technology (BIT) Centre is a place for the development of companies in the field of ICT. BIT Centre has several components:

- ICT Incubator
- ICT Training Centre
- ICT Research Centre

In addition to office space of 2,700 m2 with modern equipment, the Centre also provides professional services such as business consulting, business training, networking, knowledge and technology transfer, the possibility of applying for initial seed capital, financial, marketing, and accounting and legal services.

The main target group of the Centre are individuals in the area of ICT who have an idea or a project; people who have just founded their own company or those who have a developed company but want to expand the market.

BIT Centre cooperates with the University of Tuzla, especially with the Faculty of Electrical Engineering, in selecting the best staff in the field of ICT, encouraging startup business projects, their business training and support through seed capital fund.

HUB387

HUB387 is a co-working Space in Sarajevo that provides office spaces and support for ambitious professionals, allowing them to work together in an inspiring and supportive community. It offers community and workspace, startup support and different programmes and events.

PARK

SPARK is an IT education hub in Mostar dedicated to students and digital professionals. It consists of highly-educated experts in areas such as digital marketing, event management, education & training, finance, and project management. Its goal is to provide high-quality IT education and thus enhance the competitiveness of the market. Spark provides programmes - SPARK school, SPARK events, and SPARK projects and organises various workshops, meetups, competitions, conferences, and other community-wide events.

Networks Sarajevo

Networks is a business centre and a co-working community situated in an innovative building with over 1300m2 of interactive & modern space in Sarajevo. Its space gathers communities of creative individuals, visionaries, entrepreneurs, business professionals and young professionals. The portfolio of services includes:

- Co-working space
- Pre-accelerator and accelerator programmes for startups
- Education and training events
- Networks makerspace

BeeZone

BeeZone is a business incubator established in 2018 in Travnik to provide support to young entrepreneurs. Young entrepreneurs are provided with space, education, mentoring and access to funds and other resources necessary for the development of their business ideas. In the last three years, BeeZone has supported the development of 12 startups.

LabHub

The Society for Medical and Biological Engineering in Bosnia and Herzegovina (DMBIUBIH) is a non-governmental, non-profit organisation, founded in March 2014. DMBIUBIH is a community of stakeholders in the field of medical and biological engineering and an information exchange platform, working for the benefit of health services in Bosnia and Herzegovina. DMBIUBIH now has more than 80 active members whose number is constantly increasing. The members of the society are university professors, doctors, engineers and technicians in the field of medicine and engineering, as well as students, and young people interested in this field. Since 2015, DMBIUBIH has been a member of the International Federation of Medical and Biological Engineering (IFMBE), and since 2017, DMBIUBIH has been a member of the European Alliance for Medical and Biological Engineering and Science (EAMBES).

LabHub is a digital transformation platform of the DMBIUBIH that aims to support SMEs, laboratories and startups in their digital transformation. LabHub aims to involve young researchers in this process and empower them professionally. LabHub is strengthening their roles as an agent for transformation of Bosnia and Herzegovina health system by following the changes in the digital age.

LabHub provides support to SMEs in the process of digitising their processes. The activities aim to raise awareness about the importance of big data and further development in this area. It also supports SMEs and startups in project applications and connecting with a wide network of international partners.

LabHub supports young researchers to conduct research and develop models based on machine learning and artificial intelligence in real conditions and databases. LabHub provides the possibility of using a single database (database of measurements of

medical devices) so that through reports and articles, young researchers popularise the further development of this approach in society.

- Entrepreneurship and Technology Transfer Centre, University of Banja Luka

Entrepreneurship and Technology Transfer Centre (CPTT) was established in 2017 after the transformation of the University Entrepreneurship Centre (founded in 2009). CPTT provides the following services:

- support for the development and implementation of research and innovation, and development projects at the University,
- enable stronger links between the University and industry through activities in entrepreneurial learning and collaboration with the industry,
- support building up innovative capacities and inspire innovations at the University of Banja Luka through activities supporting knowledge and technology transfer with a particular focus on intellectual property policies.

- Development Agency of the City of Trebinje

Development Agency of the City of Trebinje (TREDEA) was founded in 2005 by the City of Trebinje. TREDEA implements various development projects funded from local or international funds and programmes, aimed to support Trebinje development processes. The main goal is to encourage the establishment, operation and development of SMEs by providing assistance, advice and information, training and consulting services. TREDEA has great cooperation with the Faculty of Production and Management Trebinje. These two institutions signed an agreement on cooperation in the field of conducting training for operators of CNC machines. Good cooperation was established with Trebinje secondary vocational schools which results in the improvement of practical teaching in schools. Through one of these projects, valuable equipment was procured for the schools: CNC machine, 3D printer, welding machine, etc.

- Prijedor Development Agency

Prijedor Development Agency (PREDA-PD) was founded in 2006 by the City of Prijedor. PREDA's scope of activities includes: developing and implementing projects in the area of economic and social development, environment protection and energy efficiency, promoting entrepreneurship, providing support to SMEs, creating conditions for the creation of new jobs and the overall improvement of the economic situation in the city of Prijedor. Prijedor HUB is a non-profit public space created by PREDA with a focus on connecting the creative industry, technology and young people. The main aim of Prijedor HUB is to provide entrepreneurial opportunities to young people and develop skills relevant to the market.

In addition to the above-mentioned innovation infrastructures, there are also other local initiatives as well as foreign branches dedicated to providing support to SMEs

and the startup community in Bosnia and Herzegovina such as SEEBA. SEEBA is a consulting company headquartered in Stockholm, Sweden that supports small and medium-sized enterprises using an innovative approach that combines business and technical advisory. With its branch office (SEEBA Balkans) located in Sarajevo, it offers its services to SMEs and startups in Bosnia and Herzegovina.

It is also worth noting the Digital Transformation Centre of the Chamber of Commerce of the Republika Srpska, whose aim is to provide support to SMEs in the process of digitising their processes.

ALBANIA

Innovation Ecosystem

The overall support by the government for the development of the startup sector in Albania remains low. Until 2019, the government has supported only the set-up of two organisations, namely Protik and TechSpace, both organisations facing challenges regarding financial sustainability and operation capacity. Moreover, cooperation between support organisations and the government is weak.

Albania is not covered by the European Innovation Scoreboard so the comparative analysis of innovation performance with other European economies as well as assessing the relative strengths and weaknesses of the innovation system cannot be implemented.

Even though the level of support from the government was not as expected, the entrepreneurial community in Albania has been developing rapidly in the last few years. The ecosystem is now supported by a growing number of events, accelerators, co-working spaces, and incubators.

The startup ecosystem is still emerging with most support organisations located in Tirana, focusing on the pre-ideation and ideation phase and offering overly broad services. There is little support for startups post ideation guiding them in a continuous incubation process. However, the service offering for startups has steadily increased since the beginning of 2019.

Significant support to the innovation ecosystem in Albania has been provided by the EU for Innovation project. This project was implemented from 2018 to 2021 and funded by the European Union with additional support from the German Federal Ministry for Economic Cooperation and Development as well as the Swedish International Development Cooperation Agency (Swedish Government). It improved the innovative ecosystem and boosted creation of startups in Albania through Capacity development for innovation among innovation ecosystem actors; Intensified linkages within the Albanian innovation ecosystem and internationally, and Funding for innovative startups and innovation support organisations/ providers.

Innovation Infrastructure: key stakeholders

Considering the last two years, Albanian innovation infrastructure has a lot of momentum. Many organisations have started to design programmes to help startups innovate and grow. These innovation infrastructures support a wide range of startups in various stages of growth but are mainly focused on the pre-ideation and ideation phases.

- National Agency of Scientific Research and Innovation

The National Agency of Scientific Research and Innovation (NASRI) is a public legal institution under the Ministry of Education, Sports and Youth that aims to build a modern system of science, strengthen research and technology, as well as their integration inside the higher education system. NASRI facilitates the exchange of knowledge, mutual activities and partnerships within and outside the economy. Its main role is to evaluate, finance, monitor and manage programmes and projects in the fields of science, technology and innovation in Albania. NASRI aims to get closer to manufacturing businesses with the academic staff of universities and to fund projects in the different fields of SMEs as well as the transfer, modernisation and renewal of their technologies through research and innovation. Additional, NASRI organise information days for researchers and businesses promoting the financial programmes of the EU such as H2020, SME Instrument, COSME, etc.

- Argjiro Innovation Hub

Argjiro Innovation Hub was established by the Chamber of Commerce and Industry of Gjirokastra through a series of projects co-financed by the European Union and National Sources that incorporate holistic services for startups, SMEs, enterprises, and local stakeholders. It offers:

- Incubation facilities–including a co-working space and professional services for startups and entrepreneurs.
- Acceleration services–free coaching and mentoring to accelerate the market introduction of your idea.
- Training academy–how to become a successful entrepreneur by creating unique products.
- Funding support–find public grants and private equity through our investor's network.

- Oficina

Oficina is a strategic initiative focused on supporting Albania's transition to a knowledge-based economy. Oficina runs yearly incubation and acceleration programmes in partnership with various international support organisations and private sector companies. Their team actively participates in various EU-funded projects covering cross-sectoral innovation and strategic SME development. They also offer free use of co-working space. Their site offers indoor and outdoor seating and access to all technical infrastructure.

- Protic Innovation Centre

Protik Innovation Centre is established by the combined efforts of Albanian American Development Foundation, the Government of Albania, USAID, Microsoft, Albtelecom and CISCO. Protik is an independent non-profit ICT centre, whose primary objectives

are to increase the demand and the use of ICT and assist in market growth, strengthen human and institutional capacity, increase cooperation between the private sector, educational institutions, and the government, to provide ICT entrepreneurs with access to modern technology and know-how, and to serve as an information-sharing networking hub.

The centre intends to provide education in innovation, entrepreneurship, technical subjects and soft skills. Protik provides access to resources for ICT entrepreneurs and business innovators. The centre aims to get involved in the creation of a business incubator, as the next step of stimulating entrepreneurship and sustaining SME growth in Albania.

- Startup Grind Tirana

  Startup Grind Tirana is a community that educates, inspires, and networks young entrepreneurs. It is a monthly activity that focuses on networking as an efficient and direct way to connect and bring together business actors, young people with business ideas, and representatives of initiatives in the field of technology. Every month, well-known Albanian businesspeople are invited to the event to share their business experiences with the audience.

- Tirana INC

  Tirana INC is a new initiative of Albanian universities in setting up the first multi-university incubator for student startup teams. The 5 founding partners are Polytechnic University of Tirana, Faculty of Economics University of Tirana, EPOKA University, Metropolitan University of Tirana, and Polis University. They envision that in three years, it will be the number one destination for ambitious Albanian student entrepreneurs to kick-start their companies. The first pilot programme has started in September 2021. The 10 selected teams will spend 100 days in 1 programme that consists of introduction bootcamps, startup launch classes, mentoring sessions and demo day.

- Uplift

  Uplift is an early-stage startup accelerator programme focused on growing business and increasing valuation. They aim to support dozens of the most innovative and promising startups from the WB region. With Uplift, startups have the opportunity to learn how to pitch to investors, protect their intellectual property, improve their business models and apply the lean methodology.

- UK-Albania Tech Hub

  UK-Albania Tech Hub is a programme that supports collaboration between Albania and the UK in the area of technology. The hub aims to facilitate bilateral tech partnerships between Albania and the UK. It focuses on tech startups that have the potential to contribute to growth in the UK by sharing innovation, skills, and business opportunities.

- Ivanaj Foundation

  The Ivanaj Foundation's business incubation and innovation hub is a non-profit organisation that offers a variety of services to support, train, and guide budding entrepreneurs who have the right idea but lack the physical resources and/or know-how to carry their ideas from conception to successful and established businesses. It provides facilities and equipment for educational training of varied nature to participants of all ages, as well as databases, references, and library services for researchers and visiting scholars, project management support for the development of innovative concepts into business ventures, and for publishing historical documents for educational purpose.

- Growpreneur Accelerator

  Growpreneur, implemented by YSB Balkans in cooperation and with the support of the EU for Innovation is an acceleration programme consisting of trainings, workshops, coaching & mentoring sessions tailored to the specific needs of the users. It offers:

  - Growth Accelerator - for startups that are at least in the early validation (have an initial prototype) or growth phases.
  - Flexible Support Plus - for startups that have completed acceleration programmes

- FasterCapital

  FasterCapital is an online incubator, accelerator, and service provider that helps accelerate/incubate startups in Albania and worldwide. It helps startups and small businesses worldwide and invests in them in a work-per-equity model. FasterCapital provides either technical development per equity or business development per equity. It invests in startups from different industries: FinTech, EduTech, HealthTech, Entertainment, Media, Software, E-commerce, Blockchain.

- Metropolitan Incubator

  Metropolitan Incubator is part of the Metro Research Centre and Metropolitan Tirana University. Talented students and young people have the opportunity to create a startup and finalise ideas with a final product, which can be a software product or other areas. It offers technical support and academic advice to students who wish to finalise their ideas. The Metropolitan Incubator has several startups currently registered.

- Barleti Hub

  Barleti Hub is the centre where young entrepreneurs with creative ideas are determined to succeed in the domestic and international markets. Proper mentoring and guidance of experts have a significant impact on the personal and professional development of young entrepreneurs. Their services include:

- Mentoring & Coaching
- Business Model Canvas
- Training and New Skills
- Commercialisation & Prototype
- Toolbox and Services
- Mapping Study
- Franchise Model

Yunus Social Business

Yunus Social Business is a funding programme that financially and technically supports young people who want to implement social business ideas. Participants in this accelerator must successfully pass the first stage of application. Their social idea is discussed and mentored by professionals in the field, depending on the field where the idea will be implemented. During the accelerator, young entrepreneurs learn how to create business plans and models, how to present their idea to the market, and how to gain their first customers. The programme has started in 2012 and it is free of charge.

Women Founders

Women Founders in Albania is the first accelerator for women founders in the Western Balkans.

INNVEST

The Innovation Investment Fund's (INNVEST) mission includes creating a concrete impact on the economies of the Western Balkans by providing growth opportunities, supporting and encouraging young entrepreneurs while decreasing the gap between new business ideas and investment opportunities. INNVEST brings together leading entrepreneurs, investors, prime investors, policy makers and merges a vast pool of ideas from across the innovative spectrum to address domestic and regional economic challenges. INNVEST has three main pillars of success:

- Fostering Entrepreneurship - help businesses and corporations to innovate from within through dedicated programmes, incubators and accelerators.
- Startup promotion - identify, mentor and integrate within the network new and innovative business ideas at different levels of their development.
- Find investment opportunities - bridging the gap of investment opportunities and startups. Through different forms, programmes and activities, INNVEST enables matchmaking opportunities, within and outside of their network, for new business ideas to meet with angel investors.

- Coolab Tirana

  Coolab Tirana is a co-working space located in Tirana and intended for entrepreneurs, freelancers, business professionals and technologists who want to be part of an active community.

- Tech Space

  TechSpace is designed to enable the co-design of innovative products, their testing, the sharing of ideas and the creation of prototypes, as well as relaxation in dedicated spaces.

- Dutch Hub

  Dutch Hub is the largest co-working space in Albania located in Tirana. Dutch Hub offers a range of services starting from hourly and daily plans to long-term ones, accompanied by 20 professional services, networking opportunities, and other facilities. It offers individual jobs, workspaces for groups and companies in open spaces or shared offices, and private offices in various formats.

- Inno Space

  Innospace Tirana is a co-working place and a Design and Entrepreneurship Academy founded in 2019. Its objective is to foster a startup community with a focus on connecting, motivating, and educating future startups. It offers a total of 560 m2 of space composed of an open co-working space, private offices with balconies, training rooms, a kitchen, a virtual meeting room and physical meeting areas, lockers, and a stunning veranda.

- MyOffice'Al

  MyOffice'Al is a coworking space in Tirana with open workplaces equipped with modern infrastructure and amenities. Located in the centre of Tirana, MyOffice'Al is an energetic, yet calm environment for freelancers, entrepreneurs, and startup teams.

MONTENEGRO

Innovation Ecosystem

According to the European Innovation Scoreboard (2021), Montenegro is an Emerging Innovator. Over time, performance relative to the EU has increased. Montenegro has a below-average share of innovators but a relatively large share of in-house product innovators with market novelties. Performance has declined in the most recent years, mostly due to performance reductions in ICT specialists, PCT patent and trademark applications, and environment-related technologies.

Montenegro is still in the early stages of building a functional and interconnected startup ecosystem with a nascent support infrastructure comprising facilitators, mentors, business angels and VC investors. Certain elements of the innovation system have been built, but

the innovative entrepreneurial community is still underdeveloped and needs to be better connected. Within the Strategy for the development of micro, small and medium enterprises (2018-2022), the Government of Montenegro aims to improve the innovation of SMEs through the following measures:

- Improving infrastructures to support innovation and technological development,
- Improving support for innovative enterprises and strengthening their potential for innovation,
- Providing support for better use of funds from EU programmes for research, development and innovation,
- Strengthening SME awareness of the importance of innovation.

However, the implementation of the Strategy needs to be improved. Policy measures supporting startups in Montenegro are mostly based on policy support facilities from the EU. Montenegro must do a lot to put itself on the map as a startup destination. Government support, changes in the education system, and a more vibrant network of venture capital, angel investors, and mentors are still lacking to help the economy get there.

In the previous period, there have not been specific policy measures influencing the startup ecosystem in Montenegro. Concerning financial support instruments (grants and loans) provided by the Government, there has been a gap in financing the initial seed phase of innovative projects, where the emergence and development of innovative startups usually take place. Also, there was a lack of an Innovation Fund as well as a public "guarantee fund" for loans to promising, risky business projects in the phase of rapid growth. However, in mid-2021, the Government of Montenegro passed a Decision on the establishment of the Innovation Fund of Montenegro, which will ensure the implementation of innovation policy through the provision and implementation of funds to encourage innovation. The establishment of the Fund shows a clear commitment of Montenegro to further orient its development towards a society based on knowledge and innovation. The newly established Innovation fund will strengthen innovative entrepreneurship in the economy, contribute to a more efficient implementation of the Smart Specialisation Strategy, as well as raise absorption capacity in attracting EU funds.

Innovation Infrastructure: key stakeholders

Although there is not a large number of innovation infrastructures in Montenegro, the existing innovation infrastructures are very active and significantly contribute to the growth of the innovation ecosystem. In addition to the Science and Technology Park, which is still under construction, the most important ones will be presented below.

- Science and Technology Park of Montenegro

  The first Science and Technology Park in Montenegro is under construction and is planned to be officially put into operation by the end of 2022. It was established in partnership with the Government of Montenegro, Ministry of Science and University of Montenegro. Once in operation, it will focus on the establishment of technological

development centre of Montenegro. The centre's programmes and activities will provide adequate support to the promotion of innovation-entrepreneurial ecosystem, thus contributing to faster overall economic development.

Given its location in the campus of the University of Montenegro, Science and Technology Park Montenegro will offer more than adequate conditions for small business development, stimulating the development of startups, and forming creative and innovative multidisciplinary teams.

According to the current state, the most important innovation infrastructures of the Montenegrin startup ecosystem include the following organisations: Tehnopolis, Mtel Digital Factory, Digitalizuj.Me, Incubator BSC Bar and Beta Bar. The centre of the innovation ecosystem is Podgorica, but innovation infrastructures are starting to evolve across the economy, in cities such as Niksic, Pljevlja and Bar.

- Tehnopolis

Tehnopolis is an innovation and entrepreneurship centre founded by the Government of Montenegro in 2016 when it officially started operating. It is the most important centre for the development of startup companies and entrepreneurship in Montenegro. As one of the key actors in the creation and reshaping of Montenegrin innovation ecosystem, Tehnopolis provides a range of infrastructure and support measures facilitating establishment of new companies and development of businesses based on new, innovative ideas and technologies. The Ministry of Economic Development is in charge of supervising the centre. Tehnopolis was established in collaboration with the following partners: Ministry of Agriculture, Forestry and Water Management, Investment and Development Fund, and Municipality of Niksic.

Currently, Tehnopolis has 10 tenants. Its innovation infrastructure consists of:

- Biotechnology Laboratory
- Data Centre
- TechLab

Biotechnology Laboratory (BioLab) was opened to provide support to agricultural producers and agricultural development, both through the provision of its services and through the integration of the academic and business sectors. It is equipped with three highly sophisticated devices:

- liquid chromatograph with mass spectrometry (HPLC LC / MS Agilent Technologies 1260 HPLC / Ultivo MS),
- q16 Real Time PCR i
- Bruker's S1 Titan 800 XRF analyser.

The data centre is a centralised location for collecting, storing, processing, distributing and providing access to data sets. It provides support to development teams and

startups, as well as all other companies in the field of IT industry through the use of infrastructure capacity and the most modern equipment that the centre contains.

The Industrial Design Laboratory (TechLab) offers access to high-quality, modern production equipment for rapid prototyping and spare parts, as well as 3D modelling and 3D scanning. The Laboratory is available to all innovative SMEs, innovators, startups, as well as the academic community. It is equipped with industrial 3D printers for metal and various types of thermoplastics, CNC machines, a 3D scanner, welding machines for various types of metals and alloys, CAM / CAD licensed software and a robotic arm.

- Mtel Digital Factory

Mtel Digital Factory, established in 2017 as a private entity, is a centre for technology entrepreneurship development and innovation, focusing on early-stage startups that develop innovative products and have the potential to make a positive impact on the environment and society. It is the first hub in Montenegro listed in the Digital Innovation Hubs (DIH) catalogue which was set up to provide a comprehensive picture of DIHs in the EU across varying competences, structures and service offerings. Over the last two years, it has managed to create a very dynamic community of freelancers, innovators, entrepreneurs, developers and other creatives by organising a large number of workshops, meetups and events in its co-working space.

Mtel Digital Factory is offering the following capital equipment to its clients: 3D printer Ultimaker 3, 3D printer Markforged Onyx Pro, and 3D printer Formlabs 2. At the moment, Startup Activator programme is currently being implemented, gathering 11 startup teams. Startup Activator is a programme intended for startups at an early stage of development.

Mtel Digital Factory is cooperating with several important stakeholders such as the Chamber of Commerce of Montenegro, Donja Gorica University, BEST Student Association, AIESEC, Association of Managers of Montenegro, Faculty of Electrical Engineering, etc.

- Digitalizuj.Me

Digitalizuj.Me is a digital community seeking to help citizens and organisations in Montenegro to understand and take advantage of new opportunities for social and business change in the digital environment. It is a non-governmental organisation that successfully implemented many innovative projects in cooperation with organisations such as the UNDP Office in Montenegro, East West Management Institute, Coca-Cola Hellenic, Telekom, Telenor Montenegro, and others.

Education is a significant part of the entire set of activities. It has extensive experience in organising educational programmes, including digital marketing workshops, blog workshops, as well as programming schools for primary school students. In addition to education, other activities include social media workshops intended for organisations,

designing, organising and conducting workshops and competitions for startups, organising free lectures by the inspiring and passionate speakers from across the region, etc.

- Incubator BSC Bar

BSC Bar was founded in 2007 within the project funded by the Ministry of Foreign Affairs of the Netherlands and conducted by the Dutch NGO SPARK with the main goal of supporting the promotion of entrepreneurship in Montenegro. Currently, BSC Bar hosts 20 tenants. It provides the following services:

- Training
- Mentoring
- Networking
- Microloan Support

Since 2007, BSC Bar has trained more than 3,527 participants through business skills trainings, facilitated the establishment of 120 enterprises, created over 400 jobs, and supported 71 startup businesses with micro loan funds (invested EUR 495,290.00 as micro-credit support for the establishment of the businesses), organised many conferences and debates joining together business entities, NGOs and representatives of local and central governments.

- Beta Bar

Beta Bar is the first co-working space in Montenegro offering rooms for intentional collaboration, access to mentors for business development and opportunities to connect with the Bar community. Besides a workspace, Beta Bar's parent company, Nova Ivica, provides consulting services dedicated to the development and promotion of a brand, using the power of social media, IT strategy management and other areas of expertise. It also offers various workshops that bring business ideas to life.

In addition to the above-mentioned innovation infrastructures, Montenegro's Chamber of Economy, Union of employers, Association of managers, the American Chamber of Commerce, and the Montenegro business alliance all provide general business development support to companies.

KOSOVO*

Innovation Ecosystem

The establishment of the Ministry of Innovation and Entrepreneurship in 2017 indicated a shift in Government priorities when it comes to entrepreneurship and innovation. The Ministry aims to stimulate innovative activities in Kosovo*, which are related closely to entrepreneurship and other economic areas.

Kosovo* is not covered by the European Innovation Scoreboard yet, so the comparative analysis of innovation performance with other European economies as well as assessing the relative strengths and weaknesses of the innovation system cannot be implemented.

Overall, startup support ecosystem in Kosovo* has been developing slowly. With an increasing number of startups and entrepreneurs, the ecosystem scene is showing signs of development. According to the research on the startup ecosystem in Kosovo* conducted by the Innovation Centre Kosovo* (2020)[12], the majority of startups in Kosovo* consider that financial aid, support in finding potential investors and consulting/mentoring are the most important ways to strengthen the startup sector. The startup environment in Kosovo* is fragile and uncertain for many startups as they face many challenges that they find difficult to overcome. Consequently, 93.33% of startups require an external support to strengthen their business. The main challenge for growth for a sizeable part of startups (61.90%) is the lack of financial means. As a result, financial assistance is considered to be the most needed support and is considered the main way to strengthen the startup ecosystem in Kosovo*.

Initiatives to set up accelerators or incubators are in their infancy. The innovation support infrastructure in Kosovo* generally lacks institutional and human resources and thus is far from being fully developed. Some institutions have been created to support technology and innovation, mostly oriented toward providing education and consultancy services to entrepreneurs. The need for stronger cooperation among relevant stakeholders and the government would strengthen the cooperation between the community in developing new and innovative products and services.

Innovation Infrastructure: key stakeholders

There are different innovation infrastructures in place in Kosovo* to support innovation and entrepreneurship. Some of them have been initiated within the frame of governmental interventions, others have been developed as a result of donor projects and supported by NGOs. The most relevant innovation infrastructures are listed and briefly described below:

- #### Innovation Centre Kosovo*

  The Innovation Centre Kosovo* (ICK), one of the most important and impactful innovation infrastructures in Kosovo*, was funded by the Embassy of Sweden and the Royal Norwegian Embassy. The establishment of ICK was financially supported by The Norwegian Ministry of Foreign Affairs. ICK was initiated in June 2012 as a project of Athene Prosjektledelse, Norway and Kosovo* Association of Information and Communication Technology with Crimson Capital LLC, Kosovo* being the main cooperating partner on this initiative.

  ICK aims to connect the research and business sectors, focusing on creating new job opportunities based on knowledge and new technology. ICK was founded to support entrepreneurship, innovation and commercially based business development, with a focus on ICT. The centre supports both startups and existing companies with growth

12 Available at: https://ickosovo.com/images/uploads/files/1._Startup_Ecosystem_Kosovo_-_Needs_Evaluation_Narrative_Report_-_Final_.pdf

potential. ICK offers a range of services such as co-working space, incubation services, training & courses, etc.

A core part of the ICK is the Incubator. ICK Incubator provides pre-incubation and incubation services, depending on the experience of the team and the level of development of the business idea. So far, it has supported 470 startups contributing to 3,100 new jobs created.

In collaboration with the GIZ project Creating Employment through Export Promotion – CETEP, with the support of the Ministry of Innovation and Entrepreneurship, ICK also provides financial support to SMEs through the Innovation Fund grant scheme.

- CEED Kosovo*

CEED Kosovo* is a local office operating within the global organisation CEED that was created by Small Enterprise Assistance Funds (SEAF), an investment management group that provides growth capital and business assistance to SMEs in emerging and transition markets underserved by traditional sources of capital.

CEED Kosovo* has been active for a decade in Kosovo* and has remained an important part of the entrepreneurial ecosystem. The CEED Centre has cooperated with multiple donors to deliver several programmes supporting youth, women, and rural entrepreneurs. Projects have ranged from establishing a local farmers market in Pristina to providing mentoring and training to entrepreneurs trying to establish new enterprises. As of 2019, the centre had 48 active members, 48% of which are women-owned, and over 100 enterprises and entrepreneurs from the community were involved in programming.

- VentureUP

VentureUP is the Entrepreneurship Centre and official incubator of the University of Pristina, which serves as a bridge between education and the labour market for over 50,000 students.

- Kosovo* Association of Information and Communication Technology (STIKK)

Being the collective voice of the ICT sector in Kosovo*, STIKK promotes the converging interests of businesses and individuals in the field of ICT. It was established in 2008 by six founding member companies. STIKK currently has over 125 members representing 90% of the entire ICT market in Kosovo*.

- JIC Jakova Innovation Centre

JIC Jakova Innovation Centre is a non-profit organisation that has been established by the Ministry of Trade and Industry in cooperation with the municipality of Gjakova. This centre serves as a business incubator with the mission of promoting and supporting young entrepreneurs in the construction and development of new companies. The incubator provides support to new companies and offers co-working space. Furthermore, Jakova Innovation Centre provides consulting and training programmes

in areas such as business management, market research, finance, marketing and many other areas which are important in the process of doing business.

- Innovation and Training Park (ITP) Prizren

  ITP Prizren offers an environment that fosters collaborations between innovation activities, research and development stakeholders, training and educational institutions and startups. An important aspect of the ITP concept is the promotion of digitalisation through partnering with the Digital Transformation Centre. ITP Prizren intends to be a changing and boosting element in the area of ICT, agro-food and creatives industries, through the creation and management of a favourable environment and efficient services for SMEs, exploiting different kinds of innovations that can contribute to improving its level of development in industry and research, bringing benefits to the economy and society of Kosovo*. The following services are offered to innovators, entrepreneurs, startups, SMEs, training and education and research and development institutions:

  - Digitalisation
  - Coworking space
  - Office space
  - Business linkages
  - Startup services
  - Incubation
  - Acceleration
  - Accommodation facilities

- Bonevet

  Bonevet is a non-profit foundation whose aim is to help youngsters to identify skills and talent. BONEVET aims to build the spirit of curiosity, innovation and creativity through active play and technology. The organisation applies a wide range of STEM classes and training to support children in coping with the challenges of the 21st century.

- CBC Innovation Hubs

  CBC Innovation Hubs are an initiative of STIKK, Syri i Vizionit, the Tourist Organisation Berane and IT Cluster Montenegro. They are part of the European Union funded project Harnessing Innovation and Entrepreneurship in Cross-border Region of Kosovo* and Montenegro. The overall objective of the action is to contribute to sustainable economic development by fostering innovation and entrepreneurship in the tourism industry.

In addition to the above-mentioned innovation infrastructures, it is worth mentioning the Kosovo* Business Angel Network (KOSBAN). However, there is no clear evidence of the results

produced by the KOSBAN. Some of the initiatives of business angel networks struggled in their work and are no longer in operation, such as the EYE initiative.

3. IDENTIFYING RESEARCH SPECIALISATIONS IN THE WB REGION: BIBLIOMETRIC ANALYSIS

3.1. THE MOST PRODUCTIVE SCIENTIFIC DISCIPLINES

The analysis of the productivity of the scientific community of WB economies was done based on the identification of research papers published in international peer-reviewed journals which are registered within the Web of Science[13] and Scopus[14] databases as the most prominent sources.

This chapter provides an analysis of the scientific productivity of authors from the WB economies in journals registered in WoS and Scopus databases, to identify the most productive scientific disciplines measured by the number of research papers published in international peer-reviewed journals.

3.1.1. SCIENTIFIC PRODUCTIVITY REGISTERED IN WOS

WoS databases classify articles into 255 disciplines. One article can be classified into several disciplines, so the number of papers in all WoS disciplines is slightly higher than the number of papers published in journals that refer to WOS databases. Such a large number of disciplines that WoS monitors is not suitable for the needs of analysis and comparison of scientific productivity. Therefore, the number of registered articles in WoS disciplines was recalculated

13 WoS - Web of Science: The research community has relied upon Web of Science™ (WoS) for decades to inform major domestic research evaluations and predict where science is headed next in order to:

- Detect emerging trends;
- Collect researcher activity data at scale;
- Select the right indicators for benchmarking and evaluation;
- Collate evidence of the broader, real-world outcomes of research.

Evidence-based planning and foresight rely on WoS with the goal to:

- Identify emerging research areas;
- Scan the horizon to detect emerging technologies;
- Benchmark the performance of one economy research relative to the economy that serves as a model to be aspired to;
- Uncover hidden opportunities within economy's research portfolio;
- Implement a framework that enables monitoring of the progress towards goals with accurate and objective data.

14 Scopus: Scopus is a source-neutral abstract and citation database, curated by independent subject matter experts. It places powerful discovery and analytics tools in the hands of researchers, librarians, institutional research managers, and funders. In addition to the search tools designed to help navigate across over 75 million items indexed, Scopus also provides features to help researchers go beyond search, into discovery and analysis:

- Track citations over time for a set of authors or documents using Citation Overview
- Assess trends in search results with Analyse Results
- View h-index for specific authors
- Analyse an author's publishing output and research impact with Author Evaluator
- Gain insight into journal performance with Compare Journals, a tool allowing you to analyse journals across multiple metrics

in the fields of science and technology as defined in the OECD methodological documents for science and innovation governance.

The scheme of translating WoS disciplines in the OECD fields of science and technology was prepared in the framework of WoS support for analytical research on scientific productivity. In addition, it was applied to this study to identify the emerging fields of science and technology in the economies of the Western Balkans.[15]

For all analysed WB economies, a search of WoS databases for the period from 2010 to 2021 was performed. This search aimed at identifying many scientific articles in journals that refer to WoS, where at least one author is from one of the WB economies. Based on the obtained data on the number of articles by WoS disciplines, the "stock of knowledge" indicator was calculated for each economy in the Western Balkans as the sum of all papers in the observed period within WoS disciplines. Then, the number of papers in WoS disciplines was converted into the number of papers by OECD science and technology. At the same time, all WoS disciplines and OECD fields of science and technology (FoS) were sorted to identify those disciplines and fields of science and technology in which the majority of papers were published.

The following tables are given as an appendix to this study:

- APPENDIX III: Scientific productivity authors from WB economies – number of articles in WoS by WoS disciplines and by economy, stock of knowledge 2010-2021;
- APPENDIX IV: Scientific productivity authors from WB economies – articles in WoS by economy, stock of knowledge 2010-2021, sorting by WoS disciplines;
- APPENDIX V: Scientific productivity authors from WB economies – number of articles in WoS by OECD FoS disciplines, by economy and by year from 2010 to 2021;
- APPENDIX VI: Scientific productivity authors from WB economies – number of articles in WoS by OECD FoS disciplines and by economy, stock of knowledge 2010-2021, sorting by OECD FoS disciplines.

Table 4 provides an overview of the number of published articles registered in the WoS database by authors from the WB economies. A common feature of scientific productivity in all analysed economies is the growth in the number of articles in journals referred to in WoS

15 Taken from Clarivate Analytics InCites Helps "OECD Category Scheme", as "OECD Category Mapping": excel tool: OECD published its new field of science and technology (FOS) classification scheme on Feb 26, 2007 (http://www.oecd.org/dataoecd/36/44/38235147.pdf). It adopted a hierarchical classification scheme, in which the science and social science are separated into six major subject categories. Each subject category includes several minor subject categories. According to the descriptions of each minor subject category in the FOS, minor subject categories consist of several fields similar to Web of Science (WoS) subject areas. So, combining and comparing the OECD FOS and Scope Notes for Science Citation Index Expanded (SCI-E), Social Science Citation Index (SSCI), and Arts & Humanities Citation Index (AHCI) (http://science.thomsonreuters.com/mjl/scope/), each WoS subject area was assigned to an OECD minor subject code with manual input; OECD MAJOR subject categories were created by de-duplicating WoS to OECD minor code relationships. The mapping of WoS subject area to CSC category must be reviewed periodically because WoS subject areas may change from one year to the next. The WoS subject areas LOGIC and AUDIOLOGY & SPEECH LANGUAGE PATHOLOGY are new to WoS for 2012. The WoS subject area GREEN & SUSTAINABLE SCIENCE & TECHNOLOGY is new to WoS for 2016. http://help.prod-incites.com/inCites2Live/filterValuesGroup/researchAreaSchema/oecdCategoryScheme.html

databases in the years from 2010 to 2015-2016 when a degree of saturation is observed, and a relatively constant number until the end of the analysed period. Some economies recorded a decline in the number of articles, not large but indicative. The data for 2021 represent only a cross-section for the first ten months and cannot be treated as data for previous years, but they are significant from the point of view of increasing the stock of knowledge. One of the explanations for the increase in the number of papers since 2010 is the implementation of laws and bylaws that regulate the advancement of scientists in their careers, which is conditioned by the publication of articles in journals referred in WoS in all WB economies.

Table 4: Number of scientific articles published by authors from the WB economies in WoS databases in the period from 2010 to 2021

Economy Year	Albania	Bosnia and Herzegovina	Kosovo*	Montenegro	North Macedonia	Serbia
2010	262	728	180	217	600	5504
2011	281	746	157	228	601	5947
2012	300	719	195	249	611	7685
2013	336	658	162	307	635	7046
2014	393	682	245	320	722	7091
2015	599	1065	319	510	909	8218
2016	587	1134	434	541	1012	8294
2017	573	1352	524	603	1024	8363
2018	576	1412	571	625	974	8149
2019	615	1492	630	660	1028	8980
2020	585	1510	590	713	877	8245
2021	514	985	459	500	554	6022
Total 2010-2021	**5621**	**12483**	**4466**	**5473**	**9547**	**89544**
WoS-Total	**6668**	**15075**	**4897**	**6380**	**20649**	**120056**
Share (%)	**84.30%**	**82.81%**	**91.20%**	**85.78%**	**46.23%**	**74.59%**

Source: authors calculations based on WoS, retrieved on 24 October 2021

Based on the data on scientific productivity, which is given in detail in the appendices to this study, 10 areas of science and technology were singled out according to the OECD FoS classification. These data are arranged and shown in Tables 5, 6 and 7. At the same time, those areas of science and technology that are common to all economies in the Western Balkans were bolded. It is characteristic that **seven areas of science and technology** have been identified as areas with the largest stock of knowledge for all 6 WB economies. These are the following areas of science and technology according to the OECD FoS classification:

1.01 Mathematics;

1.02 Computer and information sciences;

1.05 Earth and related environmental sciences;

1.06 Biological sciences;

2.02 Electrical engineering, electronic engineering;

3.02 Clinical medicine;

3.01 Basic medical research.

Table 5: Number of scientific articles published by authors from Albania and Bosnia and Herzegovina in WoS databases, stock of knowledge 2010-2021, ranking by OECD FoS, first 10 disciplines

Rank	Albania	2010-2021	Rank	Bosnia and Herzegovina	2010-2021
1	**3.02 Clinical medicine**	1970	1	**3.02 Clinical medicine**	3338
2	**1.05 Earth and related environmental sciences**	1104	2	**2.02 Electrical eng, electronic eng**	2042
3	**3.01 Basic medical research**	598	3	**1.02 Computer and information sciences**	1214
4	**1.06 Biological sciences**	549	4	**3.01 Basic medical research**	1116
5	**1.02 Computer and information sciences**	542	5	**1.06 Biological sciences**	1099
6	3.03 Health sciences	504	6	5.02 Economics and business	1071
7	5.02 Economics and business	389	7	2.11 Other engineering and technologies	901
8	**2.02 Electrical eng, electronic eng**	358	8	3.03 Health sciences	831
9	**1.01 Mathematics**	272	9	**1.05 Earth and related environmental sciences**	672
10	1.04 Chemical sciences	251	10	**1.01 Mathematics**	599

Source: WoS, retrieved on 24 October 2021, conversion from WoS disciplines to OECD FoS by ToE

Table 6: Number of scientific articles published by authors from Kosovo and Montenegro in WoS databases, stock of knowledge 2010-2021, ranking by OECD FoS, first 10 disciplines*

Rank	Kosovo*	2010-2021	Rank	Montenegro	2010-2021
1	**3.02 Clinical medicine**	1052	1	**3.02 Clinical medicine**	1028
2	**1.05 Earth and related environmental sciences**	547	2	**2.02 Electrical eng, electronic eng**	851
3	**2.02 Electrical eng, electronic eng**	449	3	**1.06 Biological sciences**	801
4	**1.06 Biological sciences**	429	4	**1.05 Earth and related environmental sciences**	460
5	1.04 Chemical sciences	422	5	1.03 Physical sciences and astronomy	452
6	**3.01 Basic medical research**	386	6	**1.02 Computer and information sciences**	438
7	**1.01 Mathematics**	337	7	**1.01 Mathematics**	431
8	3.03 Health sciences	335	8	3.03 Health sciences	352

Rank	Kosovo*	2010-2021	Rank	Montenegro	2010-2021
9	5.02 Economics and business	258	9	**3.01 Basic medical research**	328
10	**1.02 Computer and information sciences**	248	10	6.02 Languages and literature	314

Source: WoS, retrieved on 24 October 2021, conversion from WoS disciplines to OECD FoS by ToE

Table 7: Number of scientific articles published by authors from North Macedonia and Serbia in WoS databases, stock of knowledge 2010-2021, ranking by OECD FoS, first 10 disciplines

Rank	North Macedonia	2010-2021	Rank	Serbia	2010-2021
1	**3.02 Clinical medicine**	2782	1	**3.02 Clinical medicine**	23609
2	**1.02 Computer and information sciences**	1526	2	1.03 Physical sciences and astronomy	10840
3	**2.02 Electrical eng, electronic eng**	1446	3	**1.06 Biological sciences**	10586
4	**1.06 Biological sciences**	1091	4	1.04 Chemical sciences	9993
5	**3.01 Basic medical research**	906	5	**3.01 Basic medical research**	8804
6	**1.05 Earth and related environmental sciences**	807	6	**2.02 Electrical eng, electronic eng**	8276
7	1.04 Chemical sciences	702	7	**1.01 Mathematics**	7197
8	5.02 Economics and business	702	8	**1.05 Earth and related environmental sciences**	6635
9	1.03 Physical sciences and astronomy	668	9	2.11 Other engineering and technologies	6085
10	**1.01 Mathematics**	542	10	**1.02 Computer and information sciences**	5786

Source: WoS, retrieved on 24 October 2021, conversion from WoS disciplines to OECD FoS by ToE

Such a large number of fields of science and technology indicates a significant similarity in the organisation and representation of scientists in scientific disciplines, as well as the research interest of individuals, institutions and domestic scientific communities in the WB economies.

At the same time, it points to the potential for cooperation between the scientific communities of the WB economies. By pooling together research resources, the WB region can reach the critical mass necessary for quality scientific production and possibly, significantly contribute to the development of the regional economy.

3.1.2. SCIENTIFIC PRODUCTIVITY REGISTERED IN SCOPUS

In a similar way as in the case of the WoS database, the scientific productivity of the WB economies in the Scopus database was investigated. The tables with the results of the Scopus database searches for the period 2010-2021 are provided in the appendices of this study:

- APPENDIX VII: Scientific productivity authors from WB economies – number of articles in Scopus by economy, stock of knowledge 2010-2021
- APPENDIX VIII: Scientific productivity authors from WB economies – number of articles in Scopus by economy, stock of knowledge 2010-2021, sorting by Scopus disciplines

Based on the data on the scientific productivity of the WB economies registered in the Scopus database, ten areas of science and technology were singled out as those in which most of the papers were published in 2010-2021. These data are arranged and shown in Tables 8, 9 and 10. At the same time, those areas of science and technology that are common to all WB economies were bolded. It is characteristic, as in the case of the analysis of scientific productivity in WoS, that **seven areas of science and technology** have been identified as areas with the largest stock of knowledge for all 6 WB economies. These are the following areas of science and technology:

Agricultural and Biological Sciences;

Biochemistry, Genetics and Molecular Biology;

Engineering;

Environmental Science;

Mathematics;

Medicine;

Social Sciences.

These areas should be joined by two more areas that are common to at least four WB economies:

Computer Science;

Physics and Astronomy.

Table 8: Number of scientific articles published by authors from Albania and Bosnia and Herzegovina in Scopus databases, stock of knowledge 2010-2021, ranking by Scopus disciplines, first 10 disciplines

Rank	SUBJECT AREA	Albania	Rank	SUBJECT AREA	Bosnia and Herzegovina
1	**Medicine**	1096	1	**Medicine**	3792
2	**Social Sciences**	1025	2	**Engineering**	1410
3	Economics, Econometrics and Finance	713	3	**Social Sciences**	1209
4	Arts and Humanities	667	4	**Agricultural and Biological Sciences**	1056
5	**Environmental Science**	574	5	**Biochemistry, Genetics and Molecular Biology**	726

Rank	SUBJECT AREA	Albania	Rank	SUBJECT AREA	Bosnia and Herzegovina
6	**Agricultural and Biological Sciences**	566	6	*Computer Science*	712
7	**Mathematics**	315	7	**Environmental Science**	673
8	**Biochemistry, Genetics and Molecular Biology**	296	8	**Mathematics**	665
9	**Engineering**	295	9	*Physics and Astronomy*	546
10	Business, Management and Accounting	225	10	Arts and Humanities	532

Source: Scopus, retrieved on 31 October 2021

Table 9: Number of scientific articles published by authors from Kosovo and Montenegro in Scopus databases, stock of knowledge 2010-2021, ranking by Scopus disciplines, first 10 disciplines*

Rank	SUBJECT AREA	Kosovo*	Rank	SUBJECT AREA	Montenegro
1	**Medicine**	560	1	**Medicine**	758
2	**Social Sciences**	264	2	**Engineering**	741
3	**Environmental Science**	169	3	**Agricultural and Biological Sciences**	737
4	**Agricultural and Biological Sciences**	154	4	**Social Sciences**	488
5	**Engineering**	150	5	*Physics and Astronomy*	398
6	Business, Management and Accounting	101	6	**Environmental Science**	369
7	Economics, Econometrics and Finance	94	7	**Mathematics**	369
8	**Biochemistry, Genetics and Molecular Biology**	79	8	*Computer Science*	310
9	*Computer Science*	72	9	**Biochemistry, Genetics and Molecular Biology**	264
10	**Mathematics**	72	10	Arts and Humanities	244

Source: Scopus, retrieved on 31 October 2021

Table 10: Number of scientific articles published by authors from North Macedonia and Serbia in Scopus databases, stock of knowledge 2010-2021, ranking by Scopus disciplines, first 10 disciplines

Rank	SUBJECT AREA	North Macedonia	Rank	SUBJECT AREA	Serbia
1	**Medicine**	2086	1	**Medicine**	16821
2	**Engineering**	938	2	**Engineering**	12077
3	**Agricultural and Biological Sciences**	804	3	*Physics and Astronomy*	9909
4	**Social Sciences**	770	4	**Agricultural and Biological Sciences**	8927
5	**Biochemistry, Genetics and Molecular Biology**	623	5	Chemistry	8503
6	*Physics and Astronomy*	606	6	**Biochemistry, Genetics and Molecular Biology**	8420
7	Chemistry	594	7	Materials Science	6638
8	*Computer Science*	528	8	**Mathematics**	6546
9	**Mathematics**	505	9	**Social Sciences**	5540
10	**Environmental Science**	452	10	**Environmental Science**	4985

Source: Scopus, retrieved on 31 October 2021

3.1.3. OVERALL CONCLUSIONS OF THE ANALYSIS OF SCIENTIFIC PRODUCTIVITY OF WB ECONOMIES

The performed analysis points to the following findings and conclusions:

The analysis of scientific productivity in both WoS and Scopus indicated 7 areas of science and technology that are common to the WB economies:

- WoS:
  - 1.01 Mathematics;
  - 1.02 Computer and information sciences;
  - 1.05 Earth and related environmental sciences;
  - 1.06 Biological sciences;
  - 2.02 Electrical engineering, electronic engineering;
  - 3.02 Clinical medicine;
  - 3.01 Basic medical research.
- Scopus:
  - Agricultural and Biological Sciences;

- Biochemistry, Genetics and Molecular Biology;
- Engineering;
- Environmental Science;
- Mathematics;
- Medicine;
- Social Sciences;

Plus, two more areas that are common to at least four WB economies:

- Computer Science;
- Physics and Astronomy

Such a large number of fields of science and technology indicates a significant similarity in the representation of scientists in scientific disciplines, as well as the research interest of individuals, institutions and domestic scientific communities in the WB economies. All these findings point to the potential for cooperation between the scientific communities of the WB economies.

Finally, these results justify the creation of a joint RI Roadmap for the WB economies. By pooling together research resources, the WB region can reach the critical mass necessary for quality scientific production and, possibly, significantly contribute to the development of the regional economies.

3.2. SCIENTIFIC PRODUCTIVITY AND SMART SPECIALISATION

Findings of the analysis of productivity of the scientific community of WB economies are compared to the S3 priorities for those WB economies that have adopted S3. In the continuation of this paragraph, an excerpt from UNESCO Science Report: *the Race Against Time for Smarter Development* (UNESCO, 2021) is given, while in Chapter 10, the author, one of the ToE members, provided an analysis of the situation in the WB economies regarding S3. Then, for the economies of the Western Balkans that have determined the priorities of smart specialisation, they are paired with the areas of the highest scientific productivity in order to analyse the scientific potential for the delivery of these priorities.

3.2.1. SMART SPECIALISATION IN WB ECONOMIES

The concept of smart specialisation is a relatively new approach to the development of the economy and society based on knowledge and innovation and was originally intended for strategic thinking at the level of a region of an economy. Chapter 25 in the accession negotiations for EU membership has no binding content and in principle opens and closes at the same time with reports on the state of research and innovation. Therefore, it was somewhat surprising to all EU candidates to be required to report on the state of development of the S3,

that is, to have obligation to develop such a strategy. The latest review of the state of science in the world, UNESCO Science Report: *the Race Against Time for Smarter Development* (UNESCO, 2021), provides an overview of the situation in the WB economies when it comes to smart specialisation strategies.

The European Commission has invited the region's governments to develop their S3 with the idea that this strategy could be the missing link that economies need in order to integrate their research and economic sectors; it would make better use of human resources in science and engineering while inciting researchers to migrate from the government and higher education sectors to industry.

The concept of 'smart specialisation' was developed by an expert group (Foray et al., 2009) as a tool to accelerate pan-European development through an 'integrated industrial policy for the globalisation era' and an Innovation Union, the latter strategy having been adopted by the EU in 2010. The concept takes a regional, rather than an economy-level approach to innovation policy, to concentrate resources in a handful of priority sectors.

The S3 Platform was established by the European Commission at the Joint Research Centre's Institute for Prospective Technological Studies in Seville, Spain, to provide members with various forms of support, including guidelines for the development of S3. The EU's Cohesion Policy provides funding to help economies apply these principles to their industrial policy.

The European Commission's guidelines advise governments to select priority sectors only based on the outcome of direct interaction between policy-makers and the private sector, in what has been termed 'the entrepreneurial discovery process'. The selected areas for intervention should correspond to specific societal and environmental challenges or reinforce the health and security of citizens. Governments could, for example, promote the use of ICTs for active ageing, explore solutions to reduce traffic congestion or develop innovative materials for eco-construction. This phase is currently being funded by the EU as the bloc's first 'pilot action'.

The EU's second pilot action will identify and scale up bankable interregional projects that can create European value chains in priority sectors, such as big data, the bio-economy, resource efficiency, connected mobility or advanced manufacturing. This phase will consist of initiating thematic partnerships that closely involve public authorities, businesses and researchers from different regions.

Serbia was the first to begin its mapping exercise in 2017, followed by Montenegro a year later. In June 2019, Montenegro became the first non-EU economy to complete both the mapping phase and entrepreneurial discovery process, and received a positive opinion from the EU Commission in December 2019.

Montenegro

Montenegro's S3 for the period 2019–2024 will serve as the basis for priority investment in research and innovation of about € 174 million. Of this amount, the government is expected to provide € 116.4 million, the private sector € 21.7 million, the EU € 33.5 million and other international sources about € 2.5 million.

The Montenegrin Ministry of Science coordinated the S3 process with the help of the Ministry of the Economy and more than 300 stakeholders from across the academic, economic, public and civil sectors, more than half of whom came from the business sector. This exercise identified three priority domains:

- Sustainable Agriculture and Food Value Chain;
- Energy and a Sustainable Environment;
- Sustainable and Health Tourism,

and fourth is ICT, as a horizontal dimension that provides business and technological support to other priority areas.

Serbia

In Serbia, the S3 process has been initiated by the Ministry of Education, Science and Technological Development. In February 2020, Government of Serbia has adopted S3 under the title Serbia Creates Innovation, with four priority domains:

- Food for the future,
- ICT,
- Future Machines and Manufacturing Systems, and
- Creative industries.

Albania

In September 2017, the Ministry of Education, Sports and Youth began developing Albania's S3, which should be ready by 2022; it will focus on the region surrounding the capital city of Tirana. The mapping exercise, qualitative analyses and entrepreneurial discovery process should have been completed in 2020, with support from the European Commission's Technical Assistance and Information Exchange instrument (TAIEX). The main priority sectors have been identified as:

- water and energy;
- ICTs; and
- tourism and agritourism.

The strategy is foreseen to be finalised by 2022. S3 will be an umbrella strategy with a focus on Region 2 which is the main region in Albania that includes the Capital Tirana as well.

North Macedonia

North Macedonia launched its S3 process in March 2018 by establishing an interinstitutional working group consisting of representatives of the government, relevant ministries and the academic community. Following its methodology, and with the support from GIZ, the National Centre for Development of Innovation and Entrepreneurial Learning (NCDIEL) conducted the quantitative mapping as an assessment of the potential priority domains based on economic,

innovation and scientific indicators. Furthermore, in the period from September 2020 to March 2021 a qualitative analysis was carried out by an internal team from the Economic Chamber of North Macedonia (ECNM) with the support of a few external domestic experts and in close cooperation with the North Macedonia Smart Specialisation Working Group. After processing all information obtained from many sources (conducted interviews, conclusions from focus group meetings, in-depth sectoral analysis and additional studies, etc.), the following vertical priority areas and subareas were proposed as a subject to further elaboration within the EDP process:

1. Smart agriculture and food processing with high added value
   - Smart agriculture
   - Food processing with high added value
2. Information and Communication Technologies (ICT) sector
   - Custom Software Development
3. Smart/Sustainable buildings and materials
4. Electrical equipment & machinery parts

These four areas are proposed as vertical areas for smart specialisation, having economic capacities, as well as scientific and innovative potentials to be further elaborated to create a new niche market for their specialisation. The area for smart specialisation named Energy for the future is considered a horizontal one because it has strong cross-sectoral relations with the other proposed priority areas and is in line with the process of greening the industry and environmental protection. Also, Sustainable tourism and catering, as a preliminary proposed area with a significant contribution to the economy of North Macedonia and a critical mass of firms with development potential, will be additionally explored during the EDP process to provide a clearer picture of whether this preliminary area has enough potential for smart specialisation.

Bosnia and Herzegovina

Meanwhile, Bosnia and Herzegovina is in the process of preparing its S3.

3.2.2. S3 PRIORITIES AND THE MOST PRODUCTIVE SCIENTIFIC DISCIPLINES IN WB ECONOMIES

The WB economies that have identified the priorities of the S3 are Albania, Montenegro, North Macedonia, and Serbia. For these four economies, the first twenty WoS disciplines with the largest stocks of knowledge, i.e. the largest number of papers in the period 2010-2021, are provided in tables 11, 12, 13 and 14.

Albania

Table 11: Number of scientific articles published by authors from Albania in WoS databases, stock of knowledge 2010-2021, ranking by WoS disciplines, first 20 disciplines

Rank	WoS_Albania	2010-2021	Priorities of the Smart Specialisation Strategy
1	Environmental Sciences	740	• Water and Energy; • ICTs; • Tourism and Agritourism.
2	Immunology	191	
3	Clinical Neurology	181	
4	Computer Science, Information Systems	181	
5	Infectious Diseases	155	
6	Oncology	154	
7	Mathematics	153	
8	Education & Educational Research	145	
9	Economics	142	
10	Public, Environmental & Occupational Health	142	
11	Endocrinology & Metabolism	140	
12	Psychiatry	140	
13	Engineering, Electrical & Electronic	138	
14	Multidisciplinary Sciences	138	
15	Cardiac & Cardiovascular Systems	137	
16	Geosciences, Multidisciplinary	133	
17	Computer Science, Theory & Methods	132	
18	Telecommunications	130	
19	Urology & Nephrology	122	
20	Allergy	121	

The largest number of articles by Albanian authors in WoS in the period 2010-2021 were published in the field of environmental sciences, which corresponds to the priority of the smart specialisation Water and Energy. The second priority of the smart specialisation ICT directly corresponds to the 4th, 17th and 18th WoS disciplines from Table 11. The third priority of the smart specialisation Tourism and Agritourism can correspond to the 1st, 9th, 14th and 16th discipline of WoS provided in Table 11. The identified connections between the stock of knowledge and the priorities of smart specialisation strategy indicate the scientific potentials that can significantly help in the achievement of smart specialisation goals. This emphasises the importance of research and innovation infrastructure for the overall development of Albania's economy and society.

Montenegro

The situation is similar in Montenegro. The first S3 priority Sustainable Agriculture and Food Value Chain directly corresponds to the WoS disciplines from Table 12: 3 and 11. The second S3 priority Energy and a Sustainable Environment directly corresponds to the WoS disciplines

from Table 12: 1 and 3. The third priority Sustainable and Health Tourism directly corresponds to the WoS disciplines from Table 12: 3, 4 and 17. The fourth, horizontal priority ICT directly corresponds to the WoS disciplines from Table 12: 2, 5 and 20.

Table 12: Number of scientific articles published by authors from Montenegro in WoS databases, stock of knowledge 2010-2021, ranking by WoS disciplines, first 20 disciplines

Rank	WoS_Montenegro	2010-2021	Priorities of the Smart Specialisation Strategy
1	Engineering, Electrical & Electronic	544	• Sustainable Agriculture and Food Value Chain; • Energy and a Sustainable Environment; • Sustainable and Health Tourism; • ICT, as a horizontal dimension.
2	Computer Science, Theory & Methods	229	
3	Environmental Sciences	227	
4	Medicine, General & Internal	227	
5	Telecommunications	227	
6	Language & Linguistics	215	
7	Mathematics	210	
8	Physics, Particles & Fields	162	
9	Humanities, Multidisciplinary	146	
10	Zoology	145	
11	Marine & Freshwater Biology	141	
12	Mathematics, Applied	141	
13	Economics	138	
14	Engineering, Multidisciplinary	127	
15	Plant Sciences	122	
16	Materials Science, Multidisciplinary	108	
17	Public, Environmental & Occupational Health	104	
18	Chemistry, Multidisciplinary	90	
19	Pharmacology & Pharmacy	88	
20	Computer Science, Information Systems	85	

North Macedonia

The second S3 priority Information and Communication Technologies (Custom Software Development) directly corresponds to the WoS disciplines from Table 13: 1, 2, 3, 4, 10 and 11. The fourth priority Electrical Equipment & Machinery Parts directly corresponds to the WoS disciplines from Table 13: 1. Other S3 priorities, both horizontal (Energy for the future; Sustainable tourism and catering) and vertical (Smart agriculture and food processing with high added value; Smart/Sustainable buildings and materials), can hardly be found among the first twenty WoS disciplines.

Table 13: Number of scientific articles published by authors from North Macedonia in WoS databases, stock of knowledge 2010-2021, ranking by WoS disciplines, first 20 disciplines

Rank	WoS_North Macedonia	2010-2021	Priorities of the Smart Specialisation Strategy
1	Engineering, Electrical & Electronic	777	**Vertical priority areas**: • Smart agriculture and food processing with high added value • Information and Communication Technologies sector • Smart/Sustainable buildings and materials • Electrical equipment & machinery parts **Horizontal priority areas:** • Energy for the future • Sustainable tourism and catering
2	Computer Science, Information Systems	473	
3	Telecommunications	444	
4	Computer Science, Theory & Methods	389	
5	Environmental Sciences	376	
6	Transplantation	314	
7	Economics	311	
8	Education & Educational Research	304	
9	Haematology	295	
10	Computer Science, Artificial Intelligence	287	
11	Computer Science, Interdisciplinary Applications	246	
12	Chemistry, Multidisciplinary	241	
13	Immunology	235	
14	Urology & Nephrology	224	
15	Cardiac & Cardiovascular Systems	219	
16	Mathematics	201	
17	Oncology	201	
18	Genetics & Heredity	195	
19	Endocrinology & Metabolism	184	
20	Multidisciplinary Sciences	183	

Serbia

The situation in Serbia is the following: the first S3 priority Food for the Future directly corresponds to the WoS discipline from Table 14: 8 (Food Science & Technology). The second priority ICT directly corresponds to the WoS disciplines from Table 14: 2 and 9 (WoS discipline Computer Science, Artificial Intelligence is in 24th place with a stock of 1395 papers). The third priority Future Machines and Manufacturing Systems directly corresponds to the WoS disciplines from Table 14: 2, 7 and 17. The fourth priority Creative Industries directly corresponds to the WoS disciplines from Table 14: 2 and 17.

Table 14: Number of scientific articles published by authors from Serbia in WoS databases, stock of knowledge 2010-2021, ranking by WoS disciplines, first 20 disciplines

Rank	WoS_Serbia	2010-2021	Priorities of the Smart Specialisation Strategy
1	Medicine, General & Internal	5067	• Food For The Future; • ICT; • Future Machines and Manufacturing Systems; • Creative Industries.
2	Engineering, Electrical & Electronic	5002	
3	Environmental Sciences	3122	
4	Mathematics, Applied	2926	
5	Chemistry, Multidisciplinary	2883	
6	Mathematics	2827	
7	Materials Science, Multidisciplinary	2806	
8	Food Science & Technology	2289	
9	Telecommunications	2272	
10	Pharmacology & Pharmacy	2247	
11	Biochemistry & Molecular Biology	2224	
12	Physics, Particles & Fields	2179	
13	Cardiac & Cardiovascular Systems	2117	
14	Clinical Neurology	2042	
15	Engineering, Chemical	2037	
16	Chemistry, Physical	2011	
17	Engineering, Multidisciplinary	1963	
18	Physics, Applied	1786	
19	Neurosciences	1775	
20	Oncology	1775	

Three economies, Albania, Montenegro and Serbia, have scientific potential that is adequate to the priorities of S3. The fourth economy, North Macedonia, differs in part from the other three, but even in the case of North Macedonia, half of the priorities of the S3 correspond to the most productive scientific disciplines in which scientists from that economy publish their results. Since the interconnectedness of the most scientifically productive WoS disciplines has already been pointed out (as for Scopus), and the priorities of S3 have much in common for all four economies, this indicates the potential for cooperation between the scientific communities of these four economies. It is a realistic assumption that this also applies to the remaining two economies, and that all analysed economies can use the synergetic effect of cooperation of scientific communities in the implementation of smart specialisation of the entire WB region. WB Roadmap could serve as infrastructural support for possible future cooperation in research and innovation in the Western Balkans.

4. CONCLUSION AND RECOMMENDATIONS FOR THE DEVELOPMENT OF THE REGION'S R&I INFRASTRUCTURES

4.1. KEY FINDINGS

RESEARCH INFRASTRUCTURES

Lack of R&D funding is common in all WB economies, which is one of the causes of the non-competitiveness of domestic RIs at the European level and insufficient integration of research institutions in the large pan-European RIs. Domestic funds for purchasing new and maintaining existing research equipment are very limited. Regional RIs are not connected to the industrial sector. The general perception of the relevance of research is quite negative.

Existing RI facilities are outdated and mainly used for educational purposes, with very limited use for research purposes. Except for the few cases that are emphasised in this policy document, WB economies are not integrated into large pan-European RIs. WB economies are participating only in a few high-level European RIs. Serbia participates in 5 ESFRI projects, North Macedonia and Bosnia and Herzegovina in 1, while Albania, Kosovo* and Montenegro are the only European economies that do not participate in any of the ESFRI top European RIs.

The RIs in the WB region are not able to support and/or initiate the technological and economic development of the region to the extent necessary to catch up with the development of the European Union. However, there are elements of R&I infrastructure in the region that are already involved in key EU development projects. Such examples of RIs should be a role model for all economies in the region to establish similar R&I infrastructures as a prerequisite for initiating overall development mechanisms.

The development of R&I infrastructures should be in line with the available research and innovation potential of WB economies and in line with the priorities of domestic/regional S3. Comparing the most productive research areas with the S3 priority areas, a high level of concordance in 4 WB economies has been identified. It indicates adequate engagement and capabilities of research and innovation resources, which is a necessary condition for the successful implementation of S3. Furthermore, this could be an indication of the future direction in which the engagement of governing structures in the remaining two WB economies (Bosnia and Herzegovina, Kosovo*) should be organised, both for launching S3 projects and for building the necessary R&I infrastructures.

Regarding the current state of RIs in ESFRI thematic areas, the general conclusion is as follows:

Energy

WB economies are not participating in ESFRI research projects and landmarks in the area of energy, and have very limited access to other pan-European RIs. They are connected

with CERN in different ways. Serbia is an official member of CERN, while North Macedonia, Bosnia and Herzegovina, Albania and Montenegro have signed an International Cooperation Agreement that allows them access to educational content and trainings. As for the Euratom Research and Training Programme, WB economies are not eligible to apply for calls under this programme.

Regarding the participation of WB economies in H2020 projects in this area, Serbia and North Macedonia are the leading WB economies, while the project cooperation between the research institutions in the region is low.

Environment

Concerning Large European RI in the area of environment recognised by ESFRI, Serbia is a member of one distributed RI: eLTER. The WB economies have participated in 63 projects, getting an EC contribution of 10.68 million euros, which is only 0.34% of the total EC contribution in this thematic priority. Our analysis shows that Serbia is the central node in the network while research cooperation within the region is weak with the insignificant role of other WB economies.

Health and Food Sciences

Health and Food Sciences are the prioritised areas within the strategic framework of all WB economies. As a result of great potential in this area, all WB economies generally agreed to participate in the development of the first regional RI: International Institute for Sustainable Technologies in South East. This project is still in the preparatory phase. With regard to Pan-European RIs, North Macedonia participates in one ESFRI project: METROFOOD-RI.

It is important to highlight the Antares project (worth 28 million euros) implemented by the Biosense Institute, Serbia. The project aims to evolve the BioSense Institute into a European Centre of Excellence for advanced technologies in sustainable agriculture and food security. Montenegro has established the first centre of excellence: BIO-ICT Centre of Excellence. These two projects are proofs of the exceptional potential in the entire region in this thematic area.

Physical Sciences and Engineering

Generally speaking, the WB region lacks large RIs in the area of physical sciences, and the level of integration into pan-European RIs is weak. Research activities in this area are mainly oriented toward producing research papers in domestic and international peer-reviewed journals. Serbia is the only WB economy that participates in the CERN's project of high importance: High-Luminosity Large Hadron Collider - HL-LHC.

WB economies have participated in only 3 out of a total of 1,451 H2020 projects within the thematic area of physical sciences.

Social and Cultural Innovation

The strategic policy framework of most WB economies has not recognised the importance of social research and little attention has been paid to RIs in the social sciences. However,

compared to other thematic areas, WB economies are well represented in pan-European RIs in the area of social and cultural innovation. Serbia, as the most advanced WB economy, is participating in CESSDA, ESS-ERIC, OPERAS and DARIAH; Bosnia and Herzegovina and Albania participate in RESILIENCE; Bosnia and Herzegovina has recently become a member of DARIAH, while most WB economies conducted at least one social survey coordinated by ESS-ERIC.

Serbia and Bosnia and Herzegovina have made significant progress, resulting in the development of one of the most important RIs in the area of social sciences: Data Centre Serbia for Social Sciences and Data Archive for Social Sciences in Bosnia and Herzegovina.

E-Infrastructures

According to the strategic policy frameworks, the ICT sector represents an absolute priority in WB economies. However, the WB region is lagging behind the EU in terms of using HPC. While Serbia and North Macedonia have HPC infrastructures and distinguished research organisations appointed to represent them in European HPC-related projects and infrastructures, other WB economies do not have HPC infrastructures in their economies.

Our analysis shows high level of research collaboration between WB economies with the important role of EU and neighbourhood economies.

INNOVATION INFRASTRUCTURES

While RIs in the WB region are underdeveloped mainly due to insufficient support from the Governments of individual economies, Innovation Infrastructures and the innovation ecosystem as a whole are developing without government support. The innovation ecosystem has been developing rapidly in the last few years in all WB economies. However, it is still in its infancy and more efforts should be invested to continue this trend.

The WB region lacks venture capital on the level of individual economies as well as on the macro-regional level. The current presence of private equity funds in the WB region is inadequate due to the small market size for larger equity investments, lack of local market knowledge, and an unstable political and economic situation. Except for a few regional funds (such as SC Ventures Fund in Skopje and Belgrade and Eleven Ventures from Bulgaria), other venture capital funds are not interested in this region. The future of the startup ecosystem of the region lies in the greater availability of venture capital markets.

Innovation infrastructures in the WB region are mainly providing their clients with pre-incubation services, training and education activities, networking, advice on the development of new products and services, etc. The least commonly reported services provided by innovation infrastructures in the WB region are services related to the venture capital market and business angel networks access services. This is in line with the key challenges the region is facing, namely the lack of venture capital funds and alternative sources of financing in the entire WB region.

There is low cooperation between innovation infrastructures in the WB region. Except for a few reported cases of good practices, most Innovation infrastructures are not learning from others and do not use the resources of others. Cooperation with universities is also at a low level. However, given that some innovation infrastructures have reported tight cooperation with universities, their models and approaches should be explored further to identify possible models and space for cooperation between universities and innovation infrastructures in the region.

Based on the analysis of key vertical sectors supported by innovation infrastructures in the WB region, it could be concluded that the ICT and Creative Industries are the most promising areas. Innovation infrastructures are mainly focused on providing support to startups from these sectors.

RESEARCH SPECIALISATIONS IN THE WB REGION: BIBLIOMETRIC ANALYSIS

Findings of the analysis of productivity of the scientific community of WB economies are placed in relation to the S3 priorities of WB economies that adopted the S3.

S3 in WB economies

Serbia was the first to begin its mapping exercise in 2017, followed by Montenegro a year later. In June 2019, Montenegro became the first non-EU economy to complete both the mapping phase and entrepreneurial discovery process, and received a positive opinion from the European Commission in December 2019.

Montenegro

Montenegro's S3 for the period 2019–2024 will serve as the basis for priority investment in research and innovation of about € 174 million. Of this amount, the government is expected to provide € 116.4 million, the private sector € 21.7 million, the EU € 33.5 million and other international sources about € 2.5 million. This exercise identified the three priority domains:

- Sustainable Agriculture and Food Value Chain;
- Energy and a Sustainable Environment;
- Sustainable and Health Tourism,

and fourth is ICT, as a horizontal dimension that provides business and technological support to other priority areas.

Serbia

In Serbia, the S3 process has been initiated by the Ministry of Education, Science and Technological Development. In February 2020, Government of Serbia has adopted S3 under the title Serbia Creates Innovation, with four priority sectors:

- Food for the future,

- ICT,
- Future Machines and Manufacturing Systems, and
- Creative industries.

Albania

In September 2017, the Ministry of Education, Sports and Youth began developing Albania's Smart Specialisation Strategy, which should be ready by 2022. The main priority sectors have been identified as:

- Water and Energy,
- ICTs and
- Tourism and Agritourism.

North Macedonia

North Macedonia launched its S3 process in March 2018. The following vertical priority areas and sub-areas were proposed, subject to further elaboration within EDP:

1. Smart agriculture and food processing with high added value:
   - Smart agriculture,
   - Food processing with high added value;
2. Information and Communication Technologies (ICT) sector:
   - Custom Software Development;
3. Smart/Sustainable buildings and materials;
4. Electrical equipment & machinery parts.

The smart specialisation area named Energy for the future is considered horizontal because it has strong cross-sectoral relations with other proposed priority areas and is in line with the process of greening the industry and protecting the environment. Also, Sustainable tourism and Catering, as a preliminary proposed area with a significant contribution to the economy of North Macedonia and a critical mass of firms with development potential, will be additionally explored during the EDP process to provide a clearer picture of whether this preliminary area has enough potential for smart specialisation.

Bosnia and Herzegovina, Kosovo*

Meanwhile, Bosnia and Herzegovina and Kosovo* are in the process of preparing their S3.

S3 priorities and the most productive scientific disciplines in WB economies

The WB economies that have identified S3 priorities are Albania, Montenegro, North Macedonia, and Serbia. For these four economies, the first twenty WoS disciplines with the largest stocks of knowledge, i.e. the largest number of papers in the period 2010-2021, are identified.

Albania

The largest number of articles by Albanian authors in WoS in the period 2010-2021 was published in the field of environmental sciences, which corresponds to the smart specialisation priority Water and Energy. The second priority of the smart specialisation, ICT, directly corresponds to identified WoS disciplines. The third priority of smart specialisation, Tourism and Agritourism, can correspond to several identified disciplines of WoS.

Montenegro

All S3 priorities: first: Sustainable Agriculture and Food Value Chain, second Energy and a Sustainable Environment", third Sustainable and Health Tourism; and fourth horizontal priority ICT, directly correspond to the several identified WoS disciplines.

North Macedonia

The second S3 priority ICT (Custom Software Development) directly corresponds to the several identified WoS disciplines. The fourth priority Electrical Equipment & Machinery Parts directly corresponds to one identified WoS discipline. Other priorities, both horizontal (Energy for the future; Sustainable tourism and catering) and vertical (Smart agriculture and food processing with high added value; Smart/Sustainable buildings and materials), can hardly be found among the first twenty WoS disciplines.

Serbia

The situation in Serbia is the following: the first S3 priority Food for the Future directly corresponds to one identified WoS discipline. The second priority ICT directly corresponds to several identified WoS disciplines. The third priority Future Machines and Manufacturing Systems directly corresponds to several identified WoS disciplines. The fourth priority Creative Industries directly corresponds to several identified WoS disciplines.

4.2. RECOMMENDATIONS FOR THE DEVELOPMENT OF THE REGION'S R&I INFRASTRUCTURES

Further development of research and innovation infrastructures in the WB region largely depends on the economic power of each economy. The relatively low level of funds that can be allocated for investments in research and innovation infrastructure directs decision-makers to alternative initiatives that include regional cooperation and the integration of research and innovation potentials and resources. The recommendations set out here include potential policy measures and initiatives for the improvement of the R&I infrastructure at the level of individual economies and the regional level.

RECOMMENDATIONS FOR IMPROVING RESEARCH INFRASTRUCTURE IN THE REGION

To successfully integrate into the ERA, governments of WB economies should recognise RIs as strategically important for economic development. Integration of RIs in the wider European research scope needs to be improved. A strategic framework with policy measures and coordination actions is the most important on this path, while strong links to S3 priorities are necessary so that funding could be directed to research facilities that produce the best research results.

As a result of the analysis of the current situation of RIs in the WB region, the following policy recommendations emerge, aiming to improve the quality of the existing RIs in the region:

- **R1.** **Increase investments in research infrastructures.** The Western Balkans records a very low level of R&D expenditures compared to EU member states and the overall situation is even worse, considering the declining trend of R&D investments in some WB economies. Greater budget allocation for R&D is a necessary condition for the future development of RIs in the Region. Policy measures should follow two directions: direct investments in research equipment and facilities and stimulations of the business sector to invest in RIs.
- **R2.** **Introduce funding mechanisms to support research at the regional level.** According to the current state, research collaboration between RIs in the region is very low. Establishing a regional research fund that should be in line with the main research priorities in the region is strongly recommended. This measure would stimulate competition for excellence in the WB region and reflect priorities on the level of individual economies. It could also stimulate intraregional synergies, having in mind that some WB economies are too small to develop research capacities at the level of their economies.
- **R3.** **Improve policy research framework of some WB economies**. The absence of high-level strategic documents in some WB economies represents an obstacle to implementing the research policy. Furthermore, the process implementation, monitoring and evaluation of strategies should be improved in all WB economies.
- **R4.** **The Governments of WB economies should consider options for more active participation in Large European RIs**. Each WB economy should consider policy instruments that would increase participation in Pan-European RIs. The benefits of accessing large RI for researchers and research institutions are multiple and mostly related to capacity building and the implementation of high-level research projects that cannot be implemented within the economy and within the WB region due to the lack of appropriate equipment, strengthening scientific excellence, etc.

R5. **R5. Policymakers from the WB economies should address the challenge of lack of access to RIs and a low level of cooperation between sciences and industry.** Building on the experience gained from the programme Open Access Research Infrastructure in the Western Balkans Support Programme implemented by the RCC Secretariat in 2020, each WB economy should encourage research institutions to adopt their Open Access Policy documents. The final deliverables from this Programme could be taken into account when defining policies for providing access to RIs. A policy of open access to RIs should be the objective for both commercial use and academic collaborations.

R6. **WB Roadmap should serve as infrastructural support for possible future cooperation in research and innovation in the Western Balkans.**

R7. **Development of the joint R&I Infrastructures in the WB region should be based on already established projects as well as future projects based on cooperation in research and innovation in the Western Balkans**.

The process of developing S3 is based on identification of the priority domains for the future, and mapping of R&I infrastructures provides a framework for analysis of research potential and indicates how key domestic R&I infrastructures can contribute to research and innovation strengthening. The identified connections between the stock of knowledge and the priorities of S3 in four WB economies indicate scientific potentials that can significantly help in the achievement of S3 goals. This emphasises the importance of R&I infrastructure for the overall development of the economy and society. This indicates the following recommendations:

R8. **The development of domestic R&I infrastructure in the WB economies should support the implementation of the S3 priorities in those WB economies that have adopted S3**. Priority in development should be given to the areas of science and technology in which the largest stock of knowledge has been identified, which are in direct correlation with the selected S3 priorities.

R9. **Support from domestic and EU funds for cooperation between researchers and innovators in the Western Balkans should be primarily focused on the areas of science and technology identified by the process of mapping and identifying S3 priorities**, which correlate with knowledge stocks recorded in WoS and Scopus databases.

RECOMMENDATIONS FOR IMPROVING INNOVATION INFRASTRUCTURE IN THE REGION

Innovation infrastructures play an important role in the success of startups and innovative new ventures, as they provide a wide range of support in the form of advice, networking, finance, physical space, etc. The success of such infrastructure depends on a good administrative framework for entry and growth, the existence of markets for technology and a suitable intellectual property (IP) system that can strengthen the infrastructure's contributions to the successful performance of innovators. Public policy can help innovative entrepreneurs by providing financing for innovation infrastructure. Considering the most important challenges in

the development of innovation infrastructure in the WB Region, policy recommendations are as follows:

R10. **To enable further growth of the innovation ecosystem, the WB economies should provide greater access to finance by startups**. Alternative sources of financing are an important factor in the future growth of the innovation ecosystem. Therefore, all WB economies should consider the establishment of a regional innovation fund to provide much-needed support to their startups and other innovative companies. The role models could be the Innovation Fund of Serbia and the Fund for Innovation and Technology Development in North Macedonia which have been achieving significant results in recent years. Cooperation between the WB economies, which involves sharing knowledge and key resources to establish Innovation funds in Montenegro, Albania, Kosovo* and Bosnia and Herzegovina is strongly recommended.

R11. **Policy measures aimed at fostering cooperation between Innovation infrastructures in the WB region should be introduced**. Considering the low cooperation between innovation infrastructures in the Region, it would be beneficial for all actors to enhance this cooperation through knowledge sharing and learning from others.

R12. **WB economies should introduce policy measures for increasing the internal capacities of Innovation infrastructures**. Many Innovationinnovation infrastructures in the Regionregion should improve and standardise the services they provide to clients and tenants. In addition, they also need to develop the capacities of management and staff to move to the next phase of development from co-working and property-based to adding high-value services.

APPENDIX I LIST OF IMPORTANT RIS IN THE WB REGION

Research Infrastructure	Scope (ESFRI/international/domestic)	Participating WB economies
ENERGY		
European Organisation for Nuclear Research (CERN)	Pan-European RI of high importance	**Serbia** is a full member; **North Macedonia** signed an International Cooperation Agreement with CERN in 2009; **Albania** signed an International Cooperation Agreement with CERN in 2014; **Bosnia and Herzegovina** signed an International Cooperation Agreement with CERN in 2021; **Montenegro** signed an Agreement on scientific and technical cooperation in 2007
ENVIRONMENT		
eLTER – Integrated European Long-Term Ecosystem	ESFRI RI	**Serbia** is a full member
HEALTH & FOOD		
METROFOOD-RI Infrastructure for Promoting Metrology in Food and Nutrition	ESFRI RI	**North Macedonia** is a full member
International Institute for Sustainable Technologies in South East Europe (SEEIIST)	Macro Regional RI, regional initiative	**All WB economies** are the partners in the project
Population Health Information Research Infrastructure	H2020 Project, International RI	**Serbia and Bosnia and Herzegovina** are the project members
Antares project	H2020 project	Antares project (worth 28 million euros) aims to evolve **Biosense Institute, Serbia** into a European Centre of Excellence for advanced technologies in sustainable agriculture and food security.

Research Infrastructure	Scope (ESFRI/international/domestic)	Participating WB economies
BIO-ICT Centre of Excellence	Local RI: Centre of Excellence	BIO-ICT Centre of Excellence is the first centre of excellence in **Montenegro**, implemented as a three-year research programme at the University of Montenegro, led by the Faculty of Electrical Engineering.
Physical sciences and Engineering		
HL-LHC – High-Luminosity Large Hadron	ESFRI RI	**Institute of Physics, Serbia** is a full member of this RI
Virtual Atomic and Molecular Data Centre (VAMDC)	International RI	**Astronomical Observatory Belgrade, Serbia** is a member of this RI
SOCIAL AND CULTURAL INNOVATION		
Consortium of European Social Science Data Archives (CESSDA)	Pan-European RI	**Serbia and North Macedonia** are the full members of the CESSDA, while Bosnia and Herzegovina, Albania, Montenegro and Kosovo* are the potential partners currently outside the consortium.
DARIAH ERIC – Digital Research Infrastructure for the Arts and Humanities	Pan-European RI	**Ministry of Education Science and Technological Development** as a representing entity and the **Institute for the Serbian Language of the Serbian Academy for Sciences and Arts** as the coordinating institution **from Serbia** are the members of DARIAH; **Ministry of Civil Affairs** as a representing entity and **University of Sarajevo** as the coordinating institution **from Bosnia and Herzegovina** are the members of DARIAH
European Social Survey (ESS)	ESFRI RI	The majority of the WB economies participated in at least one round of the ESS. **Serbia, Montenegro and Albania** participated in two rounds of survey; **North Macedonia and Kosovo*** participated in one round.

Research Infrastructure	Scope (ESFRI/international/domestic)	Participating WB economies
OPERAS	ESFRI RI	**Centre for Evaluation in Education and Science, Serbia** is a member of this RI
RESILIENCE	ESFRI RI	**University of Sarajevo, Bosnia and Herzegovina and Albanian University in Tirana, Albania** are the members of this RI
E-INFRASTRUCTURES		
GEANT	Pan-European RI	**Serbia, North Macedonia, Albania, Montenegro and Kosovo*** are the members of this RI.
GEANT Project GN4-3	H2020 project	The following organisations from the Western Balkans are the partners in the project: • **Academic Network of Albania** • **Academic Network of Serbia** • **Macedonian Academic & Research Network** • **Montenegrin Research and Education Network**
EOSC Association – European Open Science Cloud	European e-Infrastructure	Members from the WB economies are: • **Institute of Physics Belgrade, Serbia** • **University of Banja Luka, Bosnia and Herzegovina** • **Faculty of Computer Science and Engineering, University Ss Cyril and Methodius in Skopje, North Macedonia**
EGI Federation	European e-Infrastructure	The EGI data centres are located at 3 research institutions from Serbia: • **Scientific Computing Laboratory, Institute of Physics, Belgrade, Serbia** • **Laboratory for Electronic Design Automation, Faculty of Electronic Engineering, University of Niš, Serbia** • **Belgrade University Computer Centre (RCUB), Serbia**

Research Infrastructure	Scope (ESFRI/international/domestic)	Participating WB economies
EUROCC - National Competence Centres in the framework of EuroHPC	H2020 project	**Faculty of computer science and engineering, University of Ss. Cyril and Methodius from North Macedonia and University of Donja Gorica from Montenegro** are the members of the EuroCC project
EGI-ACE: Advanced computing for research	H2020 project	**Ss. Cyril and Methodius University in Skopje, North Macedonia** is the project member of the EGI-ACE project
NI4OS-Europe: National Initiatives for Open Science in Europe	H2020 project	Members from the WB economies are: • **Institute of Physics Belgrade, Serbia** • **University of Belgrade, Serbia** • **RASH, the Academic Network of Albania** • **Ss. Cyril and Methodius University in Skopje, North Macedonia** • **University of Banja Luka, Bosnia and Herzegovina** • **University of Montenegro, Montenegro**

APPENDIX II: LIST OF INNOVATION INFRASTRUCTURES IN THE WB REGION

List of innovation infrastructures in Serbia

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
Innovation Fund of Serbia	Belgrade	Innovation Fund	Startups, innovative companies, universities
Science Fund of Serbia	Belgrade	Science Fund	Research community, R&D centres
Science Technology Park Belgrade	Belgrade	Science and Technology Park	Startups, innovative companies, universities, research institutes
Science Technology Park Niš	Niš	Science and Technology Park	Startups, innovative companies, universities, research institutes
Science Technology Park Čačak	Čačak	Science and Technology Park	Startups, innovative companies, universities, research institutes
Science Technology Park Novi Sad	Novi Sad	Science and Technology Park	Startups, innovative companies, universities, research institutes
ICT Hub	Belgrade	Entrepreneurship Centre, Business incubator and Innovation Hub	Startups, SMEs, Entrepreneurs, main focus on ICT
SEE ICT/StartIT	Belgrade	IT Centre	Youth, entrepreneurs and IT professionals
Business Incubator Novi Sad	Novi Sad	Business Incubator	Startups, SMEs, mainly focused on ICT and creative industries
Business Technology Incubator of Technical Faculties Belgrade (BITF)	Belgrade	Business Incubator	Startups, SMEs,
Vojvodina ICT Cluster	Novi Sad	Business Association	ICT industry
Serbian Games Association	Belgrade	Business Association	Gaming industry
Serbian Blockchain Initiative	Belgrade	Business Association	ICT, Blockchain Technologies
Impact Hub	Belgrade	Startup Accelerator	Early-stage startups in various sectors
In Centre	Belgrade	Innovation Hub, business incubator	Startups

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
Nova Iskra	Belgrade	Creative Hub	Freelancers, entrepreneurs, early-stage startups mainly from creative industries
StartUp Centre	Belgrade	Startup Centre	Students
KG CODE	Kragujevac	Business support organisation	ICT and Creative industries
Health Tech Lab	Belgrade	Business support organisation	Heath tech industry
Belgrade Robotics Hub	Belgrade	Innovation Hub	Robotics, ICT
Business Incubator Zrenjanin	Zrenjanin	Business incubator	Local startups
Business Incubator Subotica	Subotica	Business incubator	Local startups
BIC Bački Petrovac	Bački Petrovac	Business incubator	Local startups
iDEAlab	Novi Sad	Association of citizens, Creative space	Students
Business Innovation Centre Kragujevac	Kragujevac	Innovation Centre	Local startups
Razlivalište	Belgrade	Community Network	Social Entrepreneurship
Serbian Venture Network: Seven	Belgrade	Venture Network	Startups, innovative SMEs
Bridgeway Europe Startup Accelerator	Belgrade	Accelerator program	Startups
Belgrade Founder Institute	Belgrade	Global Network, Startup Accelerator	Early-stage startups
South Central Ventures	Belgrade office	Venture Fund	Startups
BIC Bor	Bor	Business incubator	Local startups
BIC Yumco Vranje	Vranje	Business incubator	Local startups
BIC Prokuplje	Prokuplje	Business incubator	Local startups
BIC Kladovo	Kladovo	Business incubator	Local startups
BI Majdanpek	Majdanpek	Business incubator	Local startups
Business Incubator Senta	Senta	Business incubator	Local startups
Innovation Startup Centre	Stara Pazova	Business incubator	Students, startups
Startup Centar Niš	Niš	Business incubator	Students, startups
ZIP Centre Pirot	Pirot	Business incubator	Young people, students, startups
BIC Kragujevac	Kragujevac	Business incubator	Local startups

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
BI Kruševac	Kruševac	Business incubator	Local startups
BIC Užice	Užice	Business incubator	Local startups
BI Valjevo	Valjevo	Business incubator	Local startups
NIT Novi Pazar	Novi Pazar	IT Incubator	Startups, students
Mokrin House	Mokrin	Co-working space	Freelancers, entrepreneurs, digital nomads
Think Innovative	Niš	Co-working space	IT professionals, creative industries
DELI Creative Space	Niš	Co-working space	IT professionals, creative industries
Pomak	Zaječar	Co-working space	IT professionals, startups
No Limit Hub	Niš	Co-working space	Entrepreneurs, startups
Smart Office	Belgrade	Co-working space	Startups, SMEs, entrepreneurs
KG Coworking	Kragujevac	Co-working space	ICT professionals
Coffice Užice	Užice	Co-working space	Entrepreneurs, creative people
Infostud Hub	Subotica	IT Hub	ICT professionals

List of innovation infrastructures in North Macedonia

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
Fund for Innovation and Technology Development	Skopje	Innovation Fund	Startups, innovative companies, universities, other innovation infrastructures
South Central Ventures	Skopje office	Venture Fund	Startups
CEED Macedonia Business Angels Club	Skopje	Venture Fund	Startups
Startup Macedonia	Skopje	Business association	Startups
The Chamber of Commerce for Information and Communication Technologies	Skopje	Chamber of Commerce	ICT industry, startups and SMEs
Seavus Accelerator	Skopje	Accelerator	entrepreneurs, early-stage startups in various sectors
Business Technology Accelerator UKIM	Skopje	Accelerator	ICT industry, startups, spinoffs

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
X Factor Accelerator	Veles	Accelerator	entrepreneurs, early-stage startups in various sectors
YES Incubator	Skopje	Business Incubator	ICT industry, startups,
Centre for Technology Transfer and Innovations (INNOFEIT)	Skopje	Technology Transfer Office	Innovative companies, university
Social Innovation Hub	Skopje	Innovation Hub	Social innovation, SMEs, startups
Social Impact Lab	Skopje	Innovation Hub	Social innovation, SMEs, startups
Brainster Space	Skopje	Co-working space	Creative industries, tech companies
SEEUTechPark	Tetovo	University Technology Park	Startups, spinoffs
Ceed Hub Skopje	Skopje	Innovation Hub, co-working space	early-stage startups
Newman's Business Accelerator	Skopje	Business Accelerator	startups

List of innovation infrastructures in Bosnia and Herzegovina

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
INTERA Technology Park	Mostar	Technology Park, Business Incubator	Startups, SMEs
Innovation Centre Banja Luka	Banja Luka	Business Incubator	Early-stage startups
ONEX Banja Luka	Banja Luka	Digital Innovation Hub	SMEs, startups
BIT Centre	Tuzla	Business Incubator	ICT industry, startups
HUB387	Sarajevo	Co-working space	Freelancers, startups
SPARK	Mostar	IT education hub	Students, digital professionals
Networks Sarajevo	Sarajevo	Co-working space, business centre	Individuals, entrepreneurs, startups
BeeZone	Travnik	Business Incubator	Startups, young entrepreneurs
LabHub		Digital transformation platform	Researchers (Medical and Biological Engineering), SMEs, startups
SEEBA Balkans	Sarajevo	Consulting company	Startups, SMEs

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
Digital Transformation Centre of the Chamber of Commerce of the Republika Srpska	Banja Luka	Digital transformation centre	Startups, SMEs
Entrepreneurship and Technology Transfer Centre, University of Banja Luka,	Banja Luka	Technology Transfer Centre	Innovative companies, university
Development Agency of the City of Trebinje	Trebinje	Business Incubator	Local startups, SMEs
PREDA-PD Development Agency of the City of Prijedor	Prijedor	Development agency, Hub	Local startups, SMEs

List of innovation infrastructures in Albania

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
National Agency of Scientific Research and Innovation (NASRI)	Tirana	Research and Innovation Fund	Research institutions, SMEs
Argjiro Innovation Hub	Gjirokaster	Innovation Hub	Startups, entrepreneurs
Oficina	Tirana	Business Incubator and Accelerator	Startups
Protic Innovation Centre	Tirana	Innovation ICT Centre	ICT, startups, SMEs
Startup Grind Tirana	Tirana	Business Community	Young entrepreneurs, SMEs
Tirana INC	Tirana	Multi-university incubator	Student startup teams
Uplift	Tirana	Acceleration programme	Early-stage startups
UK-Albania Tech Hub	Tirana	Innovation Hub	Tech startups
Ivanaj Foundation	Tirana	Business Incubation and Innovation Hub	Entrepreneurs, startups
Growpreneur Accelerator	Tirana	Acceleration programme	Startups
Metropolitan Incubator	Tirana	University Business Incubator	Students, startups
Barleti Hub	Tirana	Innovation Hub	Students, startups

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
Yunus Social Business	Tirana	Acceleration programme	Social innovation, young people
Women Founders	Tirana	Acceleration programme, Network community	Women
The Innovation Investment Fund (INNVEST)	Tirana	Networking community, business services	Entrepreneurs, startups, SMEs
FasterCapital	Dubai	Online incubator, Venture capital	Startups
Tech Space	Tirana	Technology Lab	Startups and students
Coolab Tirana	Tirana	Co-working space	Entrepreneurs, freelancers, business professionals
Dutch Hub	Tirana	Co-working space	Entrepreneurs, freelancers, business professionals
Inno Space	Tirana	Co-working space	Startups
MyOffice'Al	Tirana	Co-working space	Freelancers, entrepreneurs, and startup teams

List of innovation infrastructures in Montenegro

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
Science and Technology Park of Montenegro	Podgorica	Science and Technology Park	Startups, Universities
Tehnopolis	Nikšić	Innovation and Entrepreneurship Centre	Innovative SMEs, innovators, startups, academic community, support to agricultural producers
Mtel Digital Factory	Podgorica	Digital Innovation Hub	Early-stage start-ups
Digitalizuj.Me		Digital community	Students, startups
Incubator BSC Bar	Bar	Business Incubator	Startups
Beta Bar	Bar	Co-working Space	Startups, SMEs

List of innovation infrastructures in Kosovo*

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
Innovation Centre Kosovo*	Pristina	Innovation Centre	Startups, SMEs, focus on ICT

Name of Innovation infrastructure	Location	Type of Innovation Infrastructure	Target groups (sectors that are supported)
CEED Kosovo*	Pristina	Global organisation, investment management group	Youth, women, rural entrepreneurs
VentureUP	Pristina	University Business Incubator	Students
Kosovo* Association of ICT (STIKK)	Pristina	Business Association	ICT sector
JIC Jakova Innovation Centre	Gjakova	Innovation Centre, business incubator	Young entrepreneurs, startups
Innovation and Training Park (ITP) Prizren	Prizren	Innovation and Training Park	Innovators, entrepreneurs, startups, SMEs, research institutions
Centre for Innovation Support and Technology Transfer	Pristina	Technology Transfer Office	Entrepreneurs, researchers, SMEs
Bonevet	Pristina	Non-profit foundation, education centre	Children, youngsters
CBC Innovation Hubs	Istog	Innovation Hub	Tourism
Kosovo* Business Angel Network (KOSBAN)	Pristina	Business Angel Network	Startups

APPENDIX III: SCIENTIFIC PRODUCTIVITY AUTHORS FROM WB ECONOMIES – NUMBER OF ARTICLES IN WOS BY WOS DISCIPLINES AND BY ECONOMY, STOCK OF KNOWLEDGE 2010-2021

Source: WoS, retrieved on 24 October 2021

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
1	ACOUSTICS	9	6	4	11	13	152
2	AGRICULTURAL ECONOMICS & POLICY	32	53	36	14	18	617
3	AGRICULTURAL ENGINEERING	7	15	7	5	9	265
4	AGRICULTURE, DAIRY & ANIMAL SCIENCE	28	61	28	16	49	304
5	AGRICULTURE, MULTIDISCIPLINARY	41	55	31	20	34	485
6	AGRONOMY	47	115	48	46	45	1274
7	ALLERGY	121	36	13	5	109	259
8	ANATOMY & MORPHOLOGY	8	34	29	38	29	211
9	ANDROLOGY	0	0	0	6	7	25
10	ANESTHESIOLOGY	30	19	10	9	14	126
11	ANTHROPOLOGY	10	111	13	23	8	498
12	ARCHAEOLOGY	18	18	2	10	14	137
13	ARCHITECTURE	24	43	20	17	20	125
14	AREA STUDIES	44	137	34	20	58	165
15	ART	10	13	9	5	17	279
16	ASIAN STUDIES	0	5	0	0	0	7
17	ASTRONOMY & ASTROPHYSICS	15	20	5	77	68	1592
18	AUDIOLOGY & SPEECH-LANGUAGE PATHOLOGY	2	4	0	0	3	50

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
19	AUTOMATION & CONTROL SYSTEMS	16	277	84	30	130	555
20	BEHAVIORAL SCIENCES	5	4	4	2	8	99
21	BIOCHEMICAL RESEARCH METHODS	4	31	5	4	43	312
22	BIOCHEMISTRY & MOLECULAR BIOLOGY	71	200	99	55	164	2224
23	BIODIVERSITY CONSERVATION	24	22	13	25	16	169
24	BIOLOGY	37	107	56	65	61	1384
25	BIOPHYSICS	4	16	8	1	83	382
26	BIOTECHNOLOGY & APPLIED MICROBIOLOGY	38	82	39	26	78	906
27	BUSINESS	112	308	61	73	154	490
28	BUSINESS, FINANCE	39	86	20	50	56	132
29	CARDIAC & CARDIOVASCULAR SYSTEMS	137	173	104	73	219	2117
30	CELL & TISSUE ENGINEERING	3	0	2	1	10	90
31	CELL BIOLOGY	37	67	59	20	76	709
32	CHEMISTRY, ANALYTICAL	34	65	67	32	111	1000
33	CHEMISTRY, APPLIED	15	45	22	32	49	1067
34	CHEMISTRY, INORGANIC & NUCLEAR	11	22	24	14	20	551
35	CHEMISTRY, MEDICINAL	25	81	30	24	60	894
36	CHEMISTRY, MULTIDISCIPLINARY	80	237	115	90	241	2883
37	CHEMISTRY, ORGANIC	6	8	8	2	13	316
38	CHEMISTRY, PHYSICAL	46	54	86	19	98	2011
39	CLASSICS	1	1	0	0	0	9
40	CLINICAL NEUROLOGY	181	215	52	49	149	2042
41	COMMUNICATION	6	10	4	5	6	69
42	COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	81	189	47	43	287	1395

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
43	COMPUTER SCIENCE, CYBERNETICS	2	14	2	5	36	83
44	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	70	74	15	45	69	272
45	COMPUTER SCIENCE, INFORMATION SYSTEMS	181	364	58	85	473	1210
46	COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	64	280	57	54	246	1231
47	COMPUTER SCIENCE, SOFTWARE ENGINEERING	79	67	16	21	93	517
48	COMPUTER SCIENCE, THEORY & METHODS	132	294	68	229	389	1164
49	CONSTRUCTION & BUILDING TECHNOLOGY	27	34	31	20	51	438
50	CRIMINOLOGY & PENOLOGY	5	47	15	10	31	164
51	CRITICAL CARE MEDICINE	36	37	3	8	16	165
52	CRYSTALLOGRAPHY	7	5	12	17	11	298
53	CULTURAL STUDIES	2	2	1	1	0	17
54	DANCE	0	0	0	0	1	6
55	DEMOGRAPHY	6	5	1	1	19	15
56	DENTISTRY, ORAL SURGERY & MEDICINE	86	67	57	13	27	432
57	DERMATOLOGY	34	37	16	21	32	346
58	DEVELOPMENT STUDIES	11	11	2	6	15	24
59	DEVELOPMENTAL BIOLOGY	2	6	4	4	10	82
60	ECOLOGY	44	37	24	41	61	405
61	ECONOMICS	142	445	124	138	311	1252
62	EDUCATION & EDUCATIONAL RESEARCH	145	176	86	63	304	929
63	EDUCATION, SCIENTIFIC DISCIPLINES	19	41	26	13	76	374
64	EDUCATION, SPECIAL	1	17	4	1	14	78
65	ELECTROCHEMISTRY	7	33	25	1	63	516

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
66	EMERGENCY MEDICINE	19	25	7	1	9	147
67	ENDOCRINOLOGY & METABOLISM	140	147	44	63	184	1305
68	ENERGY & FUELS	25	154	47	39	105	1129
69	ENGINEERING, AEROSPACE	1	2	1	12	3	90
70	ENGINEERING, BIOMEDICAL	9	195	13	13	143	529
71	ENGINEERING, CHEMICAL	11	127	61	35	143	2037
72	ENGINEERING, CIVIL	51	161	54	53	122	907
73	ENGINEERING, ELECTRICAL & ELECTRONIC	138	1109	233	544	777	5002
74	ENGINEERING, ENVIRONMENTAL	20	35	47	10	61	631
75	ENGINEERING, GEOLOGICAL	29	100	3	13	62	159
76	ENGINEERING, INDUSTRIAL	10	58	6	21	18	287
77	ENGINEERING, MANUFACTURING	4	61	10	9	12	300
78	ENGINEERING, MARINE	8	11	0	47	2	39
79	ENGINEERING, MECHANICAL	13	218	37	85	97	1491
80	ENGINEERING, MULTIDISCIPLINARY	38	518	123	127	148	1963
81	ENGINEERING, OCEAN	2	1	0	7	1	16
82	ENGINEERING, PETROLEUM	2	1	5	1	2	36
83	ENTOMOLOGY	12	21	15	61	16	376
84	ENVIRONMENTAL SCIENCES	740	327	307	227	376	3122
85	ENVIRONMENTAL STUDIES	41	66	27	46	74	513
86	ERGONOMICS	0	8	4	0	12	54
87	ETHICS	11	9	2	1	8	48
88	ETHNIC STUDIES	3	9	5	1	5	20
89	EVOLUTIONARY BIOLOGY	13	13	2	18	11	156
90	FAMILY STUDIES	4	8	8	0	5	31

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
91	FILM, RADIO, TELEVISION	1	2	0	6	0	19
92	FISHERIES	20	22	4	36	11	92
93	FOLKLORE	0	0	1	1	1	12
94	FOOD SCIENCE & TECHNOLOGY	48	153	43	71	151	2289
95	FORESTRY	34	156	14	31	43	384
96	GASTROENTEROLOGY & HEPATOLOGY	26	87	9	22	22	444
97	GENETICS & HEREDITY	48	160	32	44	195	1013
98	GEOCHEMISTRY & GEOPHYSICS	31	17	8	11	29	162
99	GEOGRAPHY	26	71	42	20	63	305
100	GEOGRAPHY, PHYSICAL	33	22	1	6	23	248
101	GEOLOGY	21	21	30	2	38	138
102	GEOSCIENCES, MULTIDISCIPLINARY	133	96	100	56	177	869
103	GERIATRICS & GERONTOLOGY	24	7	10	3	9	159
104	GERONTOLOGY	18	2	2	0	4	26
105	GREEN & SUSTAINABLE SCIENCE & TECHNOLOGY	40	76	46	44	63	753
106	HEALTH CARE SCIENCES & SERVICES	39	92	22	23	44	314
107	HEALTH POLICY & SERVICES	21	54	18	16	24	243
108	HEMATOLOGY	37	61	17	12	295	971
109	HISTORY	14	42	25	45	18	198
110	HISTORY & PHILOSOPHY OF SCIENCE	0	4	0	3	7	81
111	HISTORY OF SOCIAL SCIENCES	2	2	1	0	0	21
112	HORTICULTURE	53	58	19	35	26	463
113	HOSPITALITY, LEISURE, SPORT & TOURISM	15	42	4	25	68	198
114	HUMANITIES, MULTIDISCIPLINARY	48	66	41	146	52	597

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
115	IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY	8	38	4	27	20	134
116	IMMUNOLOGY	191	95	33	28	235	828
117	INDUSTRIAL RELATIONS & LABOR	2	1	2	0	8	14
118	INFECTIOUS DISEASES	155	98	72	28	42	449
119	INFORMATION SCIENCE & LIBRARY SCIENCE	14	90	4	11	21	169
120	INSTRUMENTS & INSTRUMENTATION	9	64	23	40	66	801
121	INTEGRATIVE & COMPLEMENTARY MEDICINE	7	46	9	3	8	171
122	INTERNATIONAL RELATIONS	17	31	18	10	51	70
123	LANGUAGE & LINGUISTICS	11	65	8	215	23	355
124	LAW	26	48	60	15	46	145
125	LIMNOLOGY	4	2	2	5	9	31
126	LINGUISTICS	9	30	6	37	22	223
127	LITERARY REVIEWS	1	11	2	0	4	6
128	LITERARY THEORY & CRITICISM	1	2	1	1	2	22
129	LITERATURE	12	19	7	21	9	72
130	LITERATURE, AFRICAN, AUSTRALIAN, CANADIAN	0	0	0	0	0	0
131	LITERATURE, AMERICAN	0	0	0	0	0	2
132	LITERATURE, BRITISH ISLES	0	0	0	0	0	4
133	LITERATURE, GERMAN, DUTCH, SCANDINAVIAN	0	1	0	0	1	4
134	LITERATURE, ROMANCE	2	2	0	3	0	21
135	LITERATURE, SLAVIC	0	19	2	36	5	54
136	LOGIC	3	6	0	1	2	186
137	MANAGEMENT	84	183	45	37	131	643
138	MARINE & FRESHWATER BIOLOGY	45	35	5	141	25	201

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
139	MATERIALS SCIENCE, BIOMATERIALS	6	3	5	5	10	199
140	MATERIALS SCIENCE, CERAMICS	0	14	3	7	11	602
141	MATERIALS SCIENCE, CHARACTERISATION & TESTING	3	8	5	8	5	180
142	MATERIALS SCIENCE, COATINGS & FILMS	4	12	7	2	12	258
143	MATERIALS SCIENCE, COMPOSITES	3	7	27	3	3	167
144	MATERIALS SCIENCE, MULTIDISCIPLINARY	87	189	110	108	160	2806
145	MATERIALS SCIENCE, PAPER & WOOD	1	14	4	0	13	129
146	MATERIALS SCIENCE, TEXTILES	22	26	2	0	35	175
147	MATHEMATICAL & COMPUTATIONAL BIOLOGY	3	22	3	1	19	179
148	MATHEMATICS	153	291	178	210	201	2827
149	MATHEMATICS, APPLIED	98	198	106	141	165	2926
150	MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	12	56	28	37	68	596
151	MECHANICS	10	91	23	60	31	855
152	MEDICAL ETHICS	6	4	0	1	0	21
153	MEDICAL INFORMATICS	10	45	5	6	40	146
154	MEDICAL LABORATORY TECHNOLOGY	17	53	6	13	37	293
155	MEDICINE, GENERAL & INTERNAL	88	713	246	227	169	5067
156	MEDICINE, LEGAL	3	26	12	22	20	219
157	MEDICINE, RESEARCH & EXPERIMENTAL	70	212	63	37	67	896
158	MEDIEVAL & RENAISSANCE STUDIES	0	0	4	4	10	134
159	METALLURGY & METALLURGICAL ENGINEERING	36	98	61	56	21	1356
160	METEOROLOGY & ATMOSPHERIC SCIENCES	25	43	20	15	25	410
161	MICROBIOLOGY	48	54	18	18	26	470

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
162	MICROSCOPY	2	3	0	0	8	82
163	MINERALOGY	8	3	8	5	26	133
164	MINING & MINERAL PROCESSING	8	33	51	9	39	207
165	MULTIDISCIPLINARY SCIENCES	138	182	74	51	183	1147
166	MUSIC	0	14	0	5	7	92
167	MYCOLOGY	1	4	3	4	10	135
168	NANOSCIENCE & NANOTECHNOLOGY	12	36	17	19	53	703
169	NEUROIMAGING	2	1	0	2	3	27
170	NEUROSCIENCES	99	178	49	42	107	1775
171	NUCLEAR SCIENCE & TECHNOLOGY	15	57	30	39	48	768
172	NURSING	23	15	5	16	4	76
173	NUTRITION & DIETETICS	15	43	19	45	51	716
174	OBSTETRICS & GYNECOLOGY	72	76	37	47	60	609
175	OCEANOGRAPHY	21	6	0	64	4	43
176	ONCOLOGY	154	218	41	58	201	1775
177	OPERATIONS RESEARCH & MANAGEMENT SCIENCE	10	48	6	15	42	424
178	OPHTHALMOLOGY	14	44	8	8	20	220
179	OPTICS	6	115	48	9	66	1100
180	ORNITHOLOGY	2	3	0	1	0	25
181	ORTHOPEDICS	7	24	14	5	9	150
182	OTORHINOLARYNGOLOGY	8	13	4	6	3	142
183	PALEONTOLOGY	6	9	0	1	3	106
184	PARASITOLOGY	28	33	12	13	10	163
185	PATHOLOGY	33	125	22	22	109	643

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
186	PEDIATRICS	84	123	57	49	163	662
187	PERIPHERAL VASCULAR DISEASE	58	95	15	36	92	1152
188	PHARMACOLOGY & PHARMACY	118	289	91	88	170	2247
189	PHILOSOPHY	1	29	12	28	10	391
190	PHYSICS, APPLIED	87	115	74	80	139	1786
191	PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	9	74	16	4	68	793
192	PHYSICS, CONDENSED MATTER	26	26	19	14	56	752
193	PHYSICS, FLUIDS & PLASMAS	1	18	1	11	52	362
194	PHYSICS, MATHEMATICAL	2	31	6	22	72	410
195	PHYSICS, MULTIDISCIPLINARY	61	68	66	47	131	1309
196	PHYSICS, NUCLEAR	1	29	0	37	17	815
197	PHYSICS, PARTICLES & FIELDS	1	48	0	162	58	2179
198	PHYSIOLOGY	23	20	26	12	63	456
199	PLANNING & DEVELOPMENT	0	0	0	0	0	0
200	PLANT SCIENCES	70	219	44	122	140	1507
201	POETRY	0	0	0	0	2	4
202	POLITICAL SCIENCE	30	77	25	28	62	179
203	POLYMER SCIENCE	4	16	15	9	27	451
204	PRIMARY HEALTH CARE	2	8	2	0	2	26
205	PSYCHIATRY	140	623	104	70	111	1096
206	PSYCHOLOGY	10	16	8	1	29	160
207	PSYCHOLOGY, APPLIED	2	8	11	0	13	48
208	PSYCHOLOGY, BIOLOGICAL	2	0	1	0	11	33
209	PSYCHOLOGY, CLINICAL	10	28	12	3	11	116
210	PSYCHOLOGY, DEVELOPMENTAL	10	18	16	3	14	95

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
211	PSYCHOLOGY, EDUCATIONAL	0	5	4	0	10	41
212	PSYCHOLOGY, EXPERIMENTAL	1	15	6	0	15	181
213	PSYCHOLOGY, MATHEMATICAL	0	1	0	0	2	6
214	PSYCHOLOGY, MULTIDISCIPLINARY	18	50	25	6	34	535
215	PSYCHOLOGY, PSYCHOANALYSIS	0	1	1	0	1	6
216	PSYCHOLOGY, SOCIAL	3	30	12	1	5	129
217	PUBLIC ADMINISTRATION	4	22	8	15	22	83
218	PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	142	191	106	104	167	1253
219	QUANTUM SCIENCE TECHNOLOGY	1	9	2	1	6	147
220	RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING	30	106	19	29	109	826
221	REGIONAL URBAN PLANNING	36	76	19	8	67	186
222	REHABILITATION	6	29	9	6	16	241
223	RELIGION	5	95	4	6	30	104
224	REMOTE SENSING	14	37	8	18	16	159
225	REPRODUCTIVE BIOLOGY	30	10	12	15	30	126
226	RESPIRATORY SYSTEM	76	48	11	26	103	569
227	RHEUMATOLOGY	34	39	10	24	14	514
228	ROBOTICS	4	31	6	5	26	175
229	SOCIAL ISSUES	1	20	3	9	12	57
230	SOCIAL SCIENCES, BIOMEDICAL	6	8	6	4	3	59
231	SOCIAL SCIENCES, INTERDISCIPLINARY	105	50	47	18	145	225
232	SOCIAL SCIENCES, MATHEMATICAL METHODS	1	2	0	2	5	19
233	SOCIAL WORK	9	9	6	2	7	37

Rank	WoS_2010-2021	WoS_Albania	WoS_ Bosnia and Herzegovina	WoS_Kosovo*	WoS_ Montenegro	WoS_North Macedonia	WoS_Serbia
234	SOCIOLOGY	13	18	11	14	19	306
235	SOIL SCIENCE	7	18	6	4	9	172
236	SPECTROSCOPY	2	6	6	11	55	229
237	SPORT SCIENCES	15	157	29	49	38	510
238	STATISTICS & PROBABILITY	4	17	19	20	34	252
239	SUBSTANCE ABUSE	18	13	8	6	16	52
240	SURGERY	118	124	56	69	80	958
241	TELECOMMUNICATIONS	130	551	111	227	444	2272
242	THEATER	0	0	0	1	0	10
243	THERMODYNAMICS	12	91	64	34	72	1234
244	TOXICOLOGY	21	54	31	34	55	738
245	TRANSPLANTATION	65	26	20	34	314	306
246	TRANSPORTATION	8	17	12	18	5	226
247	TRANSPORTATION SCIENCE & TECHNOLOGY	19	62	11	42	31	544
248	TROPICAL MEDICINE	15	14	9	13	10	127
249	URBAN STUDIES	10	22	5	8	11	108
250	UROLOGY & NEPHROLOGY	122	102	57	50	224	751
251	VETERINARY SCIENCES	49	112	37	24	113	822
252	VIROLOGY	20	11	6	11	11	90
253	WATER RESOURCES	46	52	27	29	43	651
254	WOMEN'S STUDIES	9	2	2	1	2	42
255	ZOOLOGY	30	59	19	145	85	610
	Total:	8638	18573	6673	8041	15727	139276

APPENDIX IV: SCIENTIFIC PRODUCTIVITY AUTHORS FROM WB ECONOMIES – ARTICLES IN WOS BY ECONOMY, STOCK OF KNOWLEDGE 2010-2021, SORTING BY WOS DISCIPLINES

Source: WoS, retrieved on 24 October 2021

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
1	ENVIRONMENTAL SCIENCES	740	1	ENGINEERING, ELECTRICAL & ELECTRONIC	1109
2	IMMUNOLOGY	191	2	MEDICINE, GENERAL & INTERNAL	713
3	CLINICAL NEUROLOGY	181	3	PSYCHIATRY	623
4	COMPUTER SCIENCE, INFORMATION SYSTEMS	181	4	TELECOMMUNICATIONS	551
5	INFECTIOUS DISEASES	155	5	ENGINEERING, MULTIDISCIPLINARY	518
6	ONCOLOGY	154	6	ECONOMICS	445
7	MATHEMATICS	153	7	COMPUTER SCIENCE, INFORMATION SYSTEMS	364
8	EDUCATION & EDUCATIONAL RESEARCH	145	8	ENVIRONMENTAL SCIENCES	327
9	ECONOMICS	142	9	BUSINESS	308
10	PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	142	10	COMPUTER SCIENCE, THEORY & METHODS	294
11	ENDOCRINOLOGY & METABOLISM	140	11	MATHEMATICS	291
12	PSYCHIATRY	140	12	PHARMACOLOGY & PHARMACY	289
13	ENGINEERING, ELECTRICAL & ELECTRONIC	138	13	COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	280
14	MULTIDISCIPLINARY SCIENCES	138	14	AUTOMATION & CONTROL SYSTEMS	277
15	CARDIAC & CARDIOVASCULAR SYSTEMS	137	15	CHEMISTRY, MULTIDISCIPLINARY	237
16	GEOSCIENCES, MULTIDISCIPLINARY	133	16	PLANT SCIENCES	219
17	COMPUTER SCIENCE, THEORY & METHODS	132	17	ENGINEERING, MECHANICAL	218
18	TELECOMMUNICATIONS	130	18	ONCOLOGY	218

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
19	UROLOGY & NEPHROLOGY	122	19	CLINICAL NEUROLOGY	215
20	ALLERGY	121	20	MEDICINE, RESEARCH & EXPERIMENTAL	212
21	PHARMACOLOGY & PHARMACY	118	21	BIOCHEMISTRY & MOLECULAR BIOLOGY	200
22	SURGERY	118	22	MATHEMATICS, APPLIED	198
23	BUSINESS	112	23	ENGINEERING, BIOMEDICAL	195
24	SOCIAL SCIENCES, INTERDISCIPLINARY	105	24	PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	191
25	NEUROSCIENCES	99	25	COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	189
26	MATHEMATICS, APPLIED	98	26	MATERIALS SCIENCE, MULTIDISCIPLINARY	189
27	MEDICINE, GENERAL & INTERNAL	88	27	MANAGEMENT	183
28	MATERIALS SCIENCE, MULTIDISCIPLINARY	87	28	MULTIDISCIPLINARY SCIENCES	182
29	PHYSICS, APPLIED	87	29	NEUROSCIENCES	178
30	DENTISTRY, ORAL SURGERY & MEDICINE	86	30	EDUCATION & EDUCATIONAL RESEARCH	176
31	MANAGEMENT	84	31	CARDIAC & CARDIOVASCULAR SYSTEMS	173
32	PEDIATRICS	84	32	ENGINEERING, CIVIL	161
33	COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	81	33	GENETICS & HEREDITY	160
34	CHEMISTRY, MULTIDISCIPLINARY	80	34	SPORT SCIENCES	157
35	COMPUTER SCIENCE, SOFTWARE ENGINEERING	79	35	FORESTRY	156
36	RESPIRATORY SYSTEM	76	36	ENERGY & FUELS	154
37	OBSTETRICS & GYNECOLOGY	72	37	FOOD SCIENCE & TECHNOLOGY	153
38	BIOCHEMISTRY & MOLECULAR BIOLOGY	71	38	ENDOCRINOLOGY & METABOLISM	147
39	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	70	39	AREA STUDIES	137
40	MEDICINE, RESEARCH & EXPERIMENTAL	70	40	ENGINEERING, CHEMICAL	127
41	PLANT SCIENCES	70	41	PATHOLOGY	125
42	TRANSPLANTATION	65	42	SURGERY	124

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
43	COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	64	43	PEDIATRICS	123
44	PHYSICS, MULTIDISCIPLINARY	61	44	AGRONOMY	115
45	PERIPHERAL VASCULAR DISEASE	58	45	OPTICS	115
46	HORTICULTURE	53	46	PHYSICS, APPLIED	115
47	ENGINEERING, CIVIL	51	47	VETERINARY SCIENCES	112
48	VETERINARY SCIENCES	49	48	ANTHROPOLOGY	111
49	FOOD SCIENCE & TECHNOLOGY	48	49	BIOLOGY	107
50	GENETICS & HEREDITY	48	50	RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING	106
51	HUMANITIES, MULTIDISCIPLINARY	48	51	UROLOGY & NEPHROLOGY	102
52	MICROBIOLOGY	48	52	ENGINEERING, GEOLOGICAL	100
53	AGRONOMY	47	53	INFECTIOUS DISEASES	98
54	CHEMISTRY, PHYSICAL	46	54	METALLURGY & METALLURGICAL ENGINEERING	98
55	WATER RESOURCES	46	55	GEOSCIENCES, MULTIDISCIPLINARY	96
56	MARINE & FRESHWATER BIOLOGY	45	56	IMMUNOLOGY	95
57	AREA STUDIES	44	57	PERIPHERAL VASCULAR DISEASE	95
58	ECOLOGY	44	58	RELIGION	95
59	AGRICULTURE, MULTIDISCIPLINARY	41	59	HEALTH CARE SCIENCES & SERVICES	92
60	ENVIRONMENTAL STUDIES	41	60	MECHANICS	91
61	GREEN & SUSTAINABLE SCIENCE & TECHNOLOGY	40	61	THERMODYNAMICS	91
62	BUSINESS, FINANCE	39	62	INFORMATION SCIENCE & LIBRARY SCIENCE	90
63	HEALTH CARE SCIENCES & SERVICES	39	63	GASTROENTEROLOGY & HEPATOLOGY	87
64	BIOTECHNOLOGY & APPLIED MICROBIOLOGY	38	64	BUSINESS, FINANCE	86
65	ENGINEERING, MULTIDISCIPLINARY	38	65	BIOTECHNOLOGY & APPLIED MICROBIOLOGY	82
66	BIOLOGY	37	66	CHEMISTRY, MEDICINAL	81
67	CELL BIOLOGY	37	67	POLITICAL SCIENCE	77

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
68	HEMATOLOGY	37	68	GREEN & SUSTAINABLE SCIENCE & TECHNOLOGY	76
69	CRITICAL CARE MEDICINE	36	69	OBSTETRICS & GYNECOLOGY	76
70	METALLURGY & METALLURGICAL ENGINEERING	36	70	REGIONAL URBAN PLANNING	76
71	REGIONAL URBAN PLANNING	36	71	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	74
72	CHEMISTRY, ANALYTICAL	34	72	PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	74
73	DERMATOLOGY	34	73	GEOGRAPHY	71
74	FORESTRY	34	74	PHYSICS, MULTIDISCIPLINARY	68
75	RHEUMATOLOGY	34	75	CELL BIOLOGY	67
76	GEOGRAPHY, PHYSICAL	33	76	COMPUTER SCIENCE, SOFTWARE ENGINEERING	67
77	PATHOLOGY	33	77	DENTISTRY, ORAL SURGERY & MEDICINE	67
78	AGRICULTURAL ECONOMICS & POLICY	32	78	ENVIRONMENTAL STUDIES	66
79	GEOCHEMISTRY & GEOPHYSICS	31	79	HUMANITIES, MULTIDISCIPLINARY	66
80	ANESTHESIOLOGY	30	80	CHEMISTRY, ANALYTICAL	65
81	POLITICAL SCIENCE	30	81	LANGUAGE & LINGUISTICS	65
82	RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING	30	82	INSTRUMENTS & INSTRUMENTATION	64
83	REPRODUCTIVE BIOLOGY	30	83	TRANSPORTATION SCIENCE & TECHNOLOGY	62
84	ZOOLOGY	30	84	AGRICULTURE, DAIRY & ANIMAL SCIENCE	61
85	ENGINEERING, GEOLOGICAL	29	85	ENGINEERING, MANUFACTURING	61
86	AGRICULTURE, DAIRY & ANIMAL SCIENCE	28	86	HEMATOLOGY	61
87	PARASITOLOGY	28	87	ZOOLOGY	59
88	CONSTRUCTION & BUILDING TECHNOLOGY	27	88	ENGINEERING, INDUSTRIAL	58
89	GASTROENTEROLOGY & HEPATOLOGY	26	89	HORTICULTURE	58
90	GEOGRAPHY	26	90	NUCLEAR SCIENCE & TECHNOLOGY	57
91	LAW	26	91	MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	56
92	PHYSICS, CONDENSED MATTER	26	92	AGRICULTURE, MULTIDISCIPLINARY	55

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
93	CHEMISTRY, MEDICINAL	25	93	CHEMISTRY, PHYSICAL	54
94	ENERGY & FUELS	25	94	HEALTH POLICY & SERVICES	54
95	METEOROLOGY & ATMOSPHERIC SCIENCES	25	95	MICROBIOLOGY	54
96	ARCHITECTURE	24	96	TOXICOLOGY	54
97	BIODIVERSITY CONSERVATION	24	97	AGRICULTURAL ECONOMICS & POLICY	53
98	GERIATRICS & GERONTOLOGY	24	98	MEDICAL LABORATORY TECHNOLOGY	53
99	NURSING	23	99	WATER RESOURCES	52
100	PHYSIOLOGY	23	100	PSYCHOLOGY, MULTIDISCIPLINARY	50
101	MATERIALS SCIENCE, TEXTILES	22	101	SOCIAL SCIENCES, INTERDISCIPLINARY	50
102	GEOLOGY	21	102	LAW	48
103	HEALTH POLICY & SERVICES	21	103	OPERATIONS RESEARCH & MANAGEMENT SCIENCE	48
104	OCEANOGRAPHY	21	104	PHYSICS, PARTICLES & FIELDS	48
105	TOXICOLOGY	21	105	RESPIRATORY SYSTEM	48
106	ENGINEERING, ENVIRONMENTAL	20	106	CRIMINOLOGY & PENOLOGY	47
107	FISHERIES	20	107	INTEGRATIVE & COMPLEMENTARY MEDICINE	46
108	VIROLOGY	20	108	CHEMISTRY, APPLIED	45
109	EDUCATION, SCIENTIFIC DISCIPLINES	19	109	MEDICAL INFORMATICS	45
110	EMERGENCY MEDICINE	19	110	OPHTHALMOLOGY	44
111	TRANSPORTATION SCIENCE & TECHNOLOGY	19	111	ARCHITECTURE	43
112	ARCHAEOLOGY	18	112	METEOROLOGY & ATMOSPHERIC SCIENCES	43
113	GERONTOLOGY	18	113	NUTRITION & DIETETICS	43
114	PSYCHOLOGY, MULTIDISCIPLINARY	18	114	HISTORY	42
115	SUBSTANCE ABUSE	18	115	HOSPITALITY, LEISURE, SPORT & TOURISM	42
116	INTERNATIONAL RELATIONS	17	116	EDUCATION, SCIENTIFIC DISCIPLINES	41
117	MEDICAL LABORATORY TECHNOLOGY	17	117	RHEUMATOLOGY	39

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
118	AUTOMATION & CONTROL SYSTEMS	16	118	IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY	38
119	ASTRONOMY & ASTROPHYSICS	15	119	CRITICAL CARE MEDICINE	37
120	CHEMISTRY, APPLIED	15	120	DERMATOLOGY	37
121	HOSPITALITY, LEISURE, SPORT & TOURISM	15	121	ECOLOGY	37
122	NUCLEAR SCIENCE & TECHNOLOGY	15	122	REMOTE SENSING	37
123	NUTRITION & DIETETICS	15	123	ALLERGY	36
124	SPORT SCIENCES	15	124	NANOSCIENCE & NANOTECHNOLOGY	36
125	TROPICAL MEDICINE	15	125	ENGINEERING, ENVIRONMENTAL	35
126	HISTORY	14	126	MARINE & FRESHWATER BIOLOGY	35
127	INFORMATION SCIENCE & LIBRARY SCIENCE	14	127	ANATOMY & MORPHOLOGY	34
128	OPHTHALMOLOGY	14	128	CONSTRUCTION & BUILDING TECHNOLOGY	34
129	REMOTE SENSING	14	129	ELECTROCHEMISTRY	33
130	ENGINEERING, MECHANICAL	13	130	MINING & MINERAL PROCESSING	33
131	EVOLUTIONARY BIOLOGY	13	131	PARASITOLOGY	33
132	SOCIOLOGY	13	132	BIOCHEMICAL RESEARCH METHODS	31
133	ENTOMOLOGY	12	133	INTERNATIONAL RELATIONS	31
134	LITERATURE	12	134	PHYSICS, MATHEMATICAL	31
135	MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	12	135	ROBOTICS	31
136	NANOSCIENCE & NANOTECHNOLOGY	12	136	LINGUISTICS	30
137	THERMODYNAMICS	12	137	PSYCHOLOGY, SOCIAL	30
138	CHEMISTRY, INORGANIC & NUCLEAR	11	138	PHILOSOPHY	29
139	DEVELOPMENT STUDIES	11	139	PHYSICS, NUCLEAR	29
140	ENGINEERING, CHEMICAL	11	140	REHABILITATION	29
141	ETHICS	11	141	PSYCHOLOGY, CLINICAL	28
142	LANGUAGE & LINGUISTICS	11	142	MATERIALS SCIENCE, TEXTILES	26

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
143	ANTHROPOLOGY	10	143	MEDICINE, LEGAL	26
144	ART	10	144	PHYSICS, CONDENSED MATTER	26
145	ENGINEERING, INDUSTRIAL	10	145	TRANSPLANTATION	26
146	MECHANICS	10	146	EMERGENCY MEDICINE	25
147	MEDICAL INFORMATICS	10	147	ORTHOPEDICS	24
148	OPERATIONS RESEARCH & MANAGEMENT SCIENCE	10	148	BIODIVERSITY CONSERVATION	22
149	PSYCHOLOGY	10	149	CHEMISTRY, INORGANIC & NUCLEAR	22
150	PSYCHOLOGY, CLINICAL	10	150	FISHERIES	22
151	PSYCHOLOGY, DEVELOPMENTAL	10	151	GEOGRAPHY, PHYSICAL	22
152	URBAN STUDIES	10	152	MATHEMATICAL & COMPUTATIONAL BIOLOGY	22
153	ACOUSTICS	9	153	PUBLIC ADMINISTRATION	22
154	ENGINEERING, BIOMEDICAL	9	154	URBAN STUDIES	22
155	INSTRUMENTS & INSTRUMENTATION	9	155	ENTOMOLOGY	21
156	LINGUISTICS	9	156	GEOLOGY	21
157	PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	9	157	ASTRONOMY & ASTROPHYSICS	20
158	SOCIAL WORK	9	158	PHYSIOLOGY	20
159	WOMEN'S STUDIES	9	159	SOCIAL ISSUES	20
160	ANATOMY & MORPHOLOGY	8	160	ANESTHESIOLOGY	19
161	ENGINEERING, MARINE	8	161	LITERATURE	19
162	IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY	8	162	LITERATURE, SLAVIC	19
163	MINERALOGY	8	163	ARCHAEOLOGY	18
164	MINING & MINERAL PROCESSING	8	164	PHYSICS, FLUIDS & PLASMAS	18
165	OTORHINOLARYNGOLOGY	8	165	PSYCHOLOGY, DEVELOPMENTAL	18
166	TRANSPORTATION	8	166	SOCIOLOGY	18
167	AGRICULTURAL ENGINEERING	7	167	SOIL SCIENCE	18

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
168	CRYSTALLOGRAPHY	7	168	EDUCATION, SPECIAL	17
169	ELECTROCHEMISTRY	7	169	GEOCHEMISTRY & GEOPHYSICS	17
170	INTEGRATIVE & COMPLEMENTARY MEDICINE	7	170	STATISTICS & PROBABILITY	17
171	ORTHOPEDICS	7	171	TRANSPORTATION	17
172	SOIL SCIENCE	7	172	BIOPHYSICS	16
173	CHEMISTRY, ORGANIC	6	173	POLYMER SCIENCE	16
174	COMMUNICATION	6	174	PSYCHOLOGY	16
175	DEMOGRAPHY	6	175	AGRICULTURAL ENGINEERING	15
176	MATERIALS SCIENCE, BIOMATERIALS	6	176	NURSING	15
177	MEDICAL ETHICS	6	177	PSYCHOLOGY, EXPERIMENTAL	15
178	OPTICS	6	178	COMPUTER SCIENCE, CYBERNETICS	14
179	PALEONTOLOGY	6	179	MATERIALS SCIENCE, CERAMICS	14
180	REHABILITATION	6	180	MATERIALS SCIENCE, PAPER & WOOD	14
181	SOCIAL SCIENCES, BIOMEDICAL	6	181	MUSIC	14
182	BEHAVIORAL SCIENCES	5	182	TROPICAL MEDICINE	14
183	CRIMINOLOGY & PENOLOGY	5	183	ART	13
184	RELIGION	5	184	EVOLUTIONARY BIOLOGY	13
185	BIOCHEMICAL RESEARCH METHODS	4	185	OTORHINOLARYNGOLOGY	13
186	BIOPHYSICS	4	186	SUBSTANCE ABUSE	13
187	ENGINEERING, MANUFACTURING	4	187	MATERIALS SCIENCE, COATINGS & FILMS	12
188	FAMILY STUDIES	4	188	DEVELOPMENT STUDIES	11
189	LIMNOLOGY	4	189	ENGINEERING, MARINE	11
190	MATERIALS SCIENCE, COATINGS & FILMS	4	190	LITERARY REVIEWS	11
191	POLYMER SCIENCE	4	191	VIROLOGY	11
192	PUBLIC ADMINISTRATION	4	192	COMMUNICATION	10
193	ROBOTICS	4	193	REPRODUCTIVE BIOLOGY	10

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
194	STATISTICS & PROBABILITY	4	194	ETHICS	9
195	CELL & TISSUE ENGINEERING	3	195	ETHNIC STUDIES	9
196	ETHNIC STUDIES	3	196	PALEONTOLOGY	9
197	LOGIC	3	197	QUANTUM SCIENCE TECHNOLOGY	9
198	MATERIALS SCIENCE, CHARACTERISATION & TESTING	3	198	SOCIAL WORK	9
199	MATERIALS SCIENCE, COMPOSITES	3	199	CHEMISTRY, ORGANIC	8
200	MATHEMATICAL & COMPUTATIONAL BIOLOGY	3	200	ERGONOMICS	8
201	MEDICINE, LEGAL	3	201	FAMILY STUDIES	8
202	PSYCHOLOGY, SOCIAL	3	202	MATERIALS SCIENCE, CHARACTERISATION & TESTING	8
203	AUDIOLOGY & SPEECH-LANGUAGE PATHOLOGY	2	203	PRIMARY HEALTH CARE	8
204	COMPUTER SCIENCE, CYBERNETICS	2	204	PSYCHOLOGY, APPLIED	8
205	CULTURAL STUDIES	2	205	SOCIAL SCIENCES, BIOMEDICAL	8
206	DEVELOPMENTAL BIOLOGY	2	206	GERIATRICS & GERONTOLOGY	7
207	ENGINEERING, OCEAN	2	207	MATERIALS SCIENCE, COMPOSITES	7
208	ENGINEERING, PETROLEUM	2	208	ACOUSTICS	6
209	HISTORY OF SOCIAL SCIENCES	2	209	DEVELOPMENTAL BIOLOGY	6
210	INDUSTRIAL RELATIONS & LABOR	2	210	LOGIC	6
211	LITERATURE, ROMANCE	2	211	OCEANOGRAPHY	6
212	MICROSCOPY	2	212	SPECTROSCOPY	6
213	NEUROIMAGING	2	213	ASIAN STUDIES	5
214	ORNITHOLOGY	2	214	CRYSTALLOGRAPHY	5
215	PHYSICS, MATHEMATICAL	2	215	DEMOGRAPHY	5
216	PRIMARY HEALTH CARE	2	216	PSYCHOLOGY, EDUCATIONAL	5
217	PSYCHOLOGY, APPLIED	2	217	AUDIOLOGY & SPEECH-LANGUAGE PATHOLOGY	4
218	PSYCHOLOGY, BIOLOGICAL	2	218	BEHAVIORAL SCIENCES	4

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
219	SPECTROSCOPY	2	219	HISTORY & PHILOSOPHY OF SCIENCE	4
220	CLASSICS	1	220	MEDICAL ETHICS	4
221	EDUCATION, SPECIAL	1	221	MYCOLOGY	4
222	ENGINEERING, AEROSPACE	1	222	MATERIALS SCIENCE, BIOMATERIALS	3
223	FILM, RADIO, TELEVISION	1	223	MICROSCOPY	3
224	LITERARY REVIEWS	1	224	MINERALOGY	3
225	LITERARY THEORY & CRITICISM	1	225	ORNITHOLOGY	3
226	MATERIALS SCIENCE, PAPER & WOOD	1	226	CULTURAL STUDIES	2
227	MYCOLOGY	1	227	ENGINEERING, AEROSPACE	2
228	PHILOSOPHY	1	228	FILM, RADIO, TELEVISION	2
229	PHYSICS, FLUIDS & PLASMAS	1	229	GERONTOLOGY	2
230	PHYSICS, NUCLEAR	1	230	HISTORY OF SOCIAL SCIENCES	2
231	PHYSICS, PARTICLES & FIELDS	1	231	LIMNOLOGY	2
232	PSYCHOLOGY, EXPERIMENTAL	1	232	LITERARY THEORY & CRITICISM	2
233	QUANTUM SCIENCE TECHNOLOGY	1	233	LITERATURE, ROMANCE	2
234	SOCIAL ISSUES	1	234	SOCIAL SCIENCES, MATHEMATICAL METHODS	2
235	SOCIAL SCIENCES, MATHEMATICAL METHODS	1	235	WOMEN'S STUDIES	2
236	ANDROLOGY	0	236	CLASSICS	1
237	ASIAN STUDIES	0	237	ENGINEERING, OCEAN	1
238	DANCE	0	238	ENGINEERING, PETROLEUM	1
239	ERGONOMICS	0	239	INDUSTRIAL RELATIONS & LABOR	1
240	FOLKLORE	0	240	LITERATURE, GERMAN, DUTCH, SCANDINAVIAN	1
241	HISTORY & PHILOSOPHY OF SCIENCE	0	241	NEUROIMAGING	1
242	LITERATURE, AFRICAN, AUSTRALIAN, CANADIAN	0	242	PSYCHOLOGY, MATHEMATICAL	1
243	LITERATURE, AMERICAN	0	243	PSYCHOLOGY, PSYCHOANALYSIS	1
244	LITERATURE, BRITISH ISLES	0	244	ANDROLOGY	0

Rank	WoS_Albania	2010-2021	Rank	WoS_Bosnia and Herzegovina	2010-2021
245	LITERATURE, GERMAN, DUTCH, SCANDINAVIAN	0	245	CELL & TISSUE ENGINEERING	0
246	LITERATURE, SLAVIC	0	246	DANCE	0
247	MATERIALS SCIENCE, CERAMICS	0	247	FOLKLORE	0
248	MEDIEVAL & RENAISSANCE STUDIES	0	248	LITERATURE, AFRICAN, AUSTRALIAN, CANADIAN	0
249	MUSIC	0	249	LITERATURE, AMERICAN	0
250	PLANNING & DEVELOPMENT	0	250	LITERATURE, BRITISH ISLES	0
251	POETRY	0	251	MEDIEVAL & RENAISSANCE STUDIES	0
252	PSYCHOLOGY, EDUCATIONAL	0	252	PLANNING & DEVELOPMENT	0
253	PSYCHOLOGY, MATHEMATICAL	0	253	POETRY	0
254	PSYCHOLOGY, PSYCHOANALYSIS	0	254	PSYCHOLOGY, BIOLOGICAL	0
255	THEATER	0	255	THEATER	0
	Total:	8638		Total:	18573

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
1	ENVIRONMENTAL SCIENCES	307	1	ENGINEERING, ELECTRICAL & ELECTRONIC	544
2	MEDICINE, GENERAL & INTERNAL	246	2	COMPUTER SCIENCE, THEORY & METHODS	229
3	ENGINEERING, ELECTRICAL & ELECTRONIC	233	3	ENVIRONMENTAL SCIENCES	227
4	MATHEMATICS	178	4	MEDICINE, GENERAL & INTERNAL	227
5	ECONOMICS	124	5	TELECOMMUNICATIONS	227
6	ENGINEERING, MULTIDISCIPLINARY	123	6	LANGUAGE & LINGUISTICS	215
7	CHEMISTRY, MULTIDISCIPLINARY	115	7	MATHEMATICS	210
8	TELECOMMUNICATIONS	111	8	PHYSICS, PARTICLES & FIELDS	162
9	MATERIALS SCIENCE, MULTIDISCIPLINARY	110	9	HUMANITIES, MULTIDISCIPLINARY	146
10	MATHEMATICS, APPLIED	106	10	ZOOLOGY	145
11	PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	106	11	MARINE & FRESHWATER BIOLOGY	141
12	CARDIAC & CARDIOVASCULAR SYSTEMS	104	12	MATHEMATICS, APPLIED	141

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
13	PSYCHIATRY	104	13	ECONOMICS	138
14	GEOSCIENCES, MULTIDISCIPLINARY	100	14	ENGINEERING, MULTIDISCIPLINARY	127
15	BIOCHEMISTRY & MOLECULAR BIOLOGY	99	15	PLANT SCIENCES	122
16	PHARMACOLOGY & PHARMACY	91	16	MATERIALS SCIENCE, MULTIDISCIPLINARY	108
17	CHEMISTRY, PHYSICAL	86	17	PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	104
18	EDUCATION & EDUCATIONAL RESEARCH	86	18	CHEMISTRY, MULTIDISCIPLINARY	90
19	AUTOMATION & CONTROL SYSTEMS	84	19	PHARMACOLOGY & PHARMACY	88
20	MULTIDISCIPLINARY SCIENCES	74	20	COMPUTER SCIENCE, INFORMATION SYSTEMS	85
21	PHYSICS, APPLIED	74	21	ENGINEERING, MECHANICAL	85
22	INFECTIOUS DISEASES	72	22	PHYSICS, APPLIED	80
23	COMPUTER SCIENCE, THEORY & METHODS	68	23	ASTRONOMY & ASTROPHYSICS	77
24	CHEMISTRY, ANALYTICAL	67	24	BUSINESS	73
25	PHYSICS, MULTIDISCIPLINARY	66	25	CARDIAC & CARDIOVASCULAR SYSTEMS	73
26	THERMODYNAMICS	64	26	FOOD SCIENCE & TECHNOLOGY	71
27	MEDICINE, RESEARCH & EXPERIMENTAL	63	27	PSYCHIATRY	70
28	BUSINESS	61	28	SURGERY	69
29	ENGINEERING, CHEMICAL	61	29	BIOLOGY	65
30	METALLURGY & METALLURGICAL ENGINEERING	61	30	OCEANOGRAPHY	64
31	LAW	60	31	EDUCATION & EDUCATIONAL RESEARCH	63
32	CELL BIOLOGY	59	32	ENDOCRINOLOGY & METABOLISM	63
33	COMPUTER SCIENCE, INFORMATION SYSTEMS	58	33	ENTOMOLOGY	61
34	COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	57	34	MECHANICS	60
35	DENTISTRY, ORAL SURGERY & MEDICINE	57	35	ONCOLOGY	58
36	PEDIATRICS	57	36	GEOSCIENCES, MULTIDISCIPLINARY	56
37	UROLOGY & NEPHROLOGY	57	37	METALLURGY & METALLURGICAL ENGINEERING	56

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
38	BIOLOGY	56	38	BIOCHEMISTRY & MOLECULAR BIOLOGY	55
39	SURGERY	56	39	COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	54
40	ENGINEERING, CIVIL	54	40	ENGINEERING, CIVIL	53
41	CLINICAL NEUROLOGY	52	41	MULTIDISCIPLINARY SCIENCES	51
42	MINING & MINERAL PROCESSING	51	42	BUSINESS, FINANCE	50
43	NEUROSCIENCES	49	43	UROLOGY & NEPHROLOGY	50
44	AGRONOMY	48	44	CLINICAL NEUROLOGY	49
45	OPTICS	48	45	PEDIATRICS	49
46	COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	47	46	SPORT SCIENCES	49
47	ENERGY & FUELS	47	47	ENGINEERING, MARINE	47
48	ENGINEERING, ENVIRONMENTAL	47	48	OBSTETRICS & GYNECOLOGY	47
49	SOCIAL SCIENCES, INTERDISCIPLINARY	47	49	PHYSICS, MULTIDISCIPLINARY	47
50	GREEN & SUSTAINABLE SCIENCE & TECHNOLOGY	46	50	AGRONOMY	46
51	MANAGEMENT	45	51	ENVIRONMENTAL STUDIES	46
52	ENDOCRINOLOGY & METABOLISM	44	52	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	45
53	PLANT SCIENCES	44	53	HISTORY	45
54	FOOD SCIENCE & TECHNOLOGY	43	54	NUTRITION & DIETETICS	45
55	GEOGRAPHY	42	55	GENETICS & HEREDITY	44
56	HUMANITIES, MULTIDISCIPLINARY	41	56	GREEN & SUSTAINABLE SCIENCE & TECHNOLOGY	44
57	ONCOLOGY	41	57	COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	43
58	BIOTECHNOLOGY & APPLIED MICROBIOLOGY	39	58	NEUROSCIENCES	42
59	ENGINEERING, MECHANICAL	37	59	TRANSPORTATION SCIENCE & TECHNOLOGY	42
60	OBSTETRICS & GYNECOLOGY	37	60	ECOLOGY	41
61	VETERINARY SCIENCES	37	61	INSTRUMENTS & INSTRUMENTATION	40
62	AGRICULTURAL ECONOMICS & POLICY	36	62	ENERGY & FUELS	39

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
63	AREA STUDIES	34	63	NUCLEAR SCIENCE & TECHNOLOGY	39
64	IMMUNOLOGY	33	64	ANATOMY & MORPHOLOGY	38
65	GENETICS & HEREDITY	32	65	LINGUISTICS	37
66	AGRICULTURE, MULTIDISCIPLINARY	31	66	MANAGEMENT	37
67	CONSTRUCTION & BUILDING TECHNOLOGY	31	67	MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	37
68	TOXICOLOGY	31	68	MEDICINE, RESEARCH & EXPERIMENTAL	37
69	CHEMISTRY, MEDICINAL	30	69	PHYSICS, NUCLEAR	37
70	GEOLOGY	30	70	FISHERIES	36
71	NUCLEAR SCIENCE & TECHNOLOGY	30	71	LITERATURE, SLAVIC	36
72	ANATOMY & MORPHOLOGY	29	72	PERIPHERAL VASCULAR DISEASE	36
73	SPORT SCIENCES	29	73	ENGINEERING, CHEMICAL	35
74	AGRICULTURE, DAIRY & ANIMAL SCIENCE	28	74	HORTICULTURE	35
75	MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	28	75	THERMODYNAMICS	34
76	ENVIRONMENTAL STUDIES	27	76	TOXICOLOGY	34
77	MATERIALS SCIENCE, COMPOSITES	27	77	TRANSPLANTATION	34
78	WATER RESOURCES	27	78	CHEMISTRY, ANALYTICAL	32
79	EDUCATION, SCIENTIFIC DISCIPLINES	26	79	CHEMISTRY, APPLIED	32
80	PHYSIOLOGY	26	80	FORESTRY	31
81	ELECTROCHEMISTRY	25	81	AUTOMATION & CONTROL SYSTEMS	30
82	HISTORY	25	82	RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING	29
83	POLITICAL SCIENCE	25	83	WATER RESOURCES	29
84	PSYCHOLOGY, MULTIDISCIPLINARY	25	84	IMMUNOLOGY	28
85	CHEMISTRY, INORGANIC & NUCLEAR	24	85	INFECTIOUS DISEASES	28
86	ECOLOGY	24	86	PHILOSOPHY	28
87	INSTRUMENTS & INSTRUMENTATION	23	87	POLITICAL SCIENCE	28

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
88	MECHANICS	23	88	IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY	27
89	CHEMISTRY, APPLIED	22	89	BIOTECHNOLOGY & APPLIED MICROBIOLOGY	26
90	HEALTH CARE SCIENCES & SERVICES	22	90	RESPIRATORY SYSTEM	26
91	PATHOLOGY	22	91	BIODIVERSITY CONSERVATION	25
92	ARCHITECTURE	20	92	HOSPITALITY, LEISURE, SPORT & TOURISM	25
93	BUSINESS, FINANCE	20	93	CHEMISTRY, MEDICINAL	24
94	METEOROLOGY & ATMOSPHERIC SCIENCES	20	94	RHEUMATOLOGY	24
95	TRANSPLANTATION	20	95	VETERINARY SCIENCES	24
96	HORTICULTURE	19	96	ANTHROPOLOGY	23
97	NUTRITION & DIETETICS	19	97	HEALTH CARE SCIENCES & SERVICES	23
98	PHYSICS, CONDENSED MATTER	19	98	GASTROENTEROLOGY & HEPATOLOGY	22
99	RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING	19	99	MEDICINE, LEGAL	22
100	REGIONAL URBAN PLANNING	19	100	PATHOLOGY	22
101	STATISTICS & PROBABILITY	19	101	PHYSICS, MATHEMATICAL	22
102	ZOOLOGY	19	102	COMPUTER SCIENCE, SOFTWARE ENGINEERING	21
103	HEALTH POLICY & SERVICES	18	103	DERMATOLOGY	21
104	INTERNATIONAL RELATIONS	18	104	ENGINEERING, INDUSTRIAL	21
105	MICROBIOLOGY	18	105	LITERATURE	21
106	HEMATOLOGY	17	106	AGRICULTURE, MULTIDISCIPLINARY	20
107	NANOSCIENCE & NANOTECHNOLOGY	17	107	AREA STUDIES	20
108	COMPUTER SCIENCE, SOFTWARE ENGINEERING	16	108	CELL BIOLOGY	20
109	DERMATOLOGY	16	109	CONSTRUCTION & BUILDING TECHNOLOGY	20
110	PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	16	110	GEOGRAPHY	20
111	PSYCHOLOGY, DEVELOPMENTAL	16	111	STATISTICS & PROBABILITY	20

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
112	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	15	112	CHEMISTRY, PHYSICAL	19
113	CRIMINOLOGY & PENOLOGY	15	113	NANOSCIENCE & NANOTECHNOLOGY	19
114	ENTOMOLOGY	15	114	EVOLUTIONARY BIOLOGY	18
115	PERIPHERAL VASCULAR DISEASE	15	115	MICROBIOLOGY	18
116	POLYMER SCIENCE	15	116	REMOTE SENSING	18
117	FORESTRY	14	117	SOCIAL SCIENCES, INTERDISCIPLINARY	18
118	ORTHOPEDICS	14	118	TRANSPORTATION	18
119	ALLERGY	13	119	ARCHITECTURE	17
120	ANTHROPOLOGY	13	120	CRYSTALLOGRAPHY	17
121	BIODIVERSITY CONSERVATION	13	121	AGRICULTURE, DAIRY & ANIMAL SCIENCE	16
122	ENGINEERING, BIOMEDICAL	13	122	HEALTH POLICY & SERVICES	16
123	CRYSTALLOGRAPHY	12	123	NURSING	16
124	MEDICINE, LEGAL	12	124	LAW	15
125	PARASITOLOGY	12	125	METEOROLOGY & ATMOSPHERIC SCIENCES	15
126	PHILOSOPHY	12	126	OPERATIONS RESEARCH & MANAGEMENT SCIENCE	15
127	PSYCHOLOGY, CLINICAL	12	127	PUBLIC ADMINISTRATION	15
128	PSYCHOLOGY, SOCIAL	12	128	REPRODUCTIVE BIOLOGY	15
129	REPRODUCTIVE BIOLOGY	12	129	AGRICULTURAL ECONOMICS & POLICY	14
130	TRANSPORTATION	12	130	CHEMISTRY, INORGANIC & NUCLEAR	14
131	PSYCHOLOGY, APPLIED	11	131	PHYSICS, CONDENSED MATTER	14
132	RESPIRATORY SYSTEM	11	132	SOCIOLOGY	14
133	SOCIOLOGY	11	133	DENTISTRY, ORAL SURGERY & MEDICINE	13
134	TRANSPORTATION SCIENCE & TECHNOLOGY	11	134	EDUCATION, SCIENTIFIC DISCIPLINES	13
135	ANESTHESIOLOGY	10	135	ENGINEERING, BIOMEDICAL	13
136	ENGINEERING, MANUFACTURING	10	136	ENGINEERING, GEOLOGICAL	13

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
137	GERIATRICS & GERONTOLOGY	10	137	MEDICAL LABORATORY TECHNOLOGY	13
138	RHEUMATOLOGY	10	138	PARASITOLOGY	13
139	ART	9	139	TROPICAL MEDICINE	13
140	GASTROENTEROLOGY & HEPATOLOGY	9	140	ENGINEERING, AEROSPACE	12
141	INTEGRATIVE & COMPLEMENTARY MEDICINE	9	141	HEMATOLOGY	12
142	REHABILITATION	9	142	PHYSIOLOGY	12
143	TROPICAL MEDICINE	9	143	ACOUSTICS	11
144	BIOPHYSICS	8	144	GEOCHEMISTRY & GEOPHYSICS	11
145	CHEMISTRY, ORGANIC	8	145	INFORMATION SCIENCE & LIBRARY SCIENCE	11
146	FAMILY STUDIES	8	146	PHYSICS, FLUIDS & PLASMAS	11
147	GEOCHEMISTRY & GEOPHYSICS	8	147	SPECTROSCOPY	11
148	LANGUAGE & LINGUISTICS	8	148	VIROLOGY	11
149	MINERALOGY	8	149	ARCHAEOLOGY	10
150	OPHTHALMOLOGY	8	150	CRIMINOLOGY & PENOLOGY	10
151	PSYCHOLOGY	8	151	ENGINEERING, ENVIRONMENTAL	10
152	PUBLIC ADMINISTRATION	8	152	INTERNATIONAL RELATIONS	10
153	REMOTE SENSING	8	153	ANESTHESIOLOGY	9
154	SUBSTANCE ABUSE	8	154	ENGINEERING, MANUFACTURING	9
155	AGRICULTURAL ENGINEERING	7	155	MINING & MINERAL PROCESSING	9
156	EMERGENCY MEDICINE	7	156	OPTICS	9
157	LITERATURE	7	157	POLYMER SCIENCE	9
158	MATERIALS SCIENCE, COATINGS & FILMS	7	158	SOCIAL ISSUES	9
159	ENGINEERING, INDUSTRIAL	6	159	CRITICAL CARE MEDICINE	8
160	LINGUISTICS	6	160	MATERIALS SCIENCE, CHARACTERISATION & TESTING	8
161	MEDICAL LABORATORY TECHNOLOGY	6	161	OPHTHALMOLOGY	8

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
162	OPERATIONS RESEARCH & MANAGEMENT SCIENCE	6	162	REGIONAL URBAN PLANNING	8
163	PHYSICS, MATHEMATICAL	6	163	URBAN STUDIES	8
164	PSYCHOLOGY, EXPERIMENTAL	6	164	ENGINEERING, OCEAN	7
165	ROBOTICS	6	165	MATERIALS SCIENCE, CERAMICS	7
166	SOCIAL SCIENCES, BIOMEDICAL	6	166	ANDROLOGY	6
167	SOCIAL WORK	6	167	DEVELOPMENT STUDIES	6
168	SOIL SCIENCE	6	168	FILM, RADIO, TELEVISION	6
169	SPECTROSCOPY	6	169	GEOGRAPHY, PHYSICAL	6
170	VIROLOGY	6	170	MEDICAL INFORMATICS	6
171	ASTRONOMY & ASTROPHYSICS	5	171	OTORHINOLARYNGOLOGY	6
172	BIOCHEMICAL RESEARCH METHODS	5	172	PSYCHOLOGY, MULTIDISCIPLINARY	6
173	ENGINEERING, PETROLEUM	5	173	REHABILITATION	6
174	ETHNIC STUDIES	5	174	RELIGION	6
175	MARINE & FRESHWATER BIOLOGY	5	175	SUBSTANCE ABUSE	6
176	MATERIALS SCIENCE, BIOMATERIALS	5	176	AGRICULTURAL ENGINEERING	5
177	MATERIALS SCIENCE, CHARACTERISATION & TESTING	5	177	ALLERGY	5
178	MEDICAL INFORMATICS	5	178	ART	5
179	NURSING	5	179	COMMUNICATION	5
180	URBAN STUDIES	5	180	COMPUTER SCIENCE, CYBERNETICS	5
181	ACOUSTICS	4	181	LIMNOLOGY	5
182	BEHAVIORAL SCIENCES	4	182	MATERIALS SCIENCE, BIOMATERIALS	5
183	COMMUNICATION	4	183	MINERALOGY	5
184	DEVELOPMENTAL BIOLOGY	4	184	MUSIC	5
185	EDUCATION, SPECIAL	4	185	ORTHOPEDICS	5
186	ERGONOMICS	4	186	ROBOTICS	5

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
187	FISHERIES	4	187	BIOCHEMICAL RESEARCH METHODS	4
188	HOSPITALITY, LEISURE, SPORT & TOURISM	4	188	DEVELOPMENTAL BIOLOGY	4
189	IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY	4	189	MEDIEVAL & RENAISSANCE STUDIES	4
190	INFORMATION SCIENCE & LIBRARY SCIENCE	4	190	MYCOLOGY	4
191	MATERIALS SCIENCE, PAPER & WOOD	4	191	PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	4
192	MEDIEVAL & RENAISSANCE STUDIES	4	192	SOCIAL SCIENCES, BIOMEDICAL	4
193	OTORHINOLARYNGOLOGY	4	193	SOIL SCIENCE	4
194	PSYCHOLOGY, EDUCATIONAL	4	194	GERIATRICS & GERONTOLOGY	3
195	RELIGION	4	195	HISTORY & PHILOSOPHY OF SCIENCE	3
196	CRITICAL CARE MEDICINE	3	196	INTEGRATIVE & COMPLEMENTARY MEDICINE	3
197	ENGINEERING, GEOLOGICAL	3	197	LITERATURE, ROMANCE	3
198	MATERIALS SCIENCE, CERAMICS	3	198	MATERIALS SCIENCE, COMPOSITES	3
199	MATHEMATICAL & COMPUTATIONAL BIOLOGY	3	199	PSYCHOLOGY, CLINICAL	3
200	MYCOLOGY	3	200	PSYCHOLOGY, DEVELOPMENTAL	3
201	SOCIAL ISSUES	3	201	BEHAVIORAL SCIENCES	2
202	ARCHAEOLOGY	2	202	CHEMISTRY, ORGANIC	2
203	CELL & TISSUE ENGINEERING	2	203	GEOLOGY	2
204	COMPUTER SCIENCE, CYBERNETICS	2	204	MATERIALS SCIENCE, COATINGS & FILMS	2
205	DEVELOPMENT STUDIES	2	205	NEUROIMAGING	2
206	ETHICS	2	206	SOCIAL SCIENCES, MATHEMATICAL METHODS	2
207	EVOLUTIONARY BIOLOGY	2	207	SOCIAL WORK	2
208	GERONTOLOGY	2	208	BIOPHYSICS	1
209	INDUSTRIAL RELATIONS & LABOR	2	209	CELL & TISSUE ENGINEERING	1
210	LIMNOLOGY	2	210	CULTURAL STUDIES	1
211	LITERARY REVIEWS	2	211	DEMOGRAPHY	1

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
212	LITERATURE, SLAVIC	2	212	EDUCATION, SPECIAL	1
213	MATERIALS SCIENCE, TEXTILES	2	213	ELECTROCHEMISTRY	1
214	PRIMARY HEALTH CARE	2	214	EMERGENCY MEDICINE	1
215	QUANTUM SCIENCE TECHNOLOGY	2	215	ENGINEERING, PETROLEUM	1
216	WOMEN'S STUDIES	2	216	ETHICS	1
217	CULTURAL STUDIES	1	217	ETHNIC STUDIES	1
218	DEMOGRAPHY	1	218	FOLKLORE	1
219	ENGINEERING, AEROSPACE	1	219	LITERARY THEORY & CRITICISM	1
220	FOLKLORE	1	220	LOGIC	1
221	GEOGRAPHY, PHYSICAL	1	221	MATHEMATICAL & COMPUTATIONAL BIOLOGY	1
222	HISTORY OF SOCIAL SCIENCES	1	222	MEDICAL ETHICS	1
223	LITERARY THEORY & CRITICISM	1	223	ORNITHOLOGY	1
224	PHYSICS, FLUIDS & PLASMAS	1	224	PALEONTOLOGY	1
225	PSYCHOLOGY, BIOLOGICAL	1	225	PSYCHOLOGY	1
226	PSYCHOLOGY, PSYCHOANALYSIS	1	226	PSYCHOLOGY, SOCIAL	1
227	ANDROLOGY	0	227	QUANTUM SCIENCE TECHNOLOGY	1
228	ASIAN STUDIES	0	228	THEATER	1
229	AUDIOLOGY & SPEECH-LANGUAGE PATHOLOGY	0	229	WOMEN'S STUDIES	1
230	CLASSICS	0	230	ASIAN STUDIES	0
231	DANCE	0	231	AUDIOLOGY & SPEECH-LANGUAGE PATHOLOGY	0
232	ENGINEERING, MARINE	0	232	CLASSICS	0
233	ENGINEERING, OCEAN	0	233	DANCE	0
234	FILM, RADIO, TELEVISION	0	234	ERGONOMICS	0
235	HISTORY & PHILOSOPHY OF SCIENCE	0	235	FAMILY STUDIES	0
236	LITERATURE, AFRICAN, AUSTRALIAN, CANADIAN	0	236	GERONTOLOGY	0
237	LITERATURE, AMERICAN	0	237	HISTORY OF SOCIAL SCIENCES	0

Rank	WoS_Kosovo*	2010-2021	Rank	WoS_Montenegro	2010-2021
238	LITERATURE, BRITISH ISLES	0	238	INDUSTRIAL RELATIONS & LABOR	0
239	LITERATURE, GERMAN, DUTCH, SCANDINAVIAN	0	239	LITERARY REVIEWS	0
240	LITERATURE, ROMANCE	0	240	LITERATURE, AFRICAN, AUSTRALIAN, CANADIAN	0
241	LOGIC	0	241	LITERATURE, AMERICAN	0
242	MEDICAL ETHICS	0	242	LITERATURE, BRITISH ISLES	0
243	MICROSCOPY	0	243	LITERATURE, GERMAN, DUTCH, SCANDINAVIAN	0
244	MUSIC	0	244	MATERIALS SCIENCE, PAPER & WOOD	0
245	NEUROIMAGING	0	245	MATERIALS SCIENCE, TEXTILES	0
246	OCEANOGRAPHY	0	246	MICROSCOPY	0
247	ORNITHOLOGY	0	247	PLANNING & DEVELOPMENT	0
248	PALEONTOLOGY	0	248	POETRY	0
249	PHYSICS, NUCLEAR	0	249	PRIMARY HEALTH CARE	0
250	PHYSICS, PARTICLES & FIELDS	0	250	PSYCHOLOGY, APPLIED	0
251	PLANNING & DEVELOPMENT	0	251	PSYCHOLOGY, BIOLOGICAL	0
252	POETRY	0	252	PSYCHOLOGY, EDUCATIONAL	0
253	PSYCHOLOGY, MATHEMATICAL	0	253	PSYCHOLOGY, EXPERIMENTAL	0
254	SOCIAL SCIENCES, MATHEMATICAL METHODS	0	254	PSYCHOLOGY, MATHEMATICAL	0
255	THEATER	0	255	PSYCHOLOGY, PSYCHOANALYSIS	0
	Total:	6673		Total:	8041

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
1	ENGINEERING, ELECTRICAL & ELECTRONIC	777	1	MEDICINE, GENERAL & INTERNAL	5067
2	COMPUTER SCIENCE, INFORMATION SYSTEMS	473	2	ENGINEERING, ELECTRICAL & ELECTRONIC	5002
3	TELECOMMUNICATIONS	444	3	ENVIRONMENTAL SCIENCES	3122
4	COMPUTER SCIENCE, THEORY & METHODS	389	4	MATHEMATICS, APPLIED	2926
5	ENVIRONMENTAL SCIENCES	376	5	CHEMISTRY, MULTIDISCIPLINARY	2883
6	TRANSPLANTATION	314	6	MATHEMATICS	2827

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
7	ECONOMICS	311	7	MATERIALS SCIENCE, MULTIDISCIPLINARY	2806
8	EDUCATION & EDUCATIONAL RESEARCH	304	8	FOOD SCIENCE & TECHNOLOGY	2289
9	HEMATOLOGY	295	9	TELECOMMUNICATIONS	2272
10	COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	287	10	PHARMACOLOGY & PHARMACY	2247
11	COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	246	11	BIOCHEMISTRY & MOLECULAR BIOLOGY	2224
12	CHEMISTRY, MULTIDISCIPLINARY	241	12	PHYSICS, PARTICLES & FIELDS	2179
13	IMMUNOLOGY	235	13	CARDIAC & CARDIOVASCULAR SYSTEMS	2117
14	UROLOGY & NEPHROLOGY	224	14	CLINICAL NEUROLOGY	2042
15	CARDIAC & CARDIOVASCULAR SYSTEMS	219	15	ENGINEERING, CHEMICAL	2037
16	MATHEMATICS	201	16	CHEMISTRY, PHYSICAL	2011
17	ONCOLOGY	201	17	ENGINEERING, MULTIDISCIPLINARY	1963
18	GENETICS & HEREDITY	195	18	PHYSICS, APPLIED	1786
19	ENDOCRINOLOGY & METABOLISM	184	19	NEUROSCIENCES	1775
20	MULTIDISCIPLINARY SCIENCES	183	20	ONCOLOGY	1775
21	GEOSCIENCES, MULTIDISCIPLINARY	177	21	ASTRONOMY & ASTROPHYSICS	1592
22	PHARMACOLOGY & PHARMACY	170	22	PLANT SCIENCES	1507
23	MEDICINE, GENERAL & INTERNAL	169	23	ENGINEERING, MECHANICAL	1491
24	PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	167	24	COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	1395
25	MATHEMATICS, APPLIED	165	25	BIOLOGY	1384
26	BIOCHEMISTRY & MOLECULAR BIOLOGY	164	26	METALLURGY & METALLURGICAL ENGINEERING	1356
27	PEDIATRICS	163	27	PHYSICS, MULTIDISCIPLINARY	1309
28	MATERIALS SCIENCE, MULTIDISCIPLINARY	160	28	ENDOCRINOLOGY & METABOLISM	1305
29	BUSINESS	154	29	AGRONOMY	1274
30	FOOD SCIENCE & TECHNOLOGY	151	30	PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH	1253

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
31	CLINICAL NEUROLOGY	149	31	ECONOMICS	1252
32	ENGINEERING, MULTIDISCIPLINARY	148	32	THERMODYNAMICS	1234
33	SOCIAL SCIENCES, INTERDISCIPLINARY	145	33	COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	1231
34	ENGINEERING, BIOMEDICAL	143	34	COMPUTER SCIENCE, INFORMATION SYSTEMS	1210
35	ENGINEERING, CHEMICAL	143	35	COMPUTER SCIENCE, THEORY & METHODS	1164
36	PLANT SCIENCES	140	36	PERIPHERAL VASCULAR DISEASE	1152
37	PHYSICS, APPLIED	139	37	MULTIDISCIPLINARY SCIENCES	1147
38	MANAGEMENT	131	38	ENERGY & FUELS	1129
39	PHYSICS, MULTIDISCIPLINARY	131	39	OPTICS	1100
40	AUTOMATION & CONTROL SYSTEMS	130	40	PSYCHIATRY	1096
41	ENGINEERING, CIVIL	122	41	CHEMISTRY, APPLIED	1067
42	VETERINARY SCIENCES	113	42	GENETICS & HEREDITY	1013
43	CHEMISTRY, ANALYTICAL	111	43	CHEMISTRY, ANALYTICAL	1000
44	PSYCHIATRY	111	44	HEMATOLOGY	971
45	ALLERGY	109	45	SURGERY	958
46	PATHOLOGY	109	46	EDUCATION & EDUCATIONAL RESEARCH	929
47	RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING	109	47	ENGINEERING, CIVIL	907
48	NEUROSCIENCES	107	48	BIOTECHNOLOGY & APPLIED MICROBIOLOGY	906
49	ENERGY & FUELS	105	49	MEDICINE, RESEARCH & EXPERIMENTAL	896
50	RESPIRATORY SYSTEM	103	50	CHEMISTRY, MEDICINAL	894
51	CHEMISTRY, PHYSICAL	98	51	GEOSCIENCES, MULTIDISCIPLINARY	869
52	ENGINEERING, MECHANICAL	97	52	MECHANICS	855
53	COMPUTER SCIENCE, SOFTWARE ENGINEERING	93	53	IMMUNOLOGY	828
54	PERIPHERAL VASCULAR DISEASE	92	54	RADIOLOGY, NUCLEAR MEDICINE & MEDICAL IMAGING	826

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
55	ZOOLOGY	85	55	VETERINARY SCIENCES	822
56	BIOPHYSICS	83	56	PHYSICS, NUCLEAR	815
57	SURGERY	80	57	INSTRUMENTS & INSTRUMENTATION	801
58	BIOTECHNOLOGY & APPLIED MICROBIOLOGY	78	58	PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	793
59	CELL BIOLOGY	76	59	NUCLEAR SCIENCE & TECHNOLOGY	768
60	EDUCATION, SCIENTIFIC DISCIPLINES	76	60	GREEN & SUSTAINABLE SCIENCE & TECHNOLOGY	753
61	ENVIRONMENTAL STUDIES	74	61	PHYSICS, CONDENSED MATTER	752
62	PHYSICS, MATHEMATICAL	72	62	UROLOGY & NEPHROLOGY	751
63	THERMODYNAMICS	72	63	TOXICOLOGY	738
64	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	69	64	NUTRITION & DIETETICS	716
65	ASTRONOMY & ASTROPHYSICS	68	65	CELL BIOLOGY	709
66	HOSPITALITY, LEISURE, SPORT & TOURISM	68	66	NANOSCIENCE & NANOTECHNOLOGY	703
67	MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	68	67	PEDIATRICS	662
68	PHYSICS, ATOMIC, MOLECULAR & CHEMICAL	68	68	WATER RESOURCES	651
69	MEDICINE, RESEARCH & EXPERIMENTAL	67	69	MANAGEMENT	643
70	REGIONAL URBAN PLANNING	67	70	PATHOLOGY	643
71	INSTRUMENTS & INSTRUMENTATION	66	71	ENGINEERING, ENVIRONMENTAL	631
72	OPTICS	66	72	AGRICULTURAL ECONOMICS & POLICY	617
73	ELECTROCHEMISTRY	63	73	ZOOLOGY	610
74	GEOGRAPHY	63	74	OBSTETRICS & GYNECOLOGY	609
75	GREEN & SUSTAINABLE SCIENCE & TECHNOLOGY	63	75	MATERIALS SCIENCE, CERAMICS	602
76	PHYSIOLOGY	63	76	HUMANITIES, MULTIDISCIPLINARY	597
77	ENGINEERING, GEOLOGICAL	62	77	MATHEMATICS, INTERDISCIPLINARY APPLICATIONS	596
78	POLITICAL SCIENCE	62	78	RESPIRATORY SYSTEM	569
79	BIOLOGY	61	79	AUTOMATION & CONTROL SYSTEMS	555

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
80	ECOLOGY	61	80	CHEMISTRY, INORGANIC & NUCLEAR	551
81	ENGINEERING, ENVIRONMENTAL	61	81	TRANSPORTATION SCIENCE & TECHNOLOGY	544
82	CHEMISTRY, MEDICINAL	60	82	PSYCHOLOGY, MULTIDISCIPLINARY	535
83	OBSTETRICS & GYNECOLOGY	60	83	ENGINEERING, BIOMEDICAL	529
84	AREA STUDIES	58	84	COMPUTER SCIENCE, SOFTWARE ENGINEERING	517
85	PHYSICS, PARTICLES & FIELDS	58	85	ELECTROCHEMISTRY	516
86	BUSINESS, FINANCE	56	86	RHEUMATOLOGY	514
87	PHYSICS, CONDENSED MATTER	56	87	ENVIRONMENTAL STUDIES	513
88	SPECTROSCOPY	55	88	SPORT SCIENCES	510
89	TOXICOLOGY	55	89	ANTHROPOLOGY	498
90	NANOSCIENCE & NANOTECHNOLOGY	53	90	BUSINESS	490
91	HUMANITIES, MULTIDISCIPLINARY	52	91	AGRICULTURE, MULTIDISCIPLINARY	485
92	PHYSICS, FLUIDS & PLASMAS	52	92	MICROBIOLOGY	470
93	CONSTRUCTION & BUILDING TECHNOLOGY	51	93	HORTICULTURE	463
94	INTERNATIONAL RELATIONS	51	94	PHYSIOLOGY	456
95	NUTRITION & DIETETICS	51	95	POLYMER SCIENCE	451
96	AGRICULTURE, DAIRY & ANIMAL SCIENCE	49	96	INFECTIOUS DISEASES	449
97	CHEMISTRY, APPLIED	49	97	GASTROENTEROLOGY & HEPATOLOGY	444
98	NUCLEAR SCIENCE & TECHNOLOGY	48	98	CONSTRUCTION & BUILDING TECHNOLOGY	438
99	LAW	46	99	DENTISTRY, ORAL SURGERY & MEDICINE	432
100	AGRONOMY	45	100	OPERATIONS RESEARCH & MANAGEMENT SCIENCE	424
101	HEALTH CARE SCIENCES & SERVICES	44	101	METEOROLOGY & ATMOSPHERIC SCIENCES	410
102	BIOCHEMICAL RESEARCH METHODS	43	102	PHYSICS, MATHEMATICAL	410
103	FORESTRY	43	103	ECOLOGY	405
104	WATER RESOURCES	43	104	PHILOSOPHY	391
105	INFECTIOUS DISEASES	42	105	FORESTRY	384

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
106	OPERATIONS RESEARCH & MANAGEMENT SCIENCE	42	106	BIOPHYSICS	382
107	MEDICAL INFORMATICS	40	107	ENTOMOLOGY	376
108	MINING & MINERAL PROCESSING	39	108	EDUCATION, SCIENTIFIC DISCIPLINES	374
109	GEOLOGY	38	109	PHYSICS, FLUIDS & PLASMAS	362
110	SPORT SCIENCES	38	110	LANGUAGE & LINGUISTICS	355
111	MEDICAL LABORATORY TECHNOLOGY	37	111	DERMATOLOGY	346
112	COMPUTER SCIENCE, CYBERNETICS	36	112	CHEMISTRY, ORGANIC	316
113	MATERIALS SCIENCE, TEXTILES	35	113	HEALTH CARE SCIENCES & SERVICES	314
114	AGRICULTURE, MULTIDISCIPLINARY	34	114	BIOCHEMICAL RESEARCH METHODS	312
115	PSYCHOLOGY, MULTIDISCIPLINARY	34	115	SOCIOLOGY	306
116	STATISTICS & PROBABILITY	34	116	TRANSPLANTATION	306
117	DERMATOLOGY	32	117	GEOGRAPHY	305
118	CRIMINOLOGY & PENOLOGY	31	118	AGRICULTURE, DAIRY & ANIMAL SCIENCE	304
119	MECHANICS	31	119	ENGINEERING, MANUFACTURING	300
120	TRANSPORTATION SCIENCE & TECHNOLOGY	31	120	CRYSTALLOGRAPHY	298
121	RELIGION	30	121	MEDICAL LABORATORY TECHNOLOGY	293
122	REPRODUCTIVE BIOLOGY	30	122	ENGINEERING, INDUSTRIAL	287
123	ANATOMY & MORPHOLOGY	29	123	ART	279
124	GEOCHEMISTRY & GEOPHYSICS	29	124	COMPUTER SCIENCE, HARDWARE & ARCHITECTURE	272
125	PSYCHOLOGY	29	125	AGRICULTURAL ENGINEERING	265
126	DENTISTRY, ORAL SURGERY & MEDICINE	27	126	ALLERGY	259
127	POLYMER SCIENCE	27	127	MATERIALS SCIENCE, COATINGS & FILMS	258
128	HORTICULTURE	26	128	STATISTICS & PROBABILITY	252
129	MICROBIOLOGY	26	129	GEOGRAPHY, PHYSICAL	248
130	MINERALOGY	26	130	HEALTH POLICY & SERVICES	243
131	ROBOTICS	26	131	REHABILITATION	241

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
132	MARINE & FRESHWATER BIOLOGY	25	132	SPECTROSCOPY	229
133	METEOROLOGY & ATMOSPHERIC SCIENCES	25	133	TRANSPORTATION	226
134	HEALTH POLICY & SERVICES	24	134	SOCIAL SCIENCES, INTERDISCIPLINARY	225
135	GEOGRAPHY, PHYSICAL	23	135	LINGUISTICS	223
136	LANGUAGE & LINGUISTICS	23	136	OPHTHALMOLOGY	220
137	GASTROENTEROLOGY & HEPATOLOGY	22	137	MEDICINE, LEGAL	219
138	LINGUISTICS	22	138	ANATOMY & MORPHOLOGY	211
139	PUBLIC ADMINISTRATION	22	139	MINING & MINERAL PROCESSING	207
140	INFORMATION SCIENCE & LIBRARY SCIENCE	21	140	MARINE & FRESHWATER BIOLOGY	201
141	METALLURGY & METALLURGICAL ENGINEERING	21	141	MATERIALS SCIENCE, BIOMATERIALS	199
142	ARCHITECTURE	20	142	HISTORY	198
143	CHEMISTRY, INORGANIC & NUCLEAR	20	143	HOSPITALITY, LEISURE, SPORT & TOURISM	198
144	IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY	20	144	LOGIC	186
145	MEDICINE, LEGAL	20	145	REGIONAL URBAN PLANNING	186
146	OPHTHALMOLOGY	20	146	PSYCHOLOGY, EXPERIMENTAL	181
147	DEMOGRAPHY	19	147	MATERIALS SCIENCE, CHARACTERISATION & TESTING	180
148	MATHEMATICAL & COMPUTATIONAL BIOLOGY	19	148	MATHEMATICAL & COMPUTATIONAL BIOLOGY	179
149	SOCIOLOGY	19	149	POLITICAL SCIENCE	179
150	AGRICULTURAL ECONOMICS & POLICY	18	150	MATERIALS SCIENCE, TEXTILES	175
151	ENGINEERING, INDUSTRIAL	18	151	ROBOTICS	175
152	HISTORY	18	152	SOIL SCIENCE	172
153	ART	17	153	INTEGRATIVE & COMPLEMENTARY MEDICINE	171
154	PHYSICS, NUCLEAR	17	154	BIODIVERSITY CONSERVATION	169
155	BIODIVERSITY CONSERVATION	16	155	INFORMATION SCIENCE & LIBRARY SCIENCE	169
156	CRITICAL CARE MEDICINE	16	156	MATERIALS SCIENCE, COMPOSITES	167

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
157	ENTOMOLOGY	16	157	AREA STUDIES	165
158	REHABILITATION	16	158	CRITICAL CARE MEDICINE	165
159	REMOTE SENSING	16	159	CRIMINOLOGY & PENOLOGY	164
160	SUBSTANCE ABUSE	16	160	PARASITOLOGY	163
161	DEVELOPMENT STUDIES	15	161	GEOCHEMISTRY & GEOPHYSICS	162
162	PSYCHOLOGY, EXPERIMENTAL	15	162	PSYCHOLOGY	160
163	ANESTHESIOLOGY	14	163	ENGINEERING, GEOLOGICAL	159
164	ARCHAEOLOGY	14	164	GERIATRICS & GERONTOLOGY	159
165	EDUCATION, SPECIAL	14	165	REMOTE SENSING	159
166	PSYCHOLOGY, DEVELOPMENTAL	14	166	EVOLUTIONARY BIOLOGY	156
167	RHEUMATOLOGY	14	167	ACOUSTICS	152
168	ACOUSTICS	13	168	ORTHOPEDICS	150
169	CHEMISTRY, ORGANIC	13	169	EMERGENCY MEDICINE	147
170	MATERIALS SCIENCE, PAPER & WOOD	13	170	QUANTUM SCIENCE TECHNOLOGY	147
171	PSYCHOLOGY, APPLIED	13	171	MEDICAL INFORMATICS	146
172	ENGINEERING, MANUFACTURING	12	172	LAW	145
173	ERGONOMICS	12	173	OTORHINOLARYNGOLOGY	142
174	MATERIALS SCIENCE, COATINGS & FILMS	12	174	GEOLOGY	138
175	SOCIAL ISSUES	12	175	ARCHAEOLOGY	137
176	CRYSTALLOGRAPHY	11	176	MYCOLOGY	135
177	EVOLUTIONARY BIOLOGY	11	177	IMAGING SCIENCE & PHOTOGRAPHIC TECHNOLOGY	134
178	FISHERIES	11	178	MEDIEVAL & RENAISSANCE STUDIES	134
179	MATERIALS SCIENCE, CERAMICS	11	179	MINERALOGY	133
180	PSYCHOLOGY, BIOLOGICAL	11	180	BUSINESS, FINANCE	132
181	PSYCHOLOGY, CLINICAL	11	181	MATERIALS SCIENCE, PAPER & WOOD	129

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
182	URBAN STUDIES	11	182	PSYCHOLOGY, SOCIAL	129
183	VIROLOGY	11	183	TROPICAL MEDICINE	127
184	CELL & TISSUE ENGINEERING	10	184	ANESTHESIOLOGY	126
185	DEVELOPMENTAL BIOLOGY	10	185	REPRODUCTIVE BIOLOGY	126
186	MATERIALS SCIENCE, BIOMATERIALS	10	186	ARCHITECTURE	125
187	MEDIEVAL & RENAISSANCE STUDIES	10	187	PSYCHOLOGY, CLINICAL	116
188	MYCOLOGY	10	188	URBAN STUDIES	108
189	PARASITOLOGY	10	189	PALEONTOLOGY	106
190	PHILOSOPHY	10	190	RELIGION	104
191	PSYCHOLOGY, EDUCATIONAL	10	191	BEHAVIORAL SCIENCES	99
192	TROPICAL MEDICINE	10	192	PSYCHOLOGY, DEVELOPMENTAL	95
193	AGRICULTURAL ENGINEERING	9	193	FISHERIES	92
194	EMERGENCY MEDICINE	9	194	MUSIC	92
195	GERIATRICS & GERONTOLOGY	9	195	CELL & TISSUE ENGINEERING	90
196	LIMNOLOGY	9	196	ENGINEERING, AEROSPACE	90
197	LITERATURE	9	197	VIROLOGY	90
198	ORTHOPEDICS	9	198	COMPUTER SCIENCE, CYBERNETICS	83
199	SOIL SCIENCE	9	199	PUBLIC ADMINISTRATION	83
200	ANTHROPOLOGY	8	200	DEVELOPMENTAL BIOLOGY	82
201	BEHAVIORAL SCIENCES	8	201	MICROSCOPY	82
202	ETHICS	8	202	HISTORY & PHILOSOPHY OF SCIENCE	81
203	INDUSTRIAL RELATIONS & LABOR	8	203	EDUCATION, SPECIAL	78
204	INTEGRATIVE & COMPLEMENTARY MEDICINE	8	204	NURSING	76
205	MICROSCOPY	8	205	LITERATURE	72
206	ANDROLOGY	7	206	INTERNATIONAL RELATIONS	70
207	HISTORY & PHILOSOPHY OF SCIENCE	7	207	COMMUNICATION	69

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
208	MUSIC	7	208	SOCIAL SCIENCES, BIOMEDICAL	59
209	SOCIAL WORK	7	209	SOCIAL ISSUES	57
210	COMMUNICATION	6	210	ERGONOMICS	54
211	QUANTUM SCIENCE TECHNOLOGY	6	211	LITERATURE, SLAVIC	54
212	ETHNIC STUDIES	5	212	SUBSTANCE ABUSE	52
213	FAMILY STUDIES	5	213	AUDIOLOGY & SPEECH-LANGUAGE PATHOLOGY	50
214	LITERATURE, SLAVIC	5	214	ETHICS	48
215	MATERIALS SCIENCE, CHARACTERISATION & TESTING	5	215	PSYCHOLOGY, APPLIED	48
216	PSYCHOLOGY, SOCIAL	5	216	OCEANOGRAPHY	43
217	SOCIAL SCIENCES, MATHEMATICAL METHODS	5	217	WOMEN'S STUDIES	42
218	TRANSPORTATION	5	218	PSYCHOLOGY, EDUCATIONAL	41
219	GERONTOLOGY	4	219	ENGINEERING, MARINE	39
220	LITERARY REVIEWS	4	220	SOCIAL WORK	37
221	NURSING	4	221	ENGINEERING, PETROLEUM	36
222	OCEANOGRAPHY	4	222	PSYCHOLOGY, BIOLOGICAL	33
223	AUDIOLOGY & SPEECH-LANGUAGE PATHOLOGY	3	223	FAMILY STUDIES	31
224	ENGINEERING, AEROSPACE	3	224	LIMNOLOGY	31
225	MATERIALS SCIENCE, COMPOSITES	3	225	NEUROIMAGING	27
226	NEUROIMAGING	3	226	GERONTOLOGY	26
227	OTORHINOLARYNGOLOGY	3	227	PRIMARY HEALTH CARE	26
228	PALEONTOLOGY	3	228	ANDROLOGY	25
229	SOCIAL SCIENCES, BIOMEDICAL	3	229	ORNITHOLOGY	25
230	ENGINEERING, MARINE	2	230	DEVELOPMENT STUDIES	24
231	ENGINEERING, PETROLEUM	2	231	LITERARY THEORY & CRITICISM	22
232	LITERARY THEORY & CRITICISM	2	232	HISTORY OF SOCIAL SCIENCES	21

Rank	WoS_North Macedonia	2010-2021	Rank	WoS_Serbia	2010-2021
233	LOGIC	2	233	LITERATURE, ROMANCE	21
234	POETRY	2	234	MEDICAL ETHICS	21
235	PRIMARY HEALTH CARE	2	235	ETHNIC STUDIES	20
236	PSYCHOLOGY, MATHEMATICAL	2	236	FILM, RADIO, TELEVISION	19
237	WOMEN'S STUDIES	2	237	SOCIAL SCIENCES, MATHEMATICAL METHODS	19
238	DANCE	1	238	CULTURAL STUDIES	17
239	ENGINEERING, OCEAN	1	239	ENGINEERING, OCEAN	16
240	FOLKLORE	1	240	DEMOGRAPHY	15
241	LITERATURE, GERMAN, DUTCH, SCANDINAVIAN	1	241	INDUSTRIAL RELATIONS & LABOR	14
242	PSYCHOLOGY, PSYCHOANALYSIS	1	242	FOLKLORE	12
243	ASIAN STUDIES	0	243	THEATER	10
244	CLASSICS	0	244	CLASSICS	9
245	CULTURAL STUDIES	0	245	ASIAN STUDIES	7
246	FILM, RADIO, TELEVISION	0	246	DANCE	6
247	HISTORY OF SOCIAL SCIENCES	0	247	LITERARY REVIEWS	6
248	LITERATURE, AFRICAN, AUSTRALIAN, CANADIAN	0	248	PSYCHOLOGY, MATHEMATICAL	6
249	LITERATURE, AMERICAN	0	249	PSYCHOLOGY, PSYCHOANALYSIS	6
250	LITERATURE, BRITISH ISLES	0	250	LITERATURE, BRITISH ISLES	4
251	LITERATURE, ROMANCE	0	251	LITERATURE, GERMAN, DUTCH, SCANDINAVIAN	4
252	MEDICAL ETHICS	0	252	POETRY	4
253	ORNITHOLOGY	0	253	LITERATURE, AMERICAN	2
254	PLANNING & DEVELOPMENT	0	254	LITERATURE, AFRICAN, AUSTRALIAN, CANADIAN	0
255	THEATER	0	255	PLANNING & DEVELOPMENT	0
	Total:	15727		Total:	8638

APPENDIX V: SCIENTIFIC PRODUCTIVITY AUTHORS FROM WB ECONOMIES – NUMBER OF ARTICLES IN WOS BY OECD FOS DISCIPLINES, BY ECONOMY AND BY YEAR FROM 2010 TO 2021

Source: WoS, retrieved on 24 October 2021; conversion from WoS to OECD FoS by ToE

Albania	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
1.01 Mathematics	7	7	7	10	17	16	15	19	31	28	61	54	272
1.02 Computer and information sciences	18	24	12	34	28	88	56	44	116	54	44	24	542
1.03 Physical sciences and astronomy	4	4	7	10	3	14	25	8	14	66	31	30	216
1.04 Chemical sciences	8	12	12	12	9	9	23	28	15	29	43	51	251
1.05 Earth and related environmental sciences	37	90	67	44	71	186	128	93	81	76	115	116	1104
1.06 Biological sciences	29	30	13	39	30	73	44	41	50	73	65	62	549
1.07 Other natural sciences	2	1	4	5	1	3	23	50	14	10	17	8	138
2.01 Civil engineering	4	3	8	8	7	10	9	7	11	12	7	11	97
2.02 Electrical eng, electronic eng	11	6	6	49	11	50	38	41	68	44	31	3	358
2.03 Mechanical engineering	3	0	5	8	5	7	7	1	6	3	5	2	52
2.04 Chemical engineering	1	1	1	1	0	1	0	0	2	1	1	2	11
2.05 Materials engineering	8	2	8	13	7	5	8	8	21	18	29	29	156
2.06 Medical engineering	2	5	0	1	1	1	0	6	3	7	1	2	29
2.07 Environmental engineering	5	4	7	7	9	19	7	12	15	18	22	23	148
2.08 Environmental biotechnology	5	4	2	1	3	4	1	5	6	1	4	2	38
2.09 Industrial biotechnology	0	0	0	0	0	0	0	1	0	2	2	1	6
2.10 Nano-technology	0	0	2	1	0	1	0	2	2	3	1	0	12
2.11 Other engineering and technologies	3	5	5	16	2	10	4	14	14	15	15	18	121
3.01 Basic medical research	29	34	50	40	46	32	54	41	50	86	79	57	598

Albania	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
3.02 Clinical medicine	135	92	139	145	171	174	204	218	187	183	167	155	1970
3.03 Health sciences	25	29	25	25	36	18	58	53	42	66	65	62	504
4.01 Agriculture, forestry, fisheries	9	10	36	6	15	19	24	17	28	12	11	15	202
4.02 Animal and dairy science	1	1	1	0	0	1	6	2	2	2	7	5	28
4.03 Veterinary science	2	2	5	6	6	1	2	0	3	2	12	8	49
4.05 Other agricultural science	4	4	5	6	6	6	5	7	9	16	10	9	87
5.01 Psychology	1	1	4	4	8	17	29	9	10	16	16	21	136
5.02 Economics and business	7	17	5	17	38	32	84	36	41	45	41	26	389
5.03 Educational sciences	7	10	14	8	20	21	25	11	14	17	8	10	165
5.04 Sociology	4	2	2	3	1	1	4	8	9	11	6	5	56
5.05 Law	0	0	0	0	2	2	2	4	5	9	4	3	31
5.06 Political science	3	2	0	0	0	5	14	6	4	4	9	4	51
5.07 Social and economic geography	3	10	4	9	7	19	17	22	24	13	25	23	176
5.08 Media and communication	4	3	0	1	1	2	2	2	3	1	1	0	20
5.09 Other social sciences	0	0	2	6	18	31	27	4	17	11	3	3	122
6.01 History and archaeology	3	1	0	1	1	8	3	3	4	4	5	1	34
6.02 Languages and literature	0	0	1	2	1	7	3	5	7	4	3	4	37
6.03 Philosophy, ethics and religion	1	1	0	0	7	0	3	0	2	1	1	1	17
6.04 Art	0	0	0	0	1	14	5	4	3	3	4	1	35
6.05 Other Humanities	0	0	1	0	7	20	5	2	5	2	4	2	48
TOTAL	385	417	460	538	596	927	964	834	938	968	975	853	8855
WoS	384	412	454	530	593	911	941	825	913	928	933	814	
Ratio	1.003	1.012	1.013	1.015	1.005	1.018	1.024	1.011	1.027	1.043	1.045	1.048	

Bosnia and Herzegovina	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
1.01 Mathematics	25	22	25	28	45	55	52	48	62	52	112	73	599
1.02 Computer and information sciences	45	36	47	112	61	90	98	137	135	266	156	31	1214
1.03 Physical sciences and astronomy	31	24	20	33	38	38	51	61	52	58	60	53	519
1.04 Chemical sciences	10	23	18	25	21	25	40	72	79	77	85	95	570
1.05 Earth and related environmental sciences	27	36	30	37	25	43	42	43	94	59	112	124	672
1.06 Biological sciences	63	92	63	68	70	78	89	89	112	123	142	110	1099
1.07 Other natural sciences	3	1	2	4	10	10	12	13	31	34	37	25	182
2.01 Civil engineering	6	3	10	11	15	9	30	49	49	36	28	11	257
2.02 Electrical eng, electronic eng	61	44	136	214	149	225	238	215	240	282	184	54	2042
2.03 Mechanical engineering	23	26	31	26	20	35	35	64	43	92	43	30	468
2.04 Chemical engineering	15	12	11	14	17	5	9	9	7	8	11	9	127
2.05 Materials engineering	19	18	25	31	20	26	34	47	34	32	33	49	368
2.06 Medical engineering	5	17	5	6	8	9	9	74	9	18	85	3	248
2.07 Environmental engineering	9	7	13	24	29	46	55	54	61	46	54	50	448
2.08 Environmental biotechnology	7	6	6	9	7	5	6	10	6	7	5	8	82
2.09 Industrial biotechnology	0	0	0	0	0	0	1	0	0	0	1	1	3
2.10 Nano-technology	2	0	2	3	1	1	15	1	4	1	4	2	36
2.11 Other engineering and technologies	52	65	62	29	54	67	80	68	150	121	90	63	901
3.01 Basic medical research	149	110	57	59	81	80	105	124	80	108	88	75	1116
3.02 Clinical medicine	310	314	236	202	211	277	267	293	299	318	333	278	3338
3.03 Health sciences	34	57	51	32	35	63	74	94	118	100	95	78	831
4.01 Agriculture, forestry, fisheries	19	26	23	19	22	34	31	43	62	49	56	40	424
4.02 Animal and dairy science	2	4	5	1	7	8	10	2	5	6	5	6	61
4.03 Veterinary science	6	7	7	6	6	12	10	9	15	10	12	12	112
4.05 Other agricultural science	5	9	11	7	7	25	14	38	24	33	25	23	221
5.01 Psychology	12	13	10	19	6	16	28	23	20	33	51	31	262

Bosnia and Herzegovina	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
5.02 Economics and business	25	42	29	21	43	165	108	153	136	149	131	69	1071
5.03 Educational sciences	19	7	7	12	15	21	18	22	25	40	28	20	234
5.04 Sociology	52	14	17	20	1	8	9	10	13	10	21	9	184
5.05 Law	6	7	0	1	5	9	12	5	15	10	15	10	95
5.06 Political science	3	3	4	3	1	17	12	11	17	29	21	9	130
5.07 Social and economic geography	9	9	6	10	6	31	52	89	69	46	46	27	400
5.08 Media and communication	2	2	1	2	1	11	11	18	18	15	13	6	100
5.09 Other social sciences	1	1	2	6	3	17	10	15	4	16	16	8	99
6.01 History and archaeology	0	1	1	1	1	9	15	4	8	9	7	10	66
6.02 Languages and literature	4	6	5	0	6	11	23	22	12	23	25	13	150
6.03 Philosophy, ethics and religion	2	6	3	7	2	21	13	19	15	15	20	10	133
6.04 Art	2	6	3	5	4	4	11	8	8	13	6	2	72
6.05 Other Humanities	1	0	2	0	1	12	5	12	10	10	13	0	66
TOTAL	1066	1076	986	1107	1054	1618	1734	2068	2141	2354	2269	1527	19000
WoS	1057	1064	974	1092	1045	1590	1680	2026	2103	2303	2190	1449	
Ratio	1.009	1.011	1.012	1.014	1.009	1.018	1.032	1.021	1.018	1.022	1.036	1.054	

Kosovo*	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
1.01 Mathematics	8	12	7	16	28	23	25	47	36	51	51	33	337
1.02 Computer and information sciences	2	1	11	9	6	29	28	49	36	35	29	13	248
1.03 Physical sciences and astronomy	6	4	4	6	4	17	19	22	38	36	40	37	233
1.04 Chemical sciences	25	16	18	14	14	30	40	33	51	53	75	53	422
1.05 Earth and related environmental sciences	10	19	55	23	35	48	64	48	53	61	67	64	547
1.06 Biological sciences	45	18	28	16	33	37	38	36	45	47	50	36	429
1.07 Other natural sciences	3	0	0	1	5	3	13	10	6	8	17	8	74
2.01 Civil engineering	3	1	9	3	2	7	14	4	13	17	10	13	96

Kosovo*	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
2.02 Electrical eng, electronic eng	18	16	24	15	27	25	73	71	72	63	22	23	449
2.03 Mechanical engineering	13	13	10	9	8	12	13	18	18	11	21	11	157
2.04 Chemical engineering	5	5	5	4	2	5	4	7	7	7	3	7	61
2.05 Materials engineering	20	14	19	23	13	10	20	11	22	17	33	17	219
2.06 Medical engineering	1	1	0	0	1	5	3	2	2	6	0	0	21
2.07 Environmental engineering	8	4	21	6	9	17	25	14	26	30	19	28	207
2.08 Environmental biotechnology	9	3	1	1	1	3	5	3	7	2	1	3	39
2.09 Industrial biotechnology	0	0	0	0	0	0	3	0	1	1	0	0	5
2.10 Nano-technology	2	0	0	1	2	3	5	1	1	0	1	1	17
2.11 Other engineering and technologies	5	10	11	14	12	15	17	29	26	22	31	23	215
3.01 Basic medical research	17	27	10	15	19	28	25	34	59	72	47	33	386
3.02 Clinical medicine	69	31	52	49	83	88	84	132	116	147	115	86	1052
3.03 Health sciences	10	10	14	8	23	14	28	37	39	44	52	56	335
4.01 Agriculture, forestry, fisheries	1	1	16	4	10	5	17	10	15	16	12	15	122
4.02 Animal and dairy science	0	2	0	2	2	2	3	4	3	4	1	5	28
4.03 Veterinary science	2	1	0	2	1	2	5	4	4	1	11	4	37
4.05 Other agricultural science	0	5	1	3	5	2	3	14	16	19	11	7	86
5.01 Psychology	6	3	3	3	6	9	15	10	14	21	35	29	154
5.02 Economics and business	6	2	0	2	8	10	34	32	32	41	42	49	258
5.03 Educational sciences	0	4	2	1	14	8	17	8	10	14	18	20	116
5.04 Sociology	1	3	2	1	2	4	5	3	2	8	14	4	49
5.05 Law	2	2	0	0	0	3	14	6	16	11	14	7	75
5.06 Political science	0	2	1	1	2	3	5	5	7	8	14	3	51
5.07 Social and economic geography	0	4	0	6	4	15	19	17	27	19	13	17	141
5.08 Media and communication	0	0	2	0	0	0	2	0	0	2	1	1	8
5.09 Other social sciences	2	0	0	2	3	11	12	5	5	3	4	5	52

Kosovo*	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
6.01 History and archaeology	1	0	0	1	0	3	3	4	5	10	3	2	32
6.02 Languages and literature	0	0	1	1	2	2	1	5	2	6	5	2	27
6.03 Philosophy, ethics and religion	0	0	0	1	1	0	2	0	6	2	5	1	18
6.04 Art	1	1	0	3	0	6	4	8	1	2	2	1	29
6.05 Other Humanities	0	0	0	0	2	5	1	6	14	7	4	2	41
TOTAL	301	235	327	266	389	509	708	749	853	924	893	719	6873
WoS	296	229	326	261	384	499	683	731	821	900	864	679	
Ratio	1.017	1.026	1.003	1.019	1.013	1.020	1.037	1.025	1.039	1.027	1.034	1.059	

Montenegro	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
1.01 Mathematics	20	39	27	40	19	46	35	42	52	40	42	29	431
1.02 Computer and information sciences	11	11	5	47	7	53	49	68	86	45	39	17	438
1.03 Physical sciences and astronomy	28	27	17	27	21	20	34	17	21	55	115	70	452
1.04 Chemical sciences	14	15	11	17	15	14	13	20	28	30	43	41	261
1.05 Earth and related environmental sciences	9	10	20	24	25	31	28	36	47	71	76	83	460
1.06 Biological sciences	33	43	52	40	52	57	72	69	81	118	106	78	801
1.07 Other natural sciences	0	0	0	1	6	2	6	5	12	7	6	6	51
2.01 Civil engineering	3	2	6	5	10	7	24	12	13	12	15	6	115
2.02 Electrical eng, electronic eng	47	43	56	107	87	109	99	105	71	56	52	19	851
2.03 Mechanical engineering	15	19	17	17	23	41	26	13	15	15	21	9	231
2.04 Chemical engineering	1	1	1	1	3	5	5	1	5	5	2	5	35
2.05 Materials engineering	15	10	22	12	17	4	14	11	11	17	30	21	184
2.06 Medical engineering	1	4	1	1	3	3	2	3	1	7	0	1	27
2.07 Environmental engineering	2	3	1	5	5	12	14	28	23	26	34	35	188
2.08 Environmental biotechnology	2	1	0	0	2	1	6	3	3	5	2	1	26
2.09 Industrial biotechnology	1	0	0	0	1	0	2	0	0	0	1	0	5

Montenegro	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
2.10 Nano-technology	0	1	0	2	4	1	5	2	1	1	0	2	19
2.11 Other engineering and technologies	7	20	16	22	18	37	29	46	22	25	37	27	306
3.01 Basic medical research	12	33	10	14	23	24	25	22	30	47	55	33	328
3.02 Clinical medicine	69	36	44	54	58	112	96	112	117	112	106	112	1028
3.03 Health sciences	3	15	21	15	22	18	18	29	44	57	61	49	352
4.01 Agriculture, forestry, fisheries	1	5	11	10	17	11	19	20	24	23	15	16	172
4.02 Animal and dairy science	0	1	1	2	1	1	0	2	1	3	2	2	16
4.03 Veterinary science	1	1	1	1	0	1	3	1	2	3	7	3	24
4.05 Other agricultural science	2	8	3	1	4	10	6	13	8	12	13	10	90
5.01 Psychology	5	3	3	3	8	14	20	6	5	3	15	8	93
5.02 Economics and business	3	9	2	5	9	22	27	65	53	38	41	39	313
5.03 Educational sciences	1	4	3	3	7	6	10	8	9	12	9	5	77
5.04 Sociology	2	1	5	2	1	4	2	7	3	8	11	7	53
5.05 Law	0	0	1	0	1	4	6	4	4	4	0	1	25
5.06 Political science	2	2	0	0	2	5	4	6	4	12	9	7	53
5.07 Social and economic geography	0	2	4	3	4	7	13	10	23	17	21	22	126
5.08 Media and communication	1	0	2	0	0	0	1	1	3	3	1	4	16
5.09 Other social sciences	0	0	1	3	0	6	3	4	5	6	9	7	44
6.01 History and archaeology	2	0	0	2	1	4	14	7	8	13	5	6	62
6.02 Languages and literature	0	2	0	2	6	45	51	60	41	50	39	18	314
6.03 Philosophy, ethics and religion	1	0	0	1	1	2	5	3	2	2	13	5	35
6.04 Art	0	2	1	2	0	1	3	3	5	5	6	6	34
6.05 Other Humanities	0	0	0	1	0	26	11	23	40	23	21	1	146
TOTAL	314	373	365	492	483	766	800	887	923	988	1080	811	8282
WoS	309	363	360	489	473	745	775	869	897	961	1033	767	
Ratio	1.016	1.028	1.014	1.006	1.021	1.028	1.032	1.021	1.029	1.028	1.045	1.057	

North Macedonia	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
1.01 Mathematics	25	44	36	29	34	52	45	52	66	60	52	47	542
1.02 Computer and information sciences	65	176	35	75	119	124	166	267	197	139	121	42	1526
1.03 Physical sciences and astronomy	64	47	37	36	33	44	74	63	69	76	65	60	668
1.04 Chemical sciences	46	57	52	60	48	73	62	47	39	75	75	68	702
1.05 Earth and related environmental sciences	40	32	62	83	48	72	81	74	77	83	93	62	807
1.06 Biological sciences	71	81	77	61	87	86	83	73	98	163	131	80	1091
1.07 Other natural sciences	5	5	6	8	9	20	35	38	17	18	14	8	183
2.01 Civil engineering	16	4	19	14	13	16	19	19	20	29	17	18	204
2.02 Electrical eng, electronic eng	89	57	105	127	130	149	158	170	170	141	124	26	1446
2.03 Mechanical engineering	17	11	28	18	26	30	30	24	20	21	22	10	257
2.04 Chemical engineering	11	12	14	13	22	21	12	9	11	5	8	5	143
2.05 Materials engineering	14	13	14	14	20	20	31	21	25	29	30	29	260
2.06 Medical engineering	75	47	2	6	3	8	6	4	7	14	10	8	190
2.07 Environmental engineering	13	10	24	44	21	22	39	42	36	36	27	37	351
2.08 Environmental biotechnology	14	10	4	4	6	6	7	5	8	4	4	6	78
2.09 Industrial biotechnology	0	0	1	2	1	1	1	0	1	2	0	1	10
2.10 Nano-technology	12	2	5	2	4	5	7	2	2	6	3	3	53
2.11 Other engineering and technologies	24	22	32	33	40	48	43	42	50	34	65	45	478
3.01 Basic medical research	74	85	56	54	87	104	90	77	82	76	78	43	906
3.02 Clinical medicine	276	213	215	244	238	217	251	229	270	255	234	140	2782
3.03 Health sciences	42	25	30	29	23	41	51	44	55	52	56	40	488
4.01 Agriculture, forestry, fisheries	8	12	17	15	13	14	22	14	17	18	10	8	168
4.02 Animal and dairy science	0	3	0	4	4	4	4	10	4	5	7	4	49
4.03 Veterinary science	3	4	6	8	8	23	14	13	11	10	9	4	113
4.05 Other agricultural science	9	12	6	10	12	19	21	22	16	12	22	17	178

North Macedonia	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
5.01 Psychology	27	17	15	15	19	24	49	18	13	27	26	29	279
5.02 Economics and business	11	12	52	35	40	77	75	114	78	98	55	55	702
5.03 Educational sciences	35	31	26	20	39	46	54	49	36	22	28	8	394
5.04 Sociology	1	4	3	7	1	5	9	13	8	12	10	9	82
5.05 Law	0	2	0	1	6	9	12	4	18	9	12	4	77
5.06 Political science	4	1	3	18	15	26	21	17	14	8	5	3	135
5.07 Social and economic geography	6	5	4	13	13	9	47	79	64	18	22	13	293
5.08 Media and communication	0	0	2	0	4	4	6	2	2	3	2	2	27
5.09 Other social sciences	1	5	41	20	8	36	35	13	18	20	9	7	213
6.01 History and archaeology	2	3	4	2	5	6	1	3	6	6	8	3	49
6.02 Languages and literature	4	2	2	10	2	9	9	12	3	8	5	3	69
6.03 Philosophy, ethics and religion	0	1	2	2	1	2	5	14	9	3	6	3	48
6.04 Art	1	2	6	2	3	6	6	5	1	5	8	0	45
6.05 Other Humanities	0	1	1	0	3	4	8	10	12	5	7	1	52
TOTAL	1105	1070	1044	1138	1208	1482	1689	1714	1650	1607	1480	951	16138
WoS	1081	1043	1031	1118	1192	1454	1634	1666	1620	1573	1423	892	
Ratio	1.022	1.026	1.013	1.018	1.013	1.019	1.034	1.029	1.019	1.022	1.040	1.066	

Serbia	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
1.01 Mathematics	554	640	582	575	567	675	582	659	590	642	670	461	7197
1.02 Computer and information sciences	345	319	439	457	526	590	555	529	617	576	497	336	5786
1.03 Physical sciences and astronomy	598	776	1149	951	966	939	987	876	1012	1030	871	685	10840
1.04 Chemical sciences	629	709	752	825	781	823	887	836	863	936	1080	872	9993
1.05 Earth and related environmental sciences	307	320	415	423	470	487	631	537	641	732	852	820	6635
1.06 Biological sciences	685	724	854	831	857	923	858	902	942	1099	1045	866	10586
1.07 Other natural sciences	36	25	50	57	101	83	105	108	114	160	175	133	1147

Serbia	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
2.01 Civil engineering	46	65	177	100	159	206	263	207	198	179	153	136	1889
2.02 Electrical eng, electronic eng	366	369	819	955	707	765	796	899	822	839	620	319	8276
2.03 Mechanical engineering	320	300	483	305	393	420	461	431	461	403	345	263	4585
2.04 Chemical engineering	158	162	196	222	214	202	210	164	130	137	135	107	2037
2.05 Materials engineering	361	369	661	592	497	433	428	415	448	488	523	458	5673
2.06 Medical engineering	54	119	89	59	79	81	60	78	66	113	69	45	912
2.07 Environmental engineering	156	145	209	246	194	290	392	261	262	283	322	369	3129
2.08 Environmental biotechnology	74	84	80	76	98	87	71	71	79	85	52	49	906
2.09 Industrial biotechnology	9	14	17	14	17	18	15	17	28	20	17	13	199
2.10 Nano-technology	34	48	84	69	80	59	57	57	45	71	47	52	703
2.11 Other engineering and technologies	311	388	511	395	441	537	589	632	520	713	584	464	6085
3.01 Basic medical research	684	766	708	666	710	815	781	730	680	912	767	585	8804
3.02 Clinical medicine	1880	1781	2137	2089	2042	2235	2022	2084	1896	2046	1995	1402	23609
3.03 Health sciences	228	274	277	346	368	371	421	454	457	490	502	433	4621
4.01 Agriculture, forestry, fisheries	178	184	351	271	212	237	278	221	252	276	232	178	2870
4.02 Animal and dairy science	16	15	19	19	23	29	32	23	35	22	39	32	304
4.03 Veterinary science	63	57	69	77	59	65	72	72	82	73	77	56	822
4.05 Other agricultural science	112	147	182	178	202	335	301	402	307	438	320	247	3171
5.01 Psychology	200	176	258	256	300	289	268	222	244	287	323	296	3119
5.02 Economics and business	133	187	171	151	170	294	293	423	287	350	348	148	2955
5.03 Educational sciences	93	70	81	95	109	147	144	149	144	130	142	77	1381
5.04 Sociology	42	44	35	36	28	115	120	102	124	138	148	93	1025
5.05 Law	12	16	3	5	12	29	39	31	57	36	46	23	309
5.06 Political science	9	3	11	17	12	39	25	26	60	47	53	30	332
5.07 Social and economic geography	33	44	55	41	84	138	183	205	187	167	227	163	1527
5.08 Media and communication	11	16	19	9	20	24	29	15	24	39	23	9	238

Serbia	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010-2021
5.09 Other social sciences	18	6	10	32	29	60	33	64	26	66	63	40	447
6.01 History and archaeology	17	24	19	18	29	79	53	66	71	92	69	34	571
6.02 Languages and literature	31	33	48	31	48	86	91	88	96	82	112	42	788
6.03 Philosophy, ethics and religion	12	25	21	18	28	64	70	71	71	69	67	27	543
6.04 Art	23	16	28	17	23	67	39	59	61	103	66	29	531
6.05 Other Humanities	4	2	6	7	10	64	82	102	93	124	74	29	597
TOTAL	8842	9462	12075	11531	11665	13200	13323	13288	13092	14493	13750	10421	145142
WoS	8569	9181	11707	11133	11244	12694	12792	12776	12599	13825	13034	9722	
Ratio	1.032	1.031	1.031	1.036	1.037	1.040	1.042	1.040	1.039	1.048	1.055	1.072	

APPENDIX VI: SCIENTIFIC PRODUCTIVITY AUTHORS FROM WB ECONOMIES – NUMBER OF ARTICLES IN WOS BY OECD FOS DISCIPLINES AND BY ECONOMY, STOCK OF KNOWLEDGE 2010-2021, SORTING BY OECD FOS DISCIPLINES

Source: WoS, retrieved on 24 October 2021; conversion from WoS to OECD FoS by ToE

Rank	Albania	2010-2021	Rank	Bosnia and Herzegovina	2010-2021
1	3.02 Clinical medicine	1970	1	3.02 Clinical medicine	3338
2	1.05 Earth and related environmental sciences	1104	2	2.02 Electrical eng, electronic eng	2042
3	3.01 Basic medical research	598	3	1.02 Computer and information sciences	1214
4	1.06 Biological sciences	549	4	3.01 Basic medical research	1116
5	1.02 Computer and information sciences	542	5	1.06 Biological sciences	1099
6	3.03 Health sciences	504	6	5.02 Economics and business	1071
7	5.02 Economics and business	389	7	2.11 Other engineering and technologies	901
8	2.02 Electrical eng, electronic eng	358	8	3.03 Health sciences	831
9	1.01 Mathematics	272	9	1.05 Earth and related environmental sciences	672
10	1.04 Chemical sciences	251	10	1.01 Mathematics	599
11	1.03 Physical sciences and astronomy	216	11	1.04 Chemical sciences	570
12	4.01 Agriculture, forestry, fisheries	202	12	1.03 Physical sciences and astronomy	519
13	5.07 Social and economic geography	176	13	2.03 Mechanical engineering	468
14	5.03 Educational sciences	165	14	2.07 Environmental engineering	448
15	2.05 Materials engineering	156	15	4.01 Agriculture, forestry, fisheries	424
16	2.07 Environmental engineering	148	16	5.07 Social and economic geography	400
17	1.07 Other natural sciences	138	17	2.05 Materials engineering	368
18	5.01 Psychology	136	18	5.01 Psychology	262
19	5.09 Other social sciences	122	19	2.01 Civil engineering	257

Rank	Albania	2010-2021	Rank	Bosnia and Herzegovina	2010-2021
20	2.11 Other engineering and technologies	121	20	2.06 Medical engineering	248
21	2.01 Civil engineering	97	21	5.03 Educational sciences	234
22	4.05 Other agricultural science	87	22	4.05 Other agricultural science	221
23	5.04 Sociology	56	23	5.04 Sociology	184
24	2.03 Mechanical engineering	52	24	1.07 Other natural sciences	182
25	5.06 Political science	51	25	6.02 Languages and literature	150
26	4.03 Veterinary science	49	26	6.03 Philosophy, ethics and religion	133
27	6.05 Other Humanities	48	27	5.06 Political science	130
28	2.08 Environmental biotechnology	38	28	2.04 Chemical engineering	127
29	6.02 Languages and literature	37	29	4.03 Veterinary science	112
30	6.04 Art	35	30	5.08 Media and communication	100
31	6.01 History and archaeology	34	31	5.09 Other social sciences	99
32	5.05 Law	31	32	5.05 Law	95
33	2.06 Medical engineering	29	33	2.08 Environmental biotechnology	82
34	4.02 Animal and dairy science	28	34	6.04 Art	72
35	5.08 Media and communication	20	35	6.01 History and archaeology	66
36	6.03 Philosophy, ethics and religion	17	36	6.05 Other Humanities	66
37	2.10 Nano-technology	12	37	4.02 Animal and dairy science	61
38	2.04 Chemical engineering	11	38	2.10 Nano-technology	36
39	2.09 Industrial biotechnology	6	39	2.09 Industrial biotechnology	3
	TOTAL	8855		TOTAL	19000

Rank	Kosovo*	2010-2021	Rank	Montenegro	2010-2021
1	3.02 Clinical medicine	1052	1	3.02 Clinical medicine	1028
2	1.05 Earth and related environmental sciences	547	2	2.02 Electrical eng, electronic eng	851
3	2.02 Electrical eng, electronic eng	449	3	1.06 Biological sciences	801

Rank	Kosovo*	2010-2021	Rank	Montenegro	2010-2021
4	1.06 Biological sciences	429	4	1.05 Earth and related environmental sciences	460
5	1.04 Chemical sciences	422	5	1.03 Physical sciences and astronomy	452
6	3.01 Basic medical research	386	6	1.02 Computer and information sciences	438
7	1.01 Mathematics	337	7	1.01 Mathematics	431
8	3.03 Health sciences	335	8	3.03 Health sciences	352
9	5.02 Economics and business	258	9	3.01 Basic medical research	328
10	1.02 Computer and information sciences	248	10	6.02 Languages and literature	314
11	1.03 Physical sciences and astronomy	233	11	5.02 Economics and business	313
12	2.05 Materials engineering	219	12	2.11 Other engineering and technologies	306
13	2.11 Other engineering and technologies	215	13	1.04 Chemical sciences	261
14	2.07 Environmental engineering	207	14	2.03 Mechanical engineering	231
15	2.03 Mechanical engineering	157	15	2.07 Environmental engineering	188
16	5.01 Psychology	154	16	2.05 Materials engineering	184
17	5.07 Social and economic geography	141	17	4.01 Agriculture, forestry, fisheries	172
18	4.01 Agriculture, forestry, fisheries	122	18	6.05 Other Humanities	146
19	5.03 Educational sciences	116	19	5.07 Social and economic geography	126
20	2.01 Civil engineering	96	20	2.01 Civil engineering	115
21	4.05 Other agricultural science	86	21	5.01 Psychology	93
22	5.05 Law	75	22	4.05 Other agricultural science	90
23	1.07 Other natural sciences	74	23	5.03 Educational sciences	77
24	2.04 Chemical engineering	61	24	6.01 History and archaeology	62
25	5.09 Other social sciences	52	25	5.04 Sociology	53
26	5.06 Political science	51	26	5.06 Political science	53
27	5.04 Sociology	49	27	1.07 Other natural sciences	51
28	6.05 Other Humanities	41	28	5.09 Other social sciences	44
29	2.08 Environmental biotechnology	39	29	2.04 Chemical engineering	35

Rank	Kosovo*	2010-2021	Rank	Montenegro	2010-2021
30	4.03 Veterinary science	37	30	6.03 Philosophy, ethics and religion	35
31	6.01 History and archaeology	32	31	6.04 Art	34
32	6.04 Art	29	32	2.06 Medical engineering	27
33	4.02 Animal and dairy science	28	33	2.08 Environmental biotechnology	26
34	6.02 Languages and literature	27	34	5.05 Law	25
35	2.06 Medical engineering	21	35	4.03 Veterinary science	24
36	6.03 Philosophy, ethics and religion	18	36	2.10 Nano-technology	19
37	2.10 Nano-technology	17	37	4.02 Animal and dairy science	16
38	5.08 Media and communication	8	38	5.08 Media and communication	16
39	2.09 Industrial biotechnology	5	39	2.09 Industrial biotechnology	5
	TOTAL	6873		TOTAL	8282

Rank	North Macedonia	2010-2021	Rank	Serbia	2010-2021
1	3.02 Clinical medicine	2782	1	3.02 Clinical medicine	23609
2	1.02 Computer and information sciences	1526	2	1.03 Physical sciences and astronomy	10840
3	2.02 Electrical eng, electronic eng	1446	3	1.06 Biological sciences	10586
4	1.06 Biological sciences	1091	4	1.04 Chemical sciences	9993
5	3.01 Basic medical research	906	5	3.01 Basic medical research	8804
6	1.05 Earth and related environmental sciences	807	6	2.02 Electrical eng, electronic eng	8276
7	1.04 Chemical sciences	702	7	1.01 Mathematics	7197
8	5.02 Economics and business	702	8	1.05 Earth and related environmental sciences	6635
9	1.03 Physical sciences and astronomy	668	9	2.11 Other engineering and technologies	6085
10	1.01 Mathematics	542	10	1.02 Computer and information sciences	5786
11	3.03 Health sciences	488	11	2.05 Materials engineering	5673
12	2.11 Other engineering and technologies	478	12	3.03 Health sciences	4621
13	5.03 Educational sciences	394	13	2.03 Mechanical engineering	4585

14	2.07 Environmental engineering	351	14	4.05 Other agricultural science	3171
15	5.07 Social and economic geography	293	15	2.07 Environmental engineering	3129
16	5.01 Psychology	279	16	5.01 Psychology	3119
17	2.05 Materials engineering	260	17	5.02 Economics and business	2955
18	2.03 Mechanical engineering	257	18	4.01 Agriculture, forestry, fisheries	2870
19	5.09 Other social sciences	213	19	2.04 Chemical engineering	2037
20	2.01 Civil engineering	204	20	2.01 Civil engineering	1889
21	2.06 Medical engineering	190	21	5.07 Social and economic geography	1527
22	1.07 Other natural sciences	183	22	5.03 Educational sciences	1381
23	4.05 Other agricultural science	178	23	1.07 Other natural sciences	1147
24	4.01 Agriculture, forestry, fisheries	168	24	5.04 Sociology	1025
25	2.04 Chemical engineering	143	25	2.06 Medical engineering	912
26	5.06 Political science	135	26	2.08 Environmental biotechnology	906
27	4.03 Veterinary science	113	27	4.03 Veterinary science	822
28	5.04 Sociology	82	28	6.02 Languages and literature	788
29	2.08 Environmental biotechnology	78	29	2.10 Nano-technology	703
30	5.05 Law	77	30	6.05 Other Humanities	597
31	6.02 Languages and literature	69	31	6.01 History and archaeology	571
32	2.10 Nano-technology	53	32	6.03 Philosophy, ethics and religion	543
33	6.05 Other Humanities	52	33	6.04 Art	531
34	4.02 Animal and dairy science	49	34	5.09 Other social sciences	447
35	6.01 History and archaeology	49	35	5.06 Political science	332
36	6.03 Philosophy, ethics and religion	48	36	5.05 Law	309
37	6.04 Art	45	37	4.02 Animal and dairy science	304
38	5.08 Media and communication	27	38	5.08 Media and communication	238
39	2.09 Industrial biotechnology	10	39	2.09 Industrial biotechnology	199
	TOTAL	16138		TOTAL	145142

APPENDIX VII: SCIENTIFIC PRODUCTIVITY AUTHORS FROM WB ECONOMIES – NUMBER OF ARTICLES IN SCOPUS BY ECONOMY, STOCK OF KNOWLEDGE 2010-2021

Source: Scopus, retrieved on 31 October 2021

No	SUBJECT AREA	Albania	Bosnia and Herzegovina	Kosovo*	Montenegro	North Macedonia	Serbia
1	Agricultural and Biological Sciences	566	1056	154	737	804	8927
2	Arts and Humanities	667	532	61	244	207	1974
3	Biochemistry, Genetics and Molecular Biology	296	726	79	264	623	8420
4	Business, Management and Accounting	225	365	101	211	330	1502
5	Chemical Engineering	68	323	34	73	278	3910
6	Chemistry	174	442	67	156	594	8503
7	Computer Science	196	712	72	310	528	4403
8	Decision Sciences	35	154	8	53	76	660
9	Dentistry	90	90	63	7	51	564
10	Earth and Planetary Sciences	219	227	29	168	256	2368
11	Economics, Econometrics and Finance	713	247	94	191	283	1279
12	Energy	61	273	22	126	176	2802
13	Engineering	295	1410	150	741	938	12077
14	Environmental Science	574	673	169	369	452	4985
15	Health Professions	55	264	44	145	111	917
16	Immunology and Microbiology	160	198	31	57	136	1745
17	Materials Science	150	366	39	154	346	6638
18	Mathematics	315	665	72	369	505	6546

No	SUBJECT AREA	Albania	Bosnia and Herzegovina	Kosovo*	Montenegro	North Macedonia	Serbia
19	Medicine	1096	3792	560	758	2086	16821
20	Multidisciplinary	61	99	15	34	100	761
21	Neuroscience	19	80	11	28	134	1272
22	Nursing	42	112	15	28	33	630
23	Pharmacology, Toxicology and Pharmaceutics	92	218	41	62	209	2841
24	Physics and Astronomy	141	546	31	398	606	9909
25	Psychology	45	207	37	23	176	1148
26	Social Sciences	1025	1209	264	488	770	5540
27	Veterinary	102	167	21	17	185	955
	TOTAL:	7482	15153	2284	6211	10993	118097

APPENDIX VIII: SCIENTIFIC PRODUCTIVITY AUTHORS FROM WB ECONOMIES – NUMBER OF ARTICLES IN SCOPUS BY ECONOMY, STOCK OF KNOWLEDGE 2010-2021, SORTING BY SCOPUS DISCIPLINES

Source: Scopus, retrieved on October 31, 2021

Rank	SUBJECT AREA	Albania	Rank	SUBJECT AREA	Bosnia and Herzegovina	Rank	SUBJECT AREA	Kosovo*
1	Medicine	1096	1	Medicine	3792	1	Medicine	560
2	Social Sciences	1025	2	Engineering	1410	2	Social Sciences	264
3	Economics, Econometrics and Finance	713	3	Social Sciences	1209	3	Environmental Science	169
4	Arts and Humanities	667	4	Agricultural and Biological Sciences	1056	4	Agricultural and Biological Sciences	154
5	Environmental Science	574	5	Biochemistry, Genetics and Molecular Biology	726	5	Engineering	150
6	Agricultural and Biological Sciences	566	6	Computer Science	712	6	Business, Management and Accounting	101
7	Mathematics	315	7	Environmental Science	673	7	Economics, Econometrics and Finance	94
8	Biochemistry, Genetics and Molecular Biology	296	8	Mathematics	665	8	Biochemistry, Genetics and Molecular Biology	79
9	Engineering	295	9	Physics and Astronomy	546	9	Computer Science	72
10	Business, Management and Accounting	225	10	Arts and Humanities	532	10	Mathematics	72
11	Earth and Planetary Sciences	219	11	Chemistry	442	11	Chemistry	67

Rank	SUBJECT AREA	Albania	Rank	SUBJECT AREA	Bosnia and Herzegovina	Rank	SUBJECT AREA	Kosovo*
12	Computer Science	196	12	Materials Science	366	12	Dentistry	63
13	Chemistry	174	13	Business, Management and Accounting	365	13	Arts and Humanities	61
14	Immunology and Microbiology	160	14	Chemical Engineering	323	14	Health Professions	44
15	Materials Science	150	15	Energy	273	15	Pharmacology, Toxicology and Pharmaceutics	41
16	Physics and Astronomy	141	16	Health Professions	264	16	Materials Science	39
17	Veterinary	102	17	Economics, Econometrics and Finance	247	17	Psychology	37
18	Pharmacology, Toxicology and Pharmaceutics	92	18	Earth and Planetary Sciences	227	18	Chemical Engineering	34
19	Dentistry	90	19	Pharmacology, Toxicology and Pharmaceutics	218	19	Immunology and Microbiology	31
20	Chemical Engineering	68	20	Psychology	207	20	Physics and Astronomy	31
21	Energy	61	21	Immunology and Microbiology	198	21	Earth and Planetary Sciences	29
22	Multidisciplinary	61	22	Veterinary	167	22	Energy	22
23	Health Professions	55	23	Decision Sciences	154	23	Veterinary	21
24	Psychology	45	24	Nursing	112	24	Multidisciplinary	15
25	Nursing	42	25	Multidisciplinary	99	25	Nursing	15
26	Decision Sciences	35	26	Dentistry	90	26	Neuroscience	11
27	Neuroscience	19	27	Neuroscience	80	27	Decision Sciences	8

Rank	SUBJECT AREA	Montenegro	Rank	SUBJECT AREA	North Macedonia	Rank	SUBJECT AREA	Serbia
1	Medicine	758	1	Medicine	2086	1	Medicine	16821
2	Engineering	741	2	Engineering	938	2	Engineering	12077
3	Agricultural and Biological Sciences	737	3	Agricultural and Biological Sciences	804	3	Physics and Astronomy	9909
4	Social Sciences	488	4	Social Sciences	770	4	Agricultural and Biological Sciences	8927
5	Physics and Astronomy	398	5	Biochemistry, Genetics and Molecular Biology	623	5	Chemistry	8503
6	Environmental Science	369	6	Physics and Astronomy	606	6	Biochemistry, Genetics and Molecular Biology	8420
7	Mathematics	369	7	Chemistry	594	7	Materials Science	6638
8	Computer Science	310	8	Computer Science	528	8	Mathematics	6546
9	Biochemistry, Genetics and Molecular Biology	264	9	Mathematics	505	9	Social Sciences	5540
10	Arts and Humanities	244	10	Environmental Science	452	10	Environmental Science	4985
11	Business, Management and Accounting	211	11	Materials Science	346	11	Computer Science	4403
12	Economics, Econometrics and Finance	191	12	Business, Management and Accounting	330	12	Chemical Engineering	3910
13	Earth and Planetary Sciences	168	13	Economics, Econometrics and Finance	283	13	Pharmacology, Toxicology and Pharmaceutics	2841
14	Chemistry	156	14	Chemical Engineering	278	14	Energy	2802
15	Materials Science	154	15	Earth and Planetary Sciences	256	15	Earth and Planetary Sciences	2368
16	Health Professions	145	16	Pharmacology, Toxicology and Pharmaceutics	209	16	Arts and Humanities	1974

Rank	SUBJECT AREA	Montenegro	Rank	SUBJECT AREA	North Macedonia	Rank	SUBJECT AREA	Serbia
17	Energy	126	17	Arts and Humanities	207	17	Immunology and Microbiology	1745
18	Chemical Engineering	73	18	Veterinary	185	18	Business, Management and Accounting	1502
19	Pharmacology, Toxicology and Pharmaceutics	62	19	Energy	176	19	Economics, Econometrics and Finance	1279
20	Immunology and Microbiology	57	20	Psychology	176	20	Neuroscience	1272
21	Decision Sciences	53	21	Immunology and Microbiology	136	21	Psychology	1148
22	Multidisciplinary	34	22	Neuroscience	134	22	Veterinary	955
23	Neuroscience	28	23	Health Professions	111	23	Health Professions	917
24	Nursing	28	24	Multidisciplinary	100	24	Multidisciplinary	761
25	Psychology	23	25	Decision Sciences	76	25	Decision Sciences	660
26	Veterinary	17	26	Dentistry	51	26	Nursing	630
27	Dentistry	7	27	Nursing	33	27	Dentistry	564

APPENDIX IX: MAPPING INNOVATION INFRASTRUCTURES – SURVEY QUESTIONNAIRE

This survey questionnaire contains several sets of questions that serve as an input for the identification and evaluation of innovation infrastructures potential in Western Balkan economies. The aim of the questionnaire is to map the innovation infrastructure as the first and indispensable step in the process of designing Research and Innovation Infrastructure Roadmap (WB Roadmap).

By innovation infrastructure, we understand business support infrastructure such as: innovation centres, technology transfer offices, digital innovation hubs, science and technology parks, accelerators, business incubators, venture capital funds, and so on.

1. General information about innovation infrastructure

1.1. Please provide the general information on your organisation

Name of your organisation	
Address	
Website	
Please indicate what type of organisation you identify as	☐ Science and Technology Park ☐ Business/technology Incubator ☐ Innovation Centre ☐ Co-working space/hub ☐ Technology Transfer Office ☐ Other (please specify):
Type of organisation	☐ Public entity ☐ Private entity ☐ Within a University ☐ Non-profit organisation ☐ Other:
Total number of employees	☐ number of management staff: ☐ number of staff providing business support services to tenants/clients ☐ Secretarial ☐ Other staff

Total number of clients/ members/ your organisation is currently assisting	
Please specify the total physical space of your organisation (square meters)	
Year of establishment:	

Founder	Institution(s)	Ownership share (%)

1.2. Please provide main objectives of your organisation

2. Operations Management and Financing

How are operating costs of your organisation funded

- ☐ Subsidies - EU and other international agencies
- ☐ Subsidies - domestic authorities and public agencies
- ☐ Payments from banks and other private sector organisations
- ☐ Payments from universities and other R&D organisations
- ☐ Rental income and other incubator charges
- ☐ Other revenue, e.g. from service contracts
- ☐ Investment income, e.g. royalties, equity returns
- ☐ Other sources

Pricing Policy	**In-house**	**External**
Services are mostly free to clients		

Client charges partly cover the cost of services		
Client charges cover the entire cost of services		

3. Support Services and Networking

3.1. Please select business support services your organisation provides.

Types of Business Support Services	In-house	External
Pre-incubation* services		
Business planning and forming a company		
Training to develop business skills		
Accounting, legal and other related services		
Market research, sales and marketing		
Help with exporting and/or partner search abroad		
Help with e-business and other aspects of ICT		
Advice on development of new products and services		
Help with raising bank finance, grants, venture capital		
Incubator venture capital fund, business angel network		
Advice on recruitment of staff and personnel management		
Networking, e.g. with other entrepreneurs, customers		
Mentors, board members and other senior advisers		
Other services, please describe:		

*Pre-incubation is the term used to describe support services to would-be entrepreneurs before they launch their business. These services can include proactive identification of would-be entrepreneurs, helping them to develop a business plan, training and advice on forming a company.

4. Data on capital equipment

4.1. Does your organisation have capital equipment/technical infrastructure (3D printers, CNC machines, VR software, etc) offered to tenants/clients for use:

☐ Yes

☐ No

4.2. List of important capital equipment/ technical infrastructure provided to tenants/clients

	Name of equipment used for research and innovation activities	Purchase Price (EUR)	Year of Purchase	The source of funds for the purchase of equipment	Estimated Duration of Equipment (yrs.)	Estimated Number of Users
1.						
2.						
3.						
4.						
5.						
6.						
7.						
...n						

5. Information on cooperation

5.1. Does your organisation cooperate with universities/faculties and other educational institutions

☐ Yes

☐ No

If yes, please describe the forms of cooperation:

5.2. Please list the international projects and/or cooperation agreements and partnerships in which your organisation has been involved.

5.3. Is your organisation a member of a domestic or international network?

- ☐ Yes
- ☐ No

If yes, please list networks or associations that your organisation is a member of:

Domestic:

International:

6. Plan for the Future

6.1. Please describe in detail the plan for the following period, at least for 2-5 years:

RegionalCooperationCouncil

Trg BiH 1/V, Sarajevo
Bosnia and Herzegovina

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Phone: +387 33 561 700

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