

RESEARCH INFRASTRUCTURES IN ROMANIA. IMPACT OF PUBLIC FUNDING IN SCIENTIFIC OUTPUTS

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Abstract: *Research infrastructures play a key role in development of scientific landscape of a country and impact on that specific research fields. Since 2007, Romania allocated specific amounts to build up or upgrade equipments, research infrastructures in various R&D fields, (National Plan for Research, Technological Development and Innovation 2007-2013) and large installations (by Governmental Decision). Additionally, important amounts were earmarked in the Sectoral Operational Program – Increase Economic Competitiveness - Priority Axis 2 - to build up up-to-date research facilities.*

This paper assess the impact of public funding to research infrastructures (including installations), funded from one of the three sources above in scientific outputs. The main outputs from each research infrastructure taken into consideration are: peer reviewed scientific articles, books, chapters of books, patents (if it is the case), etc. However, it is not intended to perform a qualitative assessment on research outputs but only a quantitative one.

Based these results, it will be also seen if the priority research areas proposed in the National R&D Strategy (2014 – 2020) as well as the smart specialisation areas specified in the mentioned document match the most productive areas where these research infrastructures were built or upgraded. Recommendations to policy makers will be also provided.

Keywords: *research infrastructures, impact of public funding, smart specialization, national strategy*

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1. Introduction

Knowledge is among the most important driver for solid economic development. In the last years, the global economy felt serious financial and economic impact after the crises. During these periods, typically governments stimulate knowledge creation, in particular on innovation. EU 28 as well as the European Commission increased the public spending dedicated to research and development (R&D) since 2009 [1]. At the Barcelona Council in 2002, the EU agreed to a target of spending at least 3% of gross domestic product (GDP) on re-search by 2010, of which two thirds was to be financed by the business sector; most of the EU Member States specified their own targets in national reform programmes. Using this measure, the highest R&D intensity was recorded in Sweden (3.75 % in 2008) and Finland (3.73%) [2]. However, the ratio of GERD to GDP increased marginally in the EU-27 during the period up to 2002 reaching a high of 1.88%, before declining modestly through to 2005 (1.83%), and climbing again to 2.01% by 2009. There was a small decline in 2010 when the ratio fell to 2.00%. The decrease — despite the higher absolute level of R&D expenditure — was due to the partial recovery from the financial and economic crisis, as GDP increased at a slightly faster pace than GERD in 2010. Nevertheless, the EU-27's R&D expenditure relative to GDP remained well below the corresponding shares recorded in Japan (3.45%) and the United States (2.79%) in 2008; this pattern has existed for a lengthy period of time. Among the EU Member States, the highest R&D intensities in 2010 were recorded in Finland (3.87%), Sweden (3.42%) and Denmark (3.06%) [3] GERD (as % of GDP) had the following values: 0,42 in 2012, 0,50 in 2011, 0,46 in 2010, 0,47 in 2009, 0,58 in 2008, 0,52 in 2007 [4], which was against the general EU-28 trend. However, since 2007, Romania funded specifically Research Infrastructures (RI) using three instruments: National Plan for Research, Technology Development and Innovation (PN 2) implemented during 2007 – 2013, specific program CAPACITIES (PN2), Sectoral Operational Program “Increase the Economic Competitiveness” – axis 2 (POS-CCE-2) and funding for national installations. The research work performed by the author of this paper shows the impact of public funding to these RI on scientific outputs.

2. Research Infrastructures in Romania

“Research infrastructures” refers to **facilities, resources and related services** used by the scientific community to conduct top-level research in their respective fields, ranging from social sciences to astronomy, genomics to nanotechnologies. Examples include singular large-scale research installations, collections, special habitats, libraries, databases, biological archives, clean rooms, integrated arrays of small research installations, high-capacity/high speed communication networks, highly distributed capacity and capability computing facilities, data infrastructure, research vessels, satellite and aircraft observation facilities, coastal observatories, telescopes, synchrotrons and accelerators, networks of computing facilities, as well as infrastructural centres of competence which provide a service for the wider research community based on an assembly of techniques and know-how. RIs may be ‘**single-sited**’ (a single resource at a single location), ‘**distributed**’ (a network of distributed resources), or ‘**virtual**’ (the service is provided electronically). [5]

2.1. Research Infrastructures funded under PN2

National Authority for Scientific Research funded several “large infrastructure” projects, as follows [6]:

Table 1: Projects selected for funding under PN 2

Nr.	Title of the project (large infrastructure)	Organisation	Scientific area
1	Centre for research and treatment in gastroenterology based on imagistic methods and molecular studies.	University of Medicine and Pharmacy - Craiova	Health
2	National Research Centre for biology, conservation artificial reproduction and culture of living aquatic resources	R&D Institute for aquatic ecology, fishery and aquaculture of Galați	Agriculture
3	Update and development of a base for gasturbines testing http://www.comoti.ro/ro/Gas-turbines-experimentation-complex.htm	National R&D Institute for Gasturbines – COMOTI	Energy

Nr.	Title of the project (large infrastructure)	Organisation	Scientific area
4	Development of Bioresources department by updating the R&D Infrastructures http://biores.icechim.ro	National R&D Institutes for Chemistry and Petrochemistry – ICECHIM	Environment
5	Modernisation of molecular and bio-molecular physics department (http://www.itim-cj.ro/mdfmbio/)	National R&D institute for isotopic and molecular technologies of Cluj Napoca)	Materials
6	Setting of the Institute of Biotechnology	University of Agricultural Sciences and Veterinary Medicine – Bucharest	Bio-technologies
7	Integrated Research Network for Interdisciplinary Research http://granturi.ubbcluj.ro/rici/	University Babes – Bolyia – Cluj Napoca	Exploratory research
8	Integrated Centre for Lasers advanced Technologies – CETAL http://cetal.inflpr.ro/ro	National R&D Institute for Lasers, Plasma and Radiations – Magurele	Exploratory research
9	Infrastructure development for Frontier Research in Physics and Nuclear Engineering and Related Domains http://proiecte.nipne.ro/pn2/134-proiecte.html	National R&D Institute for Physics and Nuclear Engineering – Horia Hulubei - Magurele	Exploratory research

Out of these 9 projects only for only a few of them were concluded funding contracts, (reasons for conclusions are not discussed here).

2.2. *Research Infrastructures funded by the Sectoral Operational Programme “Increase the Economic Competitiveness” – axis 2 (POS-CCE-2)*

Within the framework of POS-CCE-2, two calls for proposals were launched, respectively in 2007 and 2009. The list approved projects is presented below.

Table 2: Projects selected for funding under POS-CCE-2, call 2007

Nr.	Organisation	Title of the project (large infrastructure)	Scientific area
1	Institute of Biology and Celular Pathology “Nicolae Simionescu” – Bucharest	Extension and modernisation of research infrastructure in the view of increase of competitiveness in the area of cardiovascular diseases, diabetes and obesity	Health
2	University “Lucian Blaga” of Sibiu	Laboratory Research Centre, Clinical and para-clinical for Paediatric Medicine Breathing Pediatric	Health
3	Colentina Medical Hospital	Colentina Research & Development Department	Health
4	University Hospital – Bucharest	Development of research translational infrastructure in molecular pathology and imaging	Health
5	R&D Station for Bovines in Dancu	Development of an Excellence Centre for Bovines Research	Agriculture
6	Institute of BioFood Resources	Increase the quality and competitiveness of R&D activities of Institute of Biofood resources	Agriculture
7	Public health institute – Iasi	R&D Centre in the area of physico-chemical and chemical risk factors in environment: water, air, aliments, with implications in environmental protection and food security	Agriculture
8	University of Agricultural Sciences and Veterinary Medicine	Development of R&D, Education and Services Infrastructure in the area of veterinary medicine and Innovative Technologies – v.2	Agriculture

Nr.	Organisation	Title of the project (large infrastructure)	Scientific area
9	University Transilvania of Braşov	R&D&I Institute: High-tech products for Sustainable development	Energy
10	Technical University of Cluj-Napoca	Testing, research and certification of internal combustion engines with bio-combustibles	Energy
11	Politehnica University of Timișoara	Research Institute for Renewable Energy	Energy
12	National R&D and Testing Institute for Electrotechnical Engineering – ICMET Craiova	Modernisation of highpower voltage to reach the EU level – v2	Energy
13	National R&D Institute for Industrial Ecology – Bucharest	Development of R&D Infrastructure for enlargement and diversification of researches in the area of industrial ecology	Environment
14	National R&D Institute Danube-Delta	Development of Enisala research base	Environment
15	Institute of Biology – Bucharest	Development of IBB Infrastructures for strengthening the research capacity	Environment
16	National R&D Institute “Grigore Antipa” – Constanța	Increase the RDI capacity by modernising the nuclear techniques infrastructure for environment and aquatic resources	Environment
17	“Ilie Murgulescu” Institute for Chemistry and Physics	Modernisation of R&D Infrastructure	Materials
18	National R&D Institute for material physic – Magurele	Euro-regional Centre for advanced materials, surfaces and interfaces	Materials
19	Institute for Macromolecular Chemistry – P.Poni – Iasi	Advanced research centre for bionanoconjugates and biopolimers	Materials
20	National R&D Institute for Electrical Engineering – Advances Research	Modernisation of R&D Infrastructure for promoting the research potential in electrical engineering	Materials

Table 3: projects selected for funding under POS-CCE-2, call 2009

Nr.	Organisation	Title of the project (large infrastructure)	Scientific area
1	University for Agricultural Sciences and Veterinary Medicine – Cluj Napoca	Advanced Horticultural Research Institute of Transylvania	Agriculture
2	University for Agricultural Sciences and Veterinary Medicine „Ion Ionescu de la Brad” – Iași	Research Institute for Agriculture and Environment	Agriculture
3	University for Agricultural Sciences and Veterinary Medicine – Bucharest	Development of the Infrastructure of the Research Center for Quality Agrofood products	Agriculture
4	CRYOHY: Development of ICSI's R&D infrastructure by creation of a low temperature laboratory for energy applications of cryogenic fluids	National R&D Institute for Isotopic And Cryogenic Technologies Rm. Vâlcea	Energy
5	Renewable energy laboratory – Photovoltaics	National R&D Institute for Electrochemistry and Condensed Matter – Timisoara	Energy
6	RDI development - Multidisciplinary Scientific research and Technological development Institute	University Valahia of Târgoviște	Energy
7	Research Centre for Nanotechnologies dedicated to integrated systems and carbon based advanced nanomaterials	National R&D Institute for Microtechnologies – Bucharest	Materials
8	Research Centre for Study and intensification of metallurgical processes at high pressures and temperatures	National R&D Institute for non-ferrous and rare metals - Bucharest	Materials
9	Research Infrastructure in applied sciences	University of Craiova	Materials

Nr.	Organisation	Title of the project (large infrastructure)	Scientific area
10	Integrated Centre in Environmental sciences for North-East region	University "Alexandru Ioan Cuza" of Iași	Environment
11	Airborne laboratory for atmospheric environmental research	National R&D Institute for Aerospace Research "Elie Carafoli" – Bucharest	Environment
12	Research Platform in biology and systemic ecology	University of Bucharest	Environment
13	Development of research infrastructure in micro-biology and biotechnology with the aim to increase the capacity of disease investigation with major impact on public health	National R&D Institute for microbiology and Immunology "Cantacuzino" – Bucharest	Health
14	Development of research infrastructure of Institute of Biology for increasing its competitiveness in biomedical proteomics	Institute of Biochemistry - Bucharest	Health
15	Extension and modernization of research centre of invasive treatment of atrial fibrillation	Cardiovascular diseases institute „prof. dr. G. I. M. Georgescu" – Iași	Health

2.3. Installations of national interest

Romanian Government funds institutionally several R&D installations of national interest (IIN). The Table 4: Installations of national **interest** below shows the full list of these large research infrastructures and the host institutions.

Table 4: Installations of national interest

Nr.	Name of the installation of national interest	Host institution
1	VVR-S Nuclear Reactor	National R&D institute for physics and nuclear engineering – Horia Hulubei
2	Treatment and repository station for radioactive waste – STDR	
3	Linear Acceleration system TANDEM -	
4	National Radioactive Waste Repository – DNDR	
5	Cyclotron accelerator	
6	National Irradiation Centre	
7	National Seismic Network	National R&D institute for Earth Physics
8	Laboratory “National Data Center” – Muntele Roșu	
9	Pilot station for tritium and deuterium separation	National R&D institute for cryogenics and isotopic separations
10	Electrons accelerator	National R&D institute for Laser, Plasma & Radiation Physics
11	Installation for dense magnetic plasmas	
12	System for production, measurement and recording of short-circuit currents	Electrical engineering, electrical equipments, testing of electrical machinery
13	“Mare Nigrum” Oceanographic Multidisciplinary Research Vessel	National R&D institute for Marine Geology and Geoecology
14	Surlari GeoMagnetic Observatory	National R&D Institute Geology
15	National Geologic Museum	
16	Photoemission spectroscope – XPS	National R&D Institute for Material Physics
17	Laboratory animal pharm – ANIMALERIA	National R&D Institute “Cantacuzino”
18	Trisomic Wind Tunnel	National R&D Institute for Aerospace Research “Elie Carafoli”
19	Subsonic Wind Tunnel	

3. Research methodology

During research activity, the followings methodology was put in place:

1. Collection of all names of large research infrastructures (IIN) and projects funded under POS-CCE-2, as well as PN2) – desktop research, as well as phone calls, discussions with responsible persons from research organizations hosting the infrastructures
2. (Phone) interviews with responsible persons for these research infrastructures. Additionally, a questionnaire was drafted and sent to them.
3. Computation of results from (phone) interviews and received questionnaires
4. Concluding remarks from the gathered data

The data sources were:

1. Ministry of National Education – Research Activity
2. Hosting organizations of these research infrastructures
3. Webpages of EUROSTAT, European Commission, Ministry of European Funds of Romania, and other public institutions involved in planning and implementation of policy and programs related to research

The following phases were implemented:

- a) Desktop research – in relation to research infrastructures, funded by PN 2, POS-CCE-2 or IIN
- b) Drafting the questionnaire and forward it to respondents
- c) Receive of the questionnaire and data processing
- d) Drawing conclusions and comments

4. Discussions and conclusions

The Research infrastructures funded from the three sources mentioned above (PN 2, POS-CCE-2, public subsidies for IIN) were assessed from the following perspectives:

1. Construction (new infrastructure or upgrade)
2. Public subsidies for operation (if it is the case)
3. Involvement of that infrastructure in research (national or international) projects
4. Research outputs (articles / books / patents / others)

5. Consideration vis-à-vis the future needs related to that specific infrastructure, in terms of R&D equipments and facilities

Following the discussions and (phone) interviews with managers of these research infrastructures there are several conclusions that are to be presented as follows:

- a) Projects funded under PN 2 and POS-CCE-2 are either not completed (it is the case of some projects funded under POS-CCE-2, second call - 2009) or is too early to be exploited to their full potential in order to generate viable outputs; Under these circumstances, the author of this paper took into consideration only the installations of national interest, funded by direct public subsidies, as the other ones have not produced significant results. To the managers of these installations a written questionnaire was addressed; they replied in due time and their answers were processed and presented below.
- b) Funding for these new infrastructures must be ensured by from public sources in order to have reliable outcomes. In the unfortunate that the government will not be able to ensure the requested funding, the research facilities will be outdated and obsolete very soon
- c) Human resources needed to exploit them at their full potential are needed; therefore, the future Romanian Operational Programs (EU structural funds) should focus also on these facilities and provide the necessary resources to ensure trainings and specialisations for the staff who operate them and for young researchers that will be employed in this respect. The “learning curve” should not be interrupted and ensured on long term in order to provide reliable outcomes and knowledge transfer towards companies and end-users.

Regarding the answers from the questionnaires, it has to be concluded the followings:

1. Public funding ensures most of the financial needs, respectively 70% - 90% of the needed resources
2. Most of them can be considered to be at least “modern” / “up-to-date”, should be able to generate outputs (articles / books / patents) under the assumption that enough financial resources are provided and the staff is able to exploit them at their full (or close

to full) potential. Additionally, research projects at national and international level are a key component of their operations. With this in mind, it has to be stressed that most of the research facilities are operating within national projects only a few of their operating time is covered in international (or European) projects.

3. Public funding for operations of major infrastructures is of crucial importance. If there is no public funding for major research infrastructures, all of them will be shut down or – in the happiest case - operate to their minimum potential.
4. Networking at European – and global – level of research infrastructures is extremely important. Scientific data, information and resources sharing are becoming more and more a “business as usual” issue
5. In terms of scientific outcomes, it is seen that the trend in negative once years are passing by, despite the fact that 70-90% from funding is ensured. The explanation for this trend is that the number of national / international projects were the infrastructure in involved is decreasing. Furthermore, a recent analysis showed that the participation to EU framework programs is directly linked to national funding, and in the last years of a EU program Romanian participants are involved in less and less projects, Romanian infrastructures did not relates to any research outcome. As presented in the introduction of this paper, GERD in Romania is the lowest in Europe and the trend is decreasing, which explains also the decrease of research outcomes.
6. Higher public funding will definitely increase the research outcomes, which shows a direct correlation of funding and outcomes. However, several comments / remarks are needed, as follows:
 - 6.1. It is not enough to ensure the adequate funding for operations of large research infrastructures but the whole complex of research instruments should be in place (e.g. national research projects, networking at European and global level, international projects, etc.). As all of them are interrelated (dependant), public funding is of crucial importance to all these channels;

- 6.2. Highly skilled human resources are strongly needed to operate these infrastructures. On long term, it is government's responsibility to ensure an adequate flow of human resources to maintain and develop these infrastructures;
 - 6.3. Internationalisation of research infrastructures is a normal and needed process. Interrelation and linkages with infrastructures from the same / complementary scientific domains is likely to increase
7. Private funding is also strongly linked to public funding. An increase of public funding attract nearly the same amount of money in research. This relates also to the transfer of knowledge into economy which also leads to economic growth. An important legal commitments of EU member states is commitment to ensure a minimum threshold of public funding for research and innovation by 2020. In this respect, Romania committed to have 2% of GDP by 2020 [7]. This commitments is extremely difficult to be fulfilled under the circumstances that the public budget for 2014 was similar to the one in 2013; for 2015 it is not foreseen a major growth [8]. In order to reach the 2% level in 2020 (linear growth) an average increase of about 35% / year would be needed, which is extremely difficult to be ensured, despite the fact that it is well known that higher public amounts generate more wealth and economic growth. In the draft Governmental Decision to approve public funding for R&D it is foreseen that public funding will be 0,97% of GDP [8].

In relation to the future exploitation of research infrastructures during the next National Plan for Research, Technological Development and Innovation (PN 3) which is due to be approved in the following months (expected by the end of the year) there are several recommendations to be made, as follows:

- 8. Research topics / areas / programs should be defined in PN 3, in order to better exploit large research facilities. Additionally, important amounts should be earmarked for investments in large research facilities. In this respect the Romanian pillar of Extreme Light Infrastructure (ELI-NP) and the Danube International Center for Advanced Studies on river-delta-seas systems are excellent targets for such investments. Structural Funds are also

foreseen to be invested in these facilities complemented by money from Romanian budget.

9. The smart specialisation areas identified in the draft National Strategy 2014 – 2020, appears that are not necessarily cover the areas of expertise of the funded IIN. However, other areas are taken into consideration which facilitates other research infrastructures funded during 2007 – 2013.

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