GAPS AND NEEDS ANALYSIS OF RESEARCH INFRASTRUCTURES IN THE WESTERN BALKAN REGION

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Abstract: *This paper aims to identify the current state and development of research infrastructures in the Western Balkan region in order to increase the general understanding of the Western Balkan's current research capabilities to conduct state of the art research projects. Considering that global research infrastructures are becoming increasingly complex and expensive, participation in large pan-European research infrastructures is considered as important condition to improve national research capabilities and to foster research mobility. When it comes to the participation in pan-European research infrastructures, WB economies are lagging significantly behind EU member states, participating only in a few top research infrastructures. To successfully integrate into the European Research Area, Western Balkan economies need to invest more efforts in recognising research infrastructures as strategically important for future economic development.*

Keywords: *Research infrastructures, Western Balkans, pan-European RIs, ESFRI*

1. INTRODUCTION

Research Infrastructures (RIs) represent the basic tools for conducting excellent research. Taking into account that in today's world RIs are becoming increasingly complex and expensive, it is important to ensure that investments in RIs are efficient as possible. Research infrastructures include major research facilities, laboratory environments, complex digital research systems and databases, etc. According to the EU Regulation, RIs are defined as follows (EU Regulation, 2013): "*RIs are facilities, resources and services that are used by the research communities to conduct research and foster innovation in their 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*".

The concept of RIs has a political origin and apparent political usefulness, and it was most likely invented by EU policymakers for political purposes (Olaf, 2020). Within the EU's innovation growth policy, RIs have received significant attention. In 2002 a special EU counsellor body was formed, the European Strategy Forum for Research Infrastructures (ESFRI), and in 2008 the European Commission also established a new organizational form – the European Research Infrastructure Consortium (ERIC). In line with the EU's policy and guidelines, most EU member states developed their national roadmaps for research infrastructures. These roadmaps are vital blueprints which enable countries to set national priorities and to earmark funds for both national and pan-European RIs including ESFRI ones (National Roadmaps, 2022).

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

This paper presents the key results of research commissioned by Regional Cooperation Council (RCC) and carried out within the consultancy services titled „Support to RCC Secretariat for the Creation of Western Balkans' Research and Innovation Infrastructure Roadmap". Research methodology for identifying RIs in the WB region encompassed the following research methods: desktop research including document analysis as a systematic procedure for reviewing and evaluating documents - both printed and electronic material and online interviews conducted with the line ministries in charge of research and innovation in all Western Balkans economies to obtain the existing roadmaps of research infrastructures and overviews of key RIs.

Next paragraph provides the general overview of research and development sector in the WB region. Paragraph 3 identifies key RIs in the region and shows the current state of development in each out of six

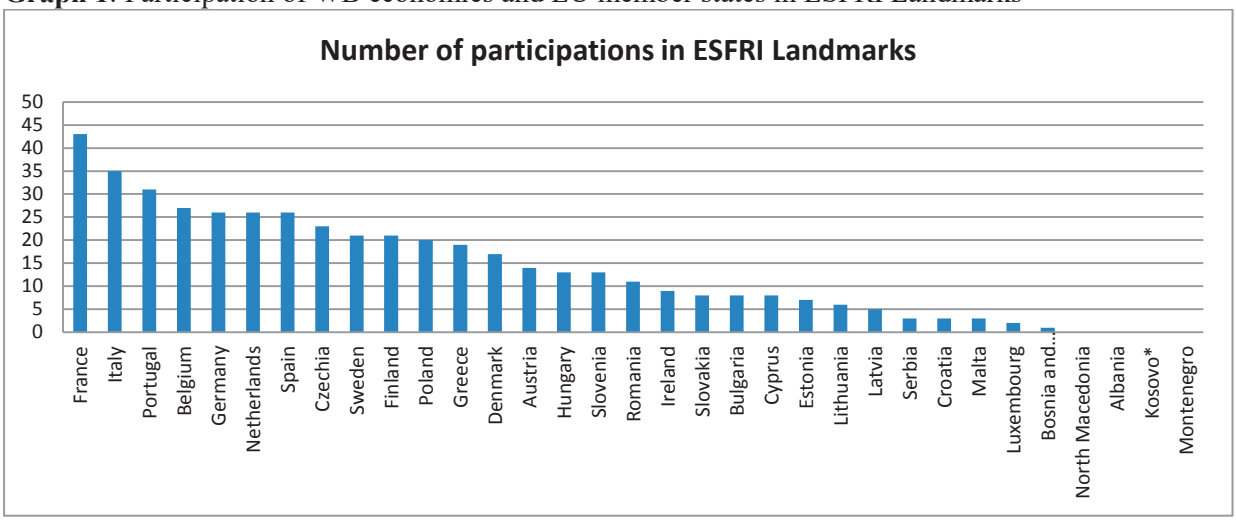
thematic areas. Finally, last section concludes the research and includes the key recommendations to improve the situation in the region.

2. GENERAL OVERVIEW OF R&D IN THE WESTERN BALKAN REGION

While developed EU member states strive to achieve the gross expenditures on research and development (GERD) of 3% of GDP, in the context of WB economies, these figures have been consistently low and some economies are experiencing a declining trend. According to the Eurostat data (2021), GERD in North Macedonia was 0.38 percent of GDP, in Montenegro 0.49 percent of GDP, and in Serbia 0.9 percent of GDP, while official data for other economies are not available. The investments in R&D consist essentially of funds allocated by the public sector (government and higher education sector), with private sector participation in R&D of around 0.10% of GDP (Eurostat, 2021).

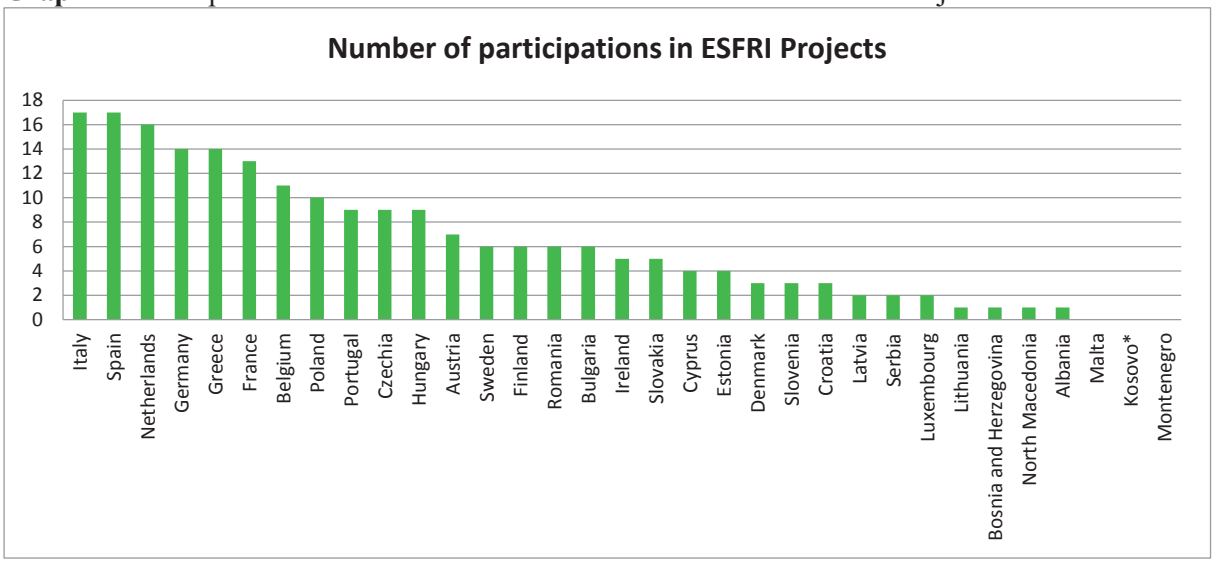
WB region lacks large RIs and the current integration into pan-European RIs is insufficient. Graph 1 shows that WB economies are considerably lagging behind EU member states when it comes to the number of participations in ESFRI Landmarks. The ESFRI Landmarks are RIs that were implemented or reached an advanced implementation phase under the Roadmap and that represent major elements of competitiveness of the ERA. Currently, Serbia participates in 3 landmarks, BiH in 1 Landmark while other economies do not participate in any of the selected top ESFRI Landmarks.

Graph 1: Participation of WB economies and EU member states in ESFRI Landmarks



Regarding ESFRI projects, Serbia participates in 1 project, Albania, North Macedonia and BiH participates in 1 project, while other 2 economies do not participate in ESFRI projects (Graph 2). The ESFRI Projects are RIs in their preparation phases 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.

Graph 2: Participation of WB economies and EU member states in ESFRI Projects



RIs in the WB region are mainly based on research equipment and research facilities located at public research institutes and universities. Aside from a few well equipped research institutions, most research equipment is outdated and need considerable investments in order to be fully operational. Degree of utilization of existing research equipment is at a low level due to the lack of an open access policy to RIs.

Most research institutions/laboratories do not have an official access policy. Internal procedures for accessing research equipment within the higher education institutions do not differ greatly between WB economies. Most institutions have open access for research staff, while external users are required a special permit, which includes: the official submission of requests for access to research infrastructure and formal approval by the management.

3. OVERVIEW OF THE CURRENT STATE OF RIS IN THE WB ECONOMIES GROUPED THEMATICALLY

The table below shows identified large pan-European RIs that WB economies have access to. WB economies have been achieving the highest level of participation in pan-European RIs within the areas of social and cultural innovation and e-infrastructures.

Table 1: Large pan-European RIs available to WB economies

Research Infrastructure	Participating WB Economies
ENERGY	
European Organization for Nuclear Research (CERN)	**Serbia** is a full member; **North Macedonia, Albania and BiH** has signed an International Cooperation Agreement **Montenegro** signed an Agreement on scientific and technical cooperation in 2007
ENVIRONMENT	
eLTER – Integrated European Long-Term Ecosystem	**Serbia** is a full member
HEALTH & FOOD	
METROFOOD-RI Infrastructure for Promoting Metrology in Food and Nutrition	**North Macedonia** is a full member
International Institute for Sustainable Technologies in South East Europe (SEEIIST)	**All WB economies** are the partners in the project
Population Health Information Research Infrastructure	**Serbia and BiH** are the project members
PHYSICAL SCIENCES AND ENGINEERING	
HL-LHC – High-Luminosity Large Hadron	**Serbia** is a full member
Virtual Atomic and Molecular Data Centre (VAMDC)	**Serbia** is a member of this RI
SOCIAL AND CULTURAL INNOVATION	
Consortium of European Social Science Data Archives (CESSDA)	**Serbia and North Macedonia** are the full members of the CESSDA; BiH, Albania, Montenegro and Kosovo* are the potential partners currently outside the consortium.

DARIAH ERIC – Digital Research Infrastructure for the Arts and Humanities	**Serbia and BiH** are the members
European Social Survey (ESS)	All WB economies participated in at least one round of the ESS
OPERAS	**Serbia** is a member
RESILIENCE	**BiH and Albania** are the members
E-INFRASTRUCTURES	
GEANT	**Serbia, North Macedonia, Albania, Montenegro and Kosovo*** are the members
GEANT Project GN4-3	Serbia, Albania, North Macedonia and Montenegro are the members
EOSC Association – European Open Science Cloud	Serbia, BiH North Macedonia are the members
EGI Federation	**Serbia** is the members
EUROCC - National Competence Centres in the framework of EuroHPC	**North Macedonia** and **Montenegro** are the members of the EuroCC project
EGI-ACE: Advanced computing for research	**North Macedonia** is the project member of the EGI-ACE project
NI4OS-Europe: National Initiatives for Open Science in Europe	**Serbia, Albania, North Macedonia, BiH and Montenegro** are the members

The following text provide an overview of the current state of RIs in the WB economies grouped thematically within the following 6 thematic areas, according to ESFRI classification:

- Energy
- Environment
- Health and Food Sciences
- Physical Sciences and Engineering
- Social and Cultural Innovation
- E-infrastructures

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

3.1. Energy

Considering the high gap between WB economies and EU member states when it comes to the use of renewable energy sources, it is expected from the WB economies to speed up the decarbonisation process. It is clear that research projects and research infrastructures in the area of energy are needed more than ever. However, the mapping exercise has shown that the participation of WB economies in high-level RIs and research projects in this area is extremely limited.

With regards to the participation in large pan-European RIs, Serbia is the full member of the European Organization for Nuclear Research (CERN), participating in projects and experiments conducted in CERN. Other economies are mainly allowed to access educational contents and trainings based on International cooperation Agreement signed with CERN.

With regards to the participation in the Horizon Europe (H2020) programme's thematic priority "Secure, Clean and Efficient Energy", 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.

Serbia is the central node in the regional network while the project cooperation between the research institutions in the WB region is rather low.

3.2. Environment

WB economies are not integrated into the most important European RIs in the area of Environment. Regarding RIs recognised by ESFRI, Serbia is a member of one distributed RI: eLTER (Long-Term Ecosystem Research in Europe), while other economies are not participating in any of existing ESFRI RIs.

The participation of the WB region in Horizon 2020 programme's thematic priority: "Climate Action, environment, resource efficiency and raw materials" is modest, getting only 0.34% of the total EC contribution within this thematic priority.

Serbia is the most advanced economy with the participation in 36 out of a total of 65 projects. Research cooperation between WB economies is weak, while the most important research partners are coming from Germany, Spain and Italy.

3.3. Health & Food

Speaking of the current strategic framework, it follows that Health and Food Sciences are one of the most prioritised research fields in all WB economies. As a result of the strong potential in the WB region, it is worth noting that the first regional RI is currently under development: the South East European International Institute for Sustainable Technologies. It is currently in the design study development phase. The SEEIST will support the hadron cancer therapy and biomedical research with protons and heavy ions as the main research area for the Institute.

North Macedonia is a member of Infrastructure for Promoting Metrology in Food and Nutrition (METROFOOD-RI). This RI consists of physical infrastructure and an 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.

Serbia has remarkable research results in the fields of health and food even at the European level. BioSense Institute from Serbia is a national 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.

3.4. Physical Sciences and Engineering

The level of integration of WB economies into pan-European RIs in the area of Physical sciences is weak. In addition, the WB economies have participated in only 3 of 1.451 H2020 projects within the thematic area of Physical sciences. Research activities within this area are mainly oriented towards research papers in national and international publications, with a very limited applied research.

Serbia is the only WB economy that participates in the CERN's project of high importance: High-Luminosity Large Hadron Collider (HL-LHC), which is the highest-energy particle collider in the world.

3.5. Social and Cultural Innovation

Although social sciences are not among the most prioritised research fields in the WB region, WB economies are the members of a certain number of important pan-European RIs. Serbia is participating in the Consortium of European Social Science Data Archives (CESSDA), European Social Survey (ESS-ERIC), The Digital Research Infrastructure for the Arts and Humanities (DARIAH) and the Open Scholarly Communication in the Social Sciences and Humanities (OPERAS). BiH has recently become a member of DARIAH and a Research Infrastructure for Religious Studies (RESILIENCE). Albania is the member of RESILIENCE 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.

Serbia North Macedonia and BiH have made significant progress in developing their national infrastructures/data centres providing long-term preservation and distribution of research data in the social sciences.

3.6. E-Infrastructures

While Information and Communication Technologies (ICT) represent the absolute priority in all WB economies, they are 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 HPC infrastructures and distinguished research organizations appointed to represent them in European HPC-related projects and infrastructures, other WB economies do not have HPC infrastructures in their economies.

In the last decade, there were several South-East European e-infrastructure initiatives (such as: 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 above initiatives have raised awareness of line ministries on the necessity of local programmes and financial support for e-Infrastructures.

Research cooperation between institutions from WB region is on much higher level than in other thematic areas. Most H2020 projects in the area of e-infrastructures include several research institutions from more than 2 WB economies which makes this cooperation better than in other fields.

4. CONCLUSION

If WB economies want to integrate into European Research Area, investments in R&D need to be increased significantly. Additionally, RIs need to be recognised as an important asset on that path. Analysis of the current state of R&D shows a very low level of investments in current research equipment which is mainly outdated in most WB economies. The greater budget allocation for R&D is a necessary condition for the future development of RIs in the Region. Policy measures should be directed in two directions: direct investments in research equipment and facilities and stimulations of the business sector to invest in RIs.

Research collaboration between research institutions within the region is low. Since some WB economies are too small to enhance internal research capacities, fostering research cooperation in the region would result in increased research excellence and relevance in the WB region.

Research results of this paper have shown extremely low integration of WB economies into large pan-European RIs. National governments in the WBs need to consider this issue since the benefits of accessing large RI for researchers and research institutions are multiple. Due to the lack of appropriate research equipment, enhanced integration into pan-European RIs would allow the implementation of high-level research projects that cannot be implemented within the economy and within the WB region.

Research has also shown that all WB economies lack open access to RIs. To improve this situation, line ministries in all WB economies should encourage research institutions to adopt their Open Access Policy documents in order to increase university-industry research collaboration as well as collaboration between research institutions.

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