THE PROGRESS OF THE MACEDONIAN R&D&I SYSTEMS FROM THE EUROPEAN RESEARCH AREA PRIORITIES' PERSPECTIVE

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Abstract: In the last decade the government of the Republic of Macedonia has expressed a high degree of commitment for implementing their economic programme through support of science, education, R&D and innovation. Therefore, the economic development and improvement of the national competitiveness and company productivity through support of research and innovation is built in the main national policies, laws and strategies. This commitment caused reorganisation of the R&D and innovation governance structure in the country, improvement of the business climate and competitiveness and strengthening the international promotion of the country as an attractive investment destination. Macedonia's Gross Domestic Expenditure on R&D (GERD), which amounted to €42.15m in 2016, was significantly increased when compared to 2011, when was only €16.81m. GERD as a percentage of GDP was also increased from 0.22% in 2011 to 0.43% in 2016, however it is still one of the lowest figures in Europe. The structure of the Macedonian GERD by its sector of performance was not in line with the EU (European Union)-28 averages in 2016. The main weakness was the share of Business Expenditure on R&D, 23.4% of GERD for 2016, which was significantly lower when compared to the corresponding EU average of 64.7% for the same year. However, comparing this figure for the country with 2011, it is significantly increased, since in 2011 was 15.6%. Furthermore, the Republic of Macedonia hasn't adopted its S3 strategy and according to the available national and international RDI (Research, Development and Innovation) statistics it is a modest innovator and has underdeveloped RDI system compared with the EU countries. Certain social and grand challenges are addressed through participation in IPA and other international funding schemes in the domain of energy, health, agriculture, biotechnology, food processing, chemistry, pharmaceutical research and environmental protection. On the other side European Research Area (ERA) is at the heart of the Europe 2020 Strategy and its Innovation Union policy flagship, which aim to ensure that new knowledge-intensive products and services contribute substantially to growth and jobs. Based on analysis of the strengths and weakness of Europe's research systems, six ERA priorities are defined: More effective national research systems; Optimal transnational co-operation and competition; An open labour market for researchers; Gender equality and gender mainstreaming in research; Optimal circulation, access to and transfer of scientific knowledge; and International cooperation. The priorities comprise a methodological framework for evaluation of the progress of the national research systems. This framework is used in this paper to assess the progress of RDI systems of the Republic of Macedonia and the level of its compatibility with ERA from the perspective of national policies in this area.
Keywords: research and development, innovation, European research area, gross domestic expenditure on R&D, ERA priorities

НАПРЕДОКОТ НА СИСТЕМИТЕ ЗА ИСТРАЖУВАЊЕ, РАЗВОЈ И ИНОВАЦИИ НА РЕПУБЛИКА МАКЕДОНИЈА ОД ПЕРСПЕКТИВА НА ПРИОРИТЕТИТЕ НА ЕВРОПСКАТА ИСТРАЖУВАЧКА ОБЛАСТ

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Резиме: Во последната декада владата на Република Македонија изрази висок степен на подготвеност за имплементирање на нејзините економски програми преку поддршка на науката, образованието, истражувањата и развојот и иновациите. Затоа, економскиот развој и подобрувањето на националната конкурентност и продуктивноста на компаниите преку поддршката на истражувањето и иновациите се вградени во главните национални политики, закони и стратегии. Ваквата посветеност предизвика реорганизација на структурата на управување на истражувањата, развојот и иновациите во земјата, подобрување на бизнис климата и конкурентноста и зајакнување на меѓународната промоција на земјата како атрактивна инвестициска дестинација. Бруто-трошоците за истражување и развој (БТИР), кои изнесуваа €42.15m во 2016 година, значително се зголемени во споредба со 2011 година, кога изнесувале само €16.81m. БТИР како процент од БДП исто така се зголемени од 0.22% во 2011 година, на 0.43% во 2016 година, но и понатаму оваа статистика е меѓу најниските во Европа. Структурата на БТИР според секторот на извршување не е иста со онаа на ЕУ. Главна слабост е делот на бизнис трошоците за истражување и развој, кои изнесувале 23.4% од БТИР во 2016 година, што е значително пониско од соодветниот ЕУ просек од 64.7% за истата година. Ако се спореди оваа статистика за земјата со 2011 година, таа е значително зголемена, со оглед на тоа што во 2011 година изнесувала 15.6%. Понатаму, Република Македонија нема усвоено S3 стратегија и според националните и интернационалните статистики за истражување и развој земјата е во групата на најскромни иноватори со недоволно развиен истражувачки и иновациски системи споредено со оние на ЕУ. Одредени општествени предизвици се поддржани преку ИПА фондовите и други меѓународни шаблони на финансирање во областите на енергијата, здравството, земјоделието, биотехнологиите, производството на храна, хемијата, фармациските истражувања и заштитата на животната средина. Од друга страна Европската истражувачка област е во срцето на Европската 2020 стратегија и нејзината политика на иновациската унија, кои имаат за цел да обезбедат нови производи и услуги кои базираат на знаење, а кои значајно придонесуваат за економскиот раст и креирањето на нови работни места. Врз база на анализата на добрите и лошите страни на Европските истражувачки системи и целите за подобрување на перфомансите и ефективноста на Европските истражувачки системи, дефинирани се шест приоритети: Поефикасен национален истражувачки систем; Оптимална транс-национална соработка и конкурентност; Отворен пазар на труд за истражувачи; Родова еднаквост во истражувањето; Оптимална циркулација, пристап и трансфер на научно знаење; и Меѓународна соработка. Приоритетите претставуваат методолошка рамка за евалуација на напредокот на националните истражувачки системи. Оваа рамка се користи во овој труд за оцена на напредокот на истражувачкиот и иновацискиот систем на Република Македонија и на степенот на неговата компатибилност со Европската истражувачка област.
Клучни зборови: истражување и развој; иновации; Европска истражувачка област; бруто трошоци за истражување и развој, приоритети на Европска истражувачка област

1. INTRODUCTION

The Macedonian research system and its governance are highly centralised at state level, with insufficient involvement of the other stakeholders in the development and implementation of R&D policies, and with a dominance of the public institutions in the both R&D funding and performing structures[8]. The ultimate vision of the government of the Republic of Macedonia for economic development and improvement of the national competitiveness and company productivity through support of science, education, R&D and innovation is built in the main national policies, laws and strategies. The framework for these policy developments comprises a Law on Innovation Activity (LIA), changes on the Law on Scientific and Research Activities (LSRA) and the Western Balkans Regional R&D Strategy on Innovation (WBRDSI), all adopted in 2013, Innovation Strategy for the Republic of Macedonia for the period 2012-2020 (ISRM 2012-2020) and a new Law on Higher Education (LHE) adopted in 2018. However, general impression is that the implementation of the policies has been slowed down due to the low capabilities of the private sector for performing RDI activities, weak university-industry linkages, incomplete reorganisation of the governance structure and the unavailability of sufficient funding from both public and private sources. Additionally, there are no clear results-based financial policies for the distribution of the public R&D and innovative funds among performing units.

[8] World Bank, Western Balkans Regional R&D Strategy on Innovation, Country Paper Series, Republic of Macedonia, World Bank Technical Assistance Project (P123211), 2013.

The public funding of the education, science and innovation in the country is highly prioritised by the government of the Republic of Macedonia. The state universities as the main performing sector in the country are provided with institutional funding for all of their basic activities, in regard to the number of students and study programmes. The scientific output of the universities is not criteria for their funding.

2. MACEDONIA AS INVESTMENT DESTINATION

The Republic of Macedonia has a small open economy in which exports and imports account for a considerable part of GDP. The economy has an unfavourable structure since it is based on traditional sectors that are by nature not knowledge-driven. Furthermore, the national industry builds its competitiveness on a relatively inexpensive workforce which also negatively influences the demand for knowledge[9]. Since 2008 the government has organised an intensive international promotion of the country as an attractive investment destination. However, the output in the observed period has been dissatisfactory, and the country lags behind all comparative economies. According to the National Bank of the Republic of Macedonia, net foreign direct investment (FDI) in Macedonia fell to a €227m in 2017 from €338m in 2016. The majority of the FDI inflows have been almost exclusively privatisation-driven and market-seeking. These disappointing numbers could be explained by various factors starting with the small market size of the country's economy, the sluggish economic development, adverse prospects for future growth, the bureaucratic and administrative constraints, and lack of law enforcement[10]. Despite all of this, manufacturing, remains the biggest FDI sector with share of 58% in 2016. Furthermore, the current manufacturing facilities are technologically obsolete due to low levels of investment in fixed assets. This is an impediment to the sector's competitiveness. Part of the FDIs was in the medium and high-tech industry sector, which is expected to increase the participation of the medium and high-tech product in the total country's export. However, the share of exports related to high-tech products in the Republic of Macedonia is low and the economy performs significantly better with regard to exports of medium-tech products. This is mostly due to automotive industry growth in the Republic of Macedonia, where high- and medium-tech products accounted for 56 % of manufactured exports.

The ISRM 2012-2020 recognises that successful economic development does not necessarily coincide with an increasing share of production in high technology sectors. High value added activities can also be found in traditional sectors and innovation can help firms move from low-value added activities to high-value added activities. Hence, instead of trying to artificially develop specific sectors such as high technology sectors, the innovation policy of the country takes a neutral stance regarding sectors and primarily fosters the innovation capabilities of businesses horizontally. It is up to the complementary policies to direct resources towards sectors where endowments and capabilities offer the greatest potential for moving up the value chain, thereby facilitating smart specialisation[11].

3. THE EFFICIENCY OF THE MACEDONIAN R&D SYSTEM

The National Strategy for Scientific R&D Activities 2020 (NSSRA 2020) and the National Programme for Scientific R&D Activities 2012-2016 (NPSRA 2012-2016) propose the newest R&D targets for the country. According to these targets, the country's expenditures in R&D as percentage of GDP should be 1% in 2016 and 1.8% in 2020, with 50% of the GERD performed by private businesses. The previous national R&D targets adopted by the Ministry of Education and Science (MES) in 2008 have obliged the government to increase scientific research funds by approximately 35% per year until reaching the EU target of 3% of GDP. However, the both targets have not been achieved. The Republic of Macedonia is continuously working towards improvement of the operational efficiency of the state institutions involved in RDI and provision of high quality public service for the citizens and businesses by using the power of technologies and innovations. The country is ranked 79th out of 193 countries by its E-government Development Index (EGDI) and 71st out of 193 countries by its E-participation index in 2018. The rank of the country has significantly increased, since in 2014 it was ranked on the 96th place by its E-government

[9] OECD, Assessment of the National Innovation System of the Republic Macedonia, Paris, 2013
[10] OECD, Assessment of the National Innovation System of the Republic Macedonia, Paris, 2013
[11] Government of the Republic of Macedonia, Innovation Strategy of the Republic of Macedonia for 2012-2020, 2012

development index and the 134th place by its E-participation index. In absolute number, EGDI (ranked 0-1) has increased from 0.4720 in 2014 to 0.6312 in 2018[12].

According to the latest available data from the State Statistical Office of the Republic of Macedonia (SSORM), GERD as a percentage of GDP was 0.52% in 2014, 0.45% in 2015 and 0.43% in 2016, significantly lagging behind the EU average of 2.04% in 2016. However, the GERD was substantially increased when compared with 2011, when was only 0.22%. The structure of the Macedonian GERD by its sector of performance is unfavourable. The main weakness is the share of BERD, which was 11.57% of GERD in 2014, 17.2% in 2015 and 23.4% in 2016. The leading performing sector in the country was Higher Educational Sector (HES) with 73.44% of GERD in 2014, 68.1% in 2015 and 63.1% in 2016, while the participation of the government sector as a share of GERD was 14.99% in 2014, 13.9% in 2015 and 11.1% in 2016. The structure of the GERD by funding source is also unfavourable. The government sector is the main funding sector for R&D activities in the country with 69.5% of GERD in 2014, 52.8% in 2015 and 46.4% in 2016, while the private R&D funding was only 20.1% of GERD in 2014, 15.3% in 2015 and 20.5% in 2016. However, private R&D finding in both terms, absolute and relative, was significantly increased in 2016 when compared with 2015 for 39% and 34% respectively[13].

The total Government Budget Appropriations or Outlays on R&D (GBAORD) in the Republic of Macedonia were €19.57m in 2016, a considerable decrease of 36% when compared to the year 2014. The GBAORD as a percentage of GDP in 2016 were increased to 0.2 compared to the year 2010, when they were 0.14. However, GBAORD as a percentage of GDP are more than three times less than the EU average. The R&D figures of the country show that in the period 2012-2016 the government did not fulfil the R&D target for this period, which proposed 1% expenditures on R&D as percentage of Gross Domestic Product (GDP), with 50% of the Gross Expenditures on R&D (GERD) performed by private businesses.

According to the European Innovation Scoreboard 2018 the Republic of Macedonia is categorised as a modest innovator. Performance relative to the EU in 2010 has increased strongly for the Republic of Macedonia for 12.1%. In other words, in 2010 the performance of the country was 34% of the EU average, while in 2017 Macedonian performance was 47% of the EU average for 2010, or 44% of the EU average for 2017. Therefore, the performance index for the country is significantly below the EU average. The strongest innovation dimensions are Attractive research systems and Innovators, while the weakest are Sales impacts and Intellectual assets. Regarding the structural differences with the EU, the employment share in manufacturing is well above the EU average. Furthermore, GDP per capita, the employment share in services and the buyer sophistication are well below the EU average. The position of the country is a consequence of the marginalised position of the RDI system since country's independence in 1991, and low participation of private companies in the creation of R&D and innovation policies. While steps have been taken to improve legislation for coordination, clear effective monitoring and evaluating system of the RDI policy in the country is still missing.

The structural challenges of the Macedonian RDI system are as follows[14] :

- Inefficient governance of the innovation system;
- Lack of quality human resources for RDI;
- Weak science-industry linkages;
- Low capacity for innovation by the companies; and
- Absence of a national roadmap for building quality research infrastructures.

The World Bank's comprehensive analysis of the RDI system of the Republic of Macedonia from 2013[15], has identified its governance as one of the main policy challenges which does not provide efficient legal and policy arrangements for a supportive environment in private sector and university–enterprise cooperation. RDI data also shows small capacity of the private sector being directly involved in RDI activities, and insufficient capacity to

[12] United Nations, UN E-Government Knowledgebase, https://publicadministration.un.org/egovkb/en-us/Data/Country-Information/id/170-The-former-Yugoslav-Republic-of-Macedonia accessed 05.09.2018

[13] State Statistical Office of the Republic of Macedonia (2010-2018): Statistical Yearbooks 2009-2017

[14] European Commission, Research inventory&Country Report&ERA Communication Fiche for the Republic of Macedonia 2013, Brussels, 2014.

[15] World Bank, Western Balkans Regional R&D Strategy on Innovation, Country Paper Series, Republic of Macedonia, World Bank Technical Assistance Project (P123211), 2013.

establish linkages with scientific institutions. Despite the significant investments in RIs through the measure Equipping Laboratories for Scientific Research and Applicative Activities (ELSR), the country has not adopted the national roadmap for quality Research Infrastructures (RIs), which can further utilise the existing and the new RIs.
The priorities, specific measures and laws that were derived from the adopted policies' action plans have had direct positive influence on the selected structural challenges. As a consequence, the analysis of the national RDI system presented as a part of the WBRDSI shows some progress towards overcoming the structural challenges.

4. LABOUR MARKET AND INTERNATIONAL COOPERATION

The commitment of the government to strengthen national RIs and access to intergovernmental and European infrastructures is realised through the following initiatives: (1) country's participation in the CERN through the National Agency for Nuclear Technologies, established in 2010; (2) establishment of the MARNet as an independent institution in 2011 and the Macedonian Point for Internet Traffic Exchange (MatrIX) within MARNet; and (3) adoption of the four-year measure ELSR. ELSR is the largest governmental investment which improves the RIs at public universities and institutes. Since 2012 the government has obliged the public institutions to open laboratories for external users and foreign researchers. The involvement of the country in ESFRI infrastructures is still in its early stages and no areas of specialisation have been specified for the country[16].
In the observed period, the biggest share of the increased state budget for science was spent for the governmental measure ELSR. Consequently, the existing RIs in the country have been notably improved. According to the governmental internal report, the Macedonian Academic and Research Network (MARNet) as an independent institution enables secure, reliable and efficient usage of domestic and international network resources by the research community in the country.
The Republic of Macedonia is currently a part of the Western Balkans Regional R&D Strategy on Innovation (WBRDSI), which is regional initiative for development of a joined strategy that integrates the strategies of all countries involved, and additionally sets regional priorities and measures.
National R&D policies focus on general research support and promotion. However, the NPSRA 2012-2016 takes into consideration certain social challenges and the Grand research challenges are addressed through participation in international projects in the domain of agriculture, biotechnology, food processing, chemistry, pharmaceutical research, and environmental protection.
The national EURAXESS portal was set up by the Macedonian Academy of Science and Arts (MASA) in 2011. MASA is a bridgehead organisation (BHO) for EURAXESS network as a representative of the Republic of Macedonia. The national EURAXESS portal enables easier integration of Macedonian researchers into Europe by supporting the mobility of researchers in both directions, to and from the Republic of Macedonia. However, due to the low inflow of researchers in the country, only a few posts published by Macedonian organisations have been hosted on the portal. The activities within the network are coordinated by MASA on voluntary basis, and they are not supported by any national regulation.
In these circumstances the domestic HES has been the only supplier of researchers and academic employees at the universities. On the other hand, the international position of the Macedonian HES is very weak, and it is listed only on "Webometrics Ranking of World Universities" where the "Ss. Cyril and Methodius" university was ranked on 1,627th place in 2018 and the other universities were ranked after 3,400th place out of the total 11,995 universities.
The available RDI statistics show a very low quality of human resources in the country and low quality of the HES as the main provider of researchers[17]. Due to the insufficient development of the educational and research systems there has been almost no inflow of researchers and university professors from abroad. For the same reason, an outflow of quality researchers and professors was recorded in the period following the independence of the country in 1991, which additionally decreased the quality of human resources for research and innovation. In the period 1995-2005, the emigration rate of tertiary educated labour force from the country approached remarkable 30%, the

[16] European Commission, Research inventory&Country Report&ERA Communication Fiche for the Republic of Macedonia 2013, Brussels, 2014.
[17] European Commission, Research inventory&Country Report&ERA Communication Fiche for the Republic of Macedonia 2013, Brussels, 2014

leading score among the SEE countries[18]. According to the SSORM, the total number of researchers in Macedonia has increased for 5% in 2016 when compared with 2015. The HE sector comprises 84.3% of the total number of researchers, and 82.3% of the total number of the published works in the country. The share of the researchers employed in the business sector is 4.7% in 2016, increased when compared with 2014 when was only 2.7%. A very low quality of human resources in the country and low quality of the HES as the main provider of researchers is noted also in the European Commission's report from 2017[19]..

Gender equality as a principle in all areas and sectors of the society has been enshrined in the Constitution, the Law on Equal Opportunities of Women and Men (LEO) and the National Strategy on Equality and non-Discrimination 2012-2015 (NSEND 2012-2015). The first version of LEO, adopted in 2006, prescribes that all public institutions, including R&D units and decision-making bodies, should aim to increase participation of less represented gender to a minimum of 40%. The new version of the LEO, along with the National Strategy on Equality and non-Discrimination 2012-2015 (NSEND 2012-2015), was adopted in 2012. The law and the strategy envision measures and actions for gender equality in all private and public sectors and decision-making bodies. The actions and measures should increase the participation of less represented gender as far as equal participation of both genders is achieved. However, no R&D specific action or measure is proposed by national authorities regarding the gender equality and gender dimension in research. Additionally, no study is available for the country that thoroughly analyses the situation of women and men in science and research community. The LEO envisions establishment of inter-sectoral working group coordinated by the Ministry of Labour and Social Policy (MLSP). The mission of the working group is promoting and monitoring the implementation of the strategy's targets on gender equality and equal gender treatment.

Since the universities and research institutions are the most important actors in research and innovation systems in transition and developing economies, the participation in EU RDI projects and establishing international partnerships through these projects is an important indicator of the country's capacity for internationalization of RDI activities. According to the European Commission database for the Framework Programme Horizon 2020, the Republic of Macedonia participated in 510 eligible applications, out of which 51 applications were retained for financing. The success rate was 10%, which is worse than the Western Balkan average success rate of 11%. Regarding the distribution of the total EU contribution for Western Balkan countries in the Framework programme Horizon 2020, the institutions from the Republic of Macedonia were granted with 7.5% of the total, which is modest amount comparing the share of Serbia which is 82,4%. However, The Serbia and Macedonia are the most successful Western Balkan countries regarding the financial effect from Horizon 2020 programme. In order to get the relative progress of the RDI system of the Republic of Macedonia, the performance of the country in Horizon 2020 is compared with its performance in the Framework Programme 7. The available information for the distribution of the EU contribution for the Western Balkan countries show that the share of the Macedonian institutions was 14.2%, almost double than the share in Horizon 2020. On contrary, the institutions from Serbia had share in Framework Programme 7 of 74.5%, obviously significantly increased in Horizon 2020. It is interesting to mention that the share of the two most successful countries Serbia and Macedonia has almost equal share in Horizon 2020 and Framework Programme 7, around 90%[20]. European Commission presents also the information on participations and the share of small and medium-sized enterprises (SMEs) in funded projects. According this parameter, among the Western Balkan countries Serbia and Macedonia show again the best performances (23,7% and 11,94% respectively).

5. CONCLUSION

Despite the major increase of the state budget for science in 2016 for 151% compared to 2011 and the intensive international promotion of the country as an attractive investment destination, limited access for finance; low capacity and research culture of the private sector for performing RDI activities; weak science-industry linkages;

[18] European Commission, Initial RIS3 Assessment of a Selected WB Country or region, WB-INCO.NET project deliverable D8.59, 2013.

[19] European Commission, Harnessing the potential: Research Capacity in the Western Balkans, Report of the Erasmus+ project SPHERE (Support and Promotion for Higher Education Reform Experts), 2017.

[20] European Commission, Supporting an Innovation Agenda for the Western Balkans, Tools and Methodologies, Publications Office of the European Union, Luxembourg, 2018.

and unfavourable structure of the economy are still the main shortcomings of the RDI system in the Republic of Macedonia compared to the international standards. Participation of the country in the trans-regional and international collaboration networks is rather limited due to the low quality of higher educational sector and human resources. However, the investment in medium and high-tech industry sectors through FDI and the increased entrepreneurial dynamics through the Fund for Innovation and Technological Developments could be regarded as positive signals towards strengthening the innovation in the country.

The country has strengthened the governance of the research and innovation system through its re-organisation and establishment of new bodies with increased decision-making power. The current policy documents and laws state and promote triple helix activities, however the low capacity of private sector for innovation and weak industry-science linkages limit their positive effects. Quadruple helix activities are in early stage of development, since they are not strengthened with links from/to the civil society. E-government public services are partially used in the country, while demand-side measures that stimulate research and innovation are missing in national policies and action plans.

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[16] World Economic Forum, The Global Competitiveness Report 2017-2018, 2018