Evaluation of investments in Research and Technological Development (RTD) infrastructures and activities supported by the European Regional Development Funds (ERDF) in the period 2007-2013

Contract N° 2018CE16BAT111

Case study report

Romania

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ACIS	Autoritatea pentru Coordonarea Instrumentelor Structurale (Authority for Coordination of the Structural Instruments)
ACM	Academy of Medical Sciences
AGs	Applicants' Guidelines
CA	Contribution Analysis
CAEN	*Clasificarea Activităților din Economia Națională* (National Classification of the Economic Activities)
CERN	European Organisation for Nuclear Research
CF	Cohesion Fund
CNSC	*Consiliul Național de Soluționare a Contestațiilor* (National Council for Appeals Resolution)
COP	Competitiveness Operational Programme
COST	European Cooperation in Science and Technology
CS	Case Study
DR	Developmental Region
EC	European Commission
ELI-DC	Extreme Light Infrastructure-Delivered Consortium
ELI-NP	Extreme Light Infrastructure-Nuclear Physics
ERA	European Research Area
ERDF	European Regional Development Fund
ERIC	European Research Infrastructure Consortium
ESF	European Social Fund
ESFRI	European Strategy Forum for Research Infrastructures
ESIFs	European Structural and Investment Funds
EU	European Union
EUREKA	Intergovernmental organisation for pan-European research and development funding and coordination
FDI	Foreign Direct Investments
FIR	Final Implementation Report
FP7	Seventh Framework Programme for Research
FR	Financial Request
GD	Government Decision
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
H2020	Horizon 2020
HEI(s)	Higher Education Institute(s)
HR	Human Resources
HRST	Human Resources in Science and Technology

HRD	Human Resources Development
IA	Implementing Agencies
IB	Intermediate Body
ICT	Information Communications Technology
IFIN-HH	*Institutul Național de Fizică și Inginerie Nucleară - Horia Hulubei* (National Institute of Physics and Nuclear Engineering – Horia Hulubei)
INSSE	*Institutul Național de Statistică din România* (National Institute of Socio-Economic Statistics)
INCSMPS	*Institutul Naţional de Cercetare Ştiinţifică în Domeniul Muncii şi Protecţiei Sociale* (National Scientific Research Institute for Labour and Social Protection)
IPR	Intellectual Property Rights
IREN	Innovating Regions in Europe Network
IUCN Dubna	*Institutul Unificat de Cercetări Nucleare Dubna* (Unified Institute for Nuclear Research of Dubna, Russia)
JASPERS	Joint Assistance to Support Projects in European Regions
JRC	Joint Research Centre
KAIs	Key Areas of Intervention
KIS	Knowledge-intensive services
MA	Managing Authority
MERYS	Ministry of Education, Research, Youth and Sport
NASR	National Authority for Scientific Research
NDP	National Development Plan
NPRDI II	National Plan for Research and Development and Innovation
NSRD	National System for Research and Development
NSRDI	National Strategy for Research Development and Innovation
NSRF	National Strategic Reference Framework
OPC	Operational Programme Competitiveness 2014-2020
OPs	Operational Programme(s)
OSIM	*Oficiul de Stat pentru Invenții și Mărci* (State Office for Inventions and Trademarks)
PA	Priority Axis
PCT	Patent Cooperation Treaty
R&D	Research and Development
RDAs	Regional Developmental Agencies
RDI	Research Development and Innovation
RIS	Regional Innovation Strategies
RIS3	Research and Innovation Strategies for Smart Specialisation
ROP	Regional Operational Programme
RTD	Research, Technology and Development
RTO(s)	Research and Technology Organisation(s)

sq. m	Square metre
SMEs	Small and Medium-sized Enterprise
SMIS	Information Management System for Structural Instruments
SOP HRD	Sectoral Operational Programme Human Resources Development
SOP IEC	Sectoral Operational Programme Increase of Economic Competitiveness
ToC	Theory(ies) of Change(s)
ToR	Terms of Reference
TTI	Technological Transfer and Innovation
UEFISCDI	*Unitatea Executivă pentru Finanțarea Invățământului Superior, a Cercetării, Dezvoltării și Inovării* (Executive Unit for Financing Higher Education and RDI)

EXECUTIVE SUMMARY

BACKGROUND AND GOAL OF THE CASE STUDY

Over the past decade, the European policy for research and technological development became central to EU level political goals. During the 2007-2013 programming period, more than EUR 16 billion of European Regional Development Fund (ERDF) resources (almost 5% of the total ERDF allocation) were invested through 212 Operational Programmes (OPs) in projects supporting Research Technological Development (RTD) infrastructure, competence centres, and activities in the EU Member States (MS) and regions (codes 01 and 02).

This evaluation study focuses on these two categories of ERDF expenditures and covers 53 OPs across 18 MS selected by the European Commission (EC). With more than EUR 500 million allocated for ERDF in the RTD field, Romania is the second largest beneficiary among EU13 countries (after Poland). It accounts for 4% of the total ERDF contribution under the respective codes of expenditure in the MS sample. A specific case study has examined the impact of ERDF funding for RTD activities and infrastructure in Romania. It provides a deep dive on three specific policy instruments financed under the Sectoral Operational Programme Increase of Economic Competitiveness (SOP IEC 2007RO161PO002), namely:

- Infrastructure investments for research;
- Collaborative science-industry R&D projects;
- Internationalisation of research.

The present case study's main aim is to illustrate the effects (intended and unintended) of investments in RTD conducted through the ERDF. The case study examines the use of funding in implementing a specific RTD policy mix in a specific geographical context while assessing the rationale, effectiveness and long-term sustainability of these investments. The analysis is conducted from the perspective of the MS, allowing the national context and the interactions among the national and regional RTD policy mix to be duly taken into account. However, as part of the evaluation, a very strong focus has been set on conducting a Contribution Analysis (CA) of the three selected policy instruments in light of drawing specific findings and lessons to conduct a cross-country comparison of similar instruments.

OVERVIEW OF KEY FINDINGS AND CONCLUSIONS

Analysis of the policy context at the national level

The Romanian RTD system went through an extremely difficult period for almost two decades. Under the effect of chronic financial shortages and long-term under-funding, the number of researchers had decreased drastically in the period 1990-2004, with a simultaneous increase in their average age. The reduced attractiveness of a research career had led to qualitative losses at the human resources level and made it extremely difficult to attract young people in the research field. Moreover, many top researchers had chosen to leave the country for better opportunities. The low level of wages in the R&D was one of the determinants for researchers' low attractiveness. Additional more complex reasons related to i) delayed institutional reform, ii) mostly outdated research-development infrastructure, and iii) the lack of an evaluation system rewarding real performance and excellence.

The long-term financial shortages also impacted the maintenance and development of the research infrastructure necessary for advanced research. This led to limited international collaboration in European research projects and networks. The modest results of R&D activities and the weak international cooperation were reflected in few articles in scientific publications, few citations of the scientific results published by Romanian researchers, and a lack of interest in protecting intellectual property rights (IPR). Overall, the level of innovation culture was low, both in businesses and in the academic environment, resulting in the lack of a proper technology transfer system.

In order to address the RDI system failures, Romanian policymakers designed interventions based on a policy mix consisting of a synergic combination of measures. In this context, the defined national public policies were implemented by mobilising SOP IEC 2007-2013, funded by ERDF, and of the National Programme for Research Development and Innovation (NPRDI II), funded by the state budget.

The ERDF support allocated to Romania accounted for EUR 8.98 billion and was channelled into financing the policy instruments of five OPs. ERDF allocation represented 46.7% of the total European Structural and Investment Funds (ESIFs) allocated to Romania. In the field of RTD, ERDF support was provided through the Sectoral Operational Programme Increase of Economic Competitiveness (SOP IEC), whose total allocated budget amounted to EUR 2.55 billion of ERDF out of which EUR 606.9 million for Priority Axis 2 (RTD related).

Achievement of intended effects of the analysed policy instruments (i.e. effectiveness)

The general objective of SOP IEC was to increase Romanian companies' productivity in compliance with the principle of sustainable development and reduce the disparities compared to the average productivity of the EU. The SOP IEC target was to achieve an average annual growth of GDP per employed person by about 5.5%. It was assumed this target would allow Romania to reach approximately 55% of the EU average productivity by 2015.

The absorption rate of the allocated financial resources to SOP IEC was almost 100%. The monitoring of progress in achieving the intended targets corresponding to the Priority Axis 2 was made based on a set of 13 indicators, out of which six outputs indicators and seven immediate outcomes indicators. The case study identified that the overall performance of the Priority Axis 2 was positive, taking into account that ten from these 13 indicators were achieved, out of which nine exceeded the established targets.

However, the fact that the targets were met does not represent conclusive evidence of objectives' achievement as this is the only existing evidence in the absence of any either performance or counterfactual analysis after SOPIEC was implemented. Additional conditions and policies should have accompanied the initial ERDF investments made by the programme in order to have a sustainable impact.

These were not made as proven by the fact that the expected over-ambitious final outcome of the Priority Axis 2 - the increase of the value of total R&D expenditure (GERD) to 2% of GDP in 2015 - was not achieved. This increase would have been meant a giant leap possible only in the context of the fast-growing economic development which had been recorded before the outbreak of the financial crisis. In order to achieve an increase in GERD, the national funding to the RDI sector should have been increased as well. The reality has shown that due to the slow recovery process and ever-changing policy priorities, the share of R&D expenditure over GDP registered a slight decrease from 0.54% in 2007 to 0.50% in 2017 and continued its declining to 0.46% in 2019 as per the latest Eurostat data although the committed target remained 2% of GDP.

Approximately 15 years after the SOP IEC was designed and five years after SOP IEC was financially and administratively closed, it can be pointed out that this target was overestimated due to the fact that risk factors were not properly taken into consideration and national funding was not contributing with the required resources.

The case study found out there is no clear evidence in terms of data regarding the increase of the whole RDI system's performance and the breakdown of the performance increase by its influencing factors. Performance indicators and targets have been defined only at the level of the Priority Axis 2 and not at the policy instrument level. Moreover, the definition of achievement indicators had various deficiencies, such as an improper or incomplete definition or lack of a reliable and accurate source of verification. However, the Contribution Analysis allowed to collected qualitative indications on the final outcomes and impact and the overall achievements of intended and unintended long-term effects.

From the case study, it is clear that '**the RTD infrastructure development**' policy instrument was very popular and addressed the research sector's needs. This is substantiated by the fact that almost 95% of ERDF funds have been invested in RTD infrastructure development, including the creation of new infrastructure. All financed projects under '**the RTD infrastructure**' policy instrument were physically completed. The number of newly created and upgraded research laboratories significantly exceeded the expectations. Interviews confirmed that infrastructure projects led to some gains in administrative and technological capacity to deliver high-level R&D services to enterprises.

At that time (2007), the allocation of 95% of the ERDF resources into infrastructural investments was the right policy mix taking into account the huge need for the existing RTD infrastructure rehabilitation and its modernisation and the need for newly built research infrastructures in RTOs and HEIs as well as in the health sector. This was considered a pre-condition for more investments in R&D activities to be carried out later when capabilities and maturity of the system had allowed that. However, despite these assumptions, the challenges that the Romanian R&I system faced in 2007 are still present[1].

The in-depth analysis on a sample of beneficiaries selected for interviews shows that the impact also materialised in terms of a 'soft type' impact such as: paving the 'connecting road' with the big and powerful industries operating in Romania, profound changes in organisational culture and the management style of the scientific research organisations and higher education institutions inherited from the previous economic regime. The case study also identified long-lasting societal benefits.

The number of applied projects by leading Romanian applicants has slightly increased in the H2020 programme compared to the FP7, while other new MS have recorded a decrease. This positive evolution might be linked to the higher visibility of these two European funded programmes and Romanian research organisations' improved capacity to meet the programme's requirements. The real participation was even higher than the number of applied projects taking into account most Romanian RTOs have been involved as partners of other European leading applicants. According to the Innovation Scoreboard, the Romanian RDI performance was steady, and large disparities were reported among Romanian regions.

In the absence of clear evidence on the impact of connections with the private sector, the case study concluded that the programme provided one of the first opportunities for facilitating mutual understanding and creating much stronger bridges of communication between R&D and the economic sector, including SMEs. The 'gap' began to narrow as a result of both ERDF and NPRDI contributions. The R&D sector better understood the concerns and demands of the economic sector, while the economic sector understood the value of a longer-term collaboration and not a contextual or intermittent one. Thereby, the projects funded under the **'Collaborative R&D'** policy instrument favoured a knowledge exchange both during the research activity as well as at project completion, when the research production was delivered to the beneficiary enterprises. The final results of this policy instrument show that the achieved targets were influenced by the effects of the financial crisis (which hit the private sector in the last quarter of 2008) and determined the insufficiency of the own financial sources of the eligible enterprises, as a result of the fall in turnover, and due to the prudential commercial banks' policy in dealing with small customers in granting bridge-loans for EU funded projects.

The case study's findings show the target eligible enterprises were able to observe the basic principles of needed research concepts. Either alone or with the help of pre-identified research partners, the enterprises were able to formulate research plans within the project applications. In the implementation stages, the financed enterprises were

[1] As last RIO Country report from later years that were able to 'catch' the impact of 2007-2013 (in fact 2016) investments. E.g., https://rio.jrc.ec.europa.eu/country-analysis/Romania/country-report

proactively participating in the research activities. They provided necessary basic technology data, and they participated in the experimental proof of concept for validation in the labs of the research partners. They also hosted experimental proof for the prototype/experimental models in their industrially relevant operational environment. This ensured research was complete and qualified to meet the requirements of the patent application. The number of patent applications submitted for formal registration was one of the priority axis output indicators whose target has been exceeded.

There are a wide consensus and evidence that, despite the small share of projects, the policy instrument played a pioneering role. It demonstrated the need to change the previous approaches towards collaborative R&D, which privileged applied research projects with a strong industrial application carried out by HEIs without enterprises' direct involvement. The policy instrument managed to give a determinant contribution to the promotion of collaborative science-industry partnerships in light of this pioneering approach. The financial crisis in 2008, which affected the private enterprises' cash flow capacity and the lack of macroeconomic stability during the long economic recovery timeframe, led to a generally limited achievement of intermediate and final outcomes. However, evidence is limited to the achievement of intermediate and final outcomes and broader impacts.

The case study concludes that due to the small number of completed projects, this policy measure has only pioneered collaborative research but did not contribute to the achievement of significant changes to 'move the needle'. Although it can be stated retroactively that the level of funding allocated to this programme measure was sufficient, it did not result in the critical mass of specific successful projects necessary to influence R&D system change. Therefore, the Contribution Analysis concludes that the intended outputs and immediate results were achieved only to a small extent.

Concerning **'the internationalisation of the research',** the principal goal was to attract from abroad well-known researchers in their area of specialisation, willing to join project research teams' activities since the end objective was to re-connect the Romanian research community to European and international ones. The policy instrument has contributed to the restoration of previous connections, dismantled either by the country's previous regime or interrupted due to Romanian public RTO's financial shortages. The projects financed under this measure achieved their intended results and contributed to other Priority axis achievements.

Regarding intermediate and final outcomes, the picture is not clear. The case study finds out in most cases, the long-lasting 'soft type' impact was perceived as even stronger and more visible at a micro-level (implementing organisations, their professional and/or local community) than the impact achieved at a macro-level (the economy or society as a whole). There is no doubt that the ERDF support has contributed to maintaining research capacities and personnel capabilities. Interviews suggest considerable programme-induced impacts on increasing employment and research staff income. The programme measures implemented under the RTD infrastructure development policy instrument have favoured collaboration between the financed public RTOs and HEIs, and the local and regional business system. In the medium term, these investments contributed to a change of attitude and increased mutual knowledge. In the long term, the collaboration experience was aimed at raising awareness of partnership culture. However, an effective partnership culture has not been entirely achieved yet.

As concluded, the type of investment designed by SOPIEC seemed appropriate for 2007-2013, but in the longer-term did not improve the R&I performance much. It would have been indicated further steps to diversify the policy mix, envisage supporting other types of measures (and not only infrastructure) and enhance strategic thinking, monitoring and implementation capacities (i.e. the same issues related to low capacities for implementation – either at MA or at the beneficiary level are still present now).

In terms of the use of funds, the ERDF not only pioneered the financial support of the first generation of OPs but also demonstrated that competitive participation in the RTD sector has the potential to attract financial resources at the regions' level by

safeguarding equal access and transparent, competitive basis and not through pre-allocation policies and policy instruments directing funds to the regions. It can also be concluded that it had the potential to play a positive role in promoting scientific excellence and quality projects as the only targeting criterion.

Drivers and barriers to success

The programme achievements in terms of outputs are connected with the capacity and readiness to apply for the target eligible applicants' funding. The national funded Technical Assistance (TA) programme (e.g. IMPACT programme) and other donors, including the EU in the pre-accession stage, played an important role in helping interested applicants to acquire experience in drafting applications, in supporting technical and economic documentation, and in enhancing managerial skills within projects.

The analysis showed the main drivers ensuring the effectiveness of the selected policy instruments were the EU support in RDI and education during the pre-accession period and the timely approval of the national policy documents, including the upfront investment (e.g. IMPACT programme) in capacity building of the eligible applicants. Another important driver for success was identifying the research sector needs and major investments' challenges.

The following barriers restricted full success: (i) a lack of experience in managing the ESIF; (ii) the newly set up management and control system needed time to strengthen and to become fully operational; (iii) the lack of a domestic professional (engineering, consulting) services market; (iv) a weak entrepreneurial culture as well as poor partnership culture aimed at promoting collaborative/joint projects; (v) a lack of social capital, especially of its major pillar, the trust among partners and all stakeholders. In addition, there was a lack of regulatory framework predictability and burdensome administrative barriers, insufficient coordination within the institutional framework subsystems, and a lack of experience in strategic planning. The latter led to an immediate and short-term focus on the chosen indicators (inputs, outputs, and, eventually, immediate outcomes) rather than to medium and long-term targets (final outcomes and foreseen impact).

It was found that the most constraining barrier to the success of the PA was the financial and economic crisis that hit Romania in the last quarter of 2008. The crisis affected the co-financing capacity of the private beneficiaries and the pre-financing capacity of the public beneficiaries. It impeded most of them from continuing project implementation, leaving no possibility of influence from programme stakeholders.

Relevance

The general objective of SOP IEC was to increase Romanian companies' productivity in compliance with the principle of sustainable development and to reduce the disparities compared to the average productivity of the EU. The target was an average annual growth of GDP per employed person by about 5.5%. It was assumed that this target would allow Romania to reach approximately 55% of the EU average productivity by 2015.

The programme's strategic rationale was fully justified by the comprehensive analysis of Romania's economic situation within its 2007-2013 NDP and the National Strategic Reference Framework (NSRF). The programme was and remained relevant during the entire lifetime of its implementation. The financial and economic crisis in 2008-2009, and the scarcity of the RTD national budget expenditures in the subsequent austerity years and slow recovery period, made the programme and the ERDF funding allocated for RTD activities and infrastructure development even more relevant for the survival of the public RTOs and the improvement of the public HEI educational infrastructure.

The ERDF funding represented a real 'safety belt' for these two categories of targeted eligible beneficiaries, aimed at defending them in the financial turbulence and severe shortages brought by the crisis.

The crisis hit the private sector even harder than the public entities. Their sources for financing hard and soft investments were cut almost overnight in December 2008. Cash flow estimations were not reliable due to the lack of predictability, and their creditworthiness capacity dramatically diminished. In such a new context, the capacity to get additional funding was reduced, and the relevance of the EU-funded OPs increased significantly.

The relevance of the Priority Axis 2 of SOP IEC was not only preserved but also increased during the programming cycle. Priority Axis 2 focused on RTD infrastructure and activities, and SOP IEC as a whole did not suffer any programming change but only a reshuffling of funds between two of its programme axes and within the policy measures of the Priority Axis 2.

Innovation and more knowledge-based economic activities were the overarching policy approaches to integrate the Romanian economy into the EU markets and to make it more competitive internationally. Therefore, the logic of intervention built at the whole programme level matched the country's identified needs and developmental challenges.

Efficiency

ERDF funding played an outstanding role in developing RTD infrastructure and carrying out R&D activities in Romania. ERDF available funds for building new RTD infrastructure and for modernising existing ones was a major opportunity – 'a gold mine' – to reduce the gap in the technological level of public RTOs and HEIs. Although the volume of financial support was not sufficiently high to 'move the needle' for the country's research system as a whole, the financed beneficiaries were able to upgrade their working premises significantly. Due to concern over the speed of funds and over full compliance with EU regulations and the country's regulatory framework, the programming was affected by a sort of organisational myopia. The lack of proper long-term planning (with a proper definition of the set of indicators, targets and reliable sources of documentation) should be now judged, taking into consideration the weak strategic planning knowledge and skills at the time of programming (2005-2006) and the lack of proper guidance.

This case study shows that it is crucial to have a robust monitoring system and use appropriate result/impact indicators and use then to inform systematic impact evaluation exercise to determine the effectiveness and efficiency of the investments/policy mix. In the absence of these mechanisms, some path dependency can be observed without learning lessons from what was implemented in the past. This is particularly evident when noting that Romania continues to allocate the majority of R&I ERDF funding in infrastructural projects in the lack of solid evidence about how this has improved capacities or performance of the Romanian R&I sector.

The pursued policy mix and the repartition of the budget (both internally as well as related to the overall NSRF allocations) can be regarded as justified. As regards categorisation and earmarking (the latter is not obligatory for Romania as an acceding country), more than 80% of Lisbon-earmarked operations were foreseen. This was twenty percentage points more than the threshold for Convergence programmes. However, a big share of that 80% was related to direct subsidies to enterprises.

The regional concentration of RTD investments in Romania reflects differences in terms of RTD performance across developmental regions. However, the financial instrument's design did not provide a mechanism for pre-allocating ERDF resources to developmental regions. This is a completely different approach compared to other countries characterised by strong regional disparities in the RTD performance, such as Italy.

The ERDF funding was mainly aimed at further promoting the efficiency of excellence-oriented research rather than at pursuing an objective of territorial cohesion within the country. A high concentration of ERDF investments was concentrated in RTOs and HEIs located in the Capital city and few other big university towns (Iasi, Timisoara, etc.), and a share of 31% of ERDF funding allocated to RTD objectives has been invested in the single major project (ELI-NP). This proved to be an effective strategy, given that most of

the national flagship research and technology organisations (RTOs), including those from the top medical sciences, as well as the higher education institutions (HEIs) with a long tradition in academic research, were interested in applying for financing and successfully carried out the projects' planned achievements.

Sustainability and replicability

The safeguarding policy aimed at ensuring long term sustainability was a major concern issue within SOP IEC. Therefore, within the Financial Request (FR), the eligible applicant had to include a section on the sustainability of the results obtained from the R&D investments and the environmental protection assessment conclusions. Moreover, in the process of evaluating the submitted FRs, the evidence brought by them was accordingly scored.

The evaluation process found that the outputs achieved under RTD infrastructure development were sustainable from a technical, institutional, and financial perspective. Technical sustainability was safeguarded by a high degree of novelty, by technologies implied by procured equipment, which belonged to the latest generation class of equipment, and by a long warranty period negotiated with the equipment's providers. The detailed technical specifications in tenders' ToR were also prerequisites for ensuring technical sustainability.

In light of the ownership rights and the legal regime over the built infrastructure (buildings, other assets), institutional sustainability was clarified even at the FR submission, or at the latest, at the contractual phase.

Financial sustainability, in terms of assurance of the recurrent and operational costs, was covered from various sources of financing: from the public R&D organisations, from the annual allocated budget, from extra-budgetary own revenues (RTO, HEI), from participation in follow-up projects, including ERDF funds of the ongoing Competitiveness Operational Programme (COP) 2014-2020, or national programmes. A firm commitment regarding financial sustainability assumed at the organisation's leadership level (board of administration, university Senate, etc.) was required even at the submission of the project proposals.

In 2015 the Romanian Government allocated to NPRDI II EUR 3,672.8 million from the state budget, disaggregated on the six national policy priorities defined by NSRDI 2007-2013[2]. This represented additional resources aimed at ensuring the sustainability of the newly built infrastructures.

The evaluation results show that the collaborative R&D measure was not fully successful in ensuring the financial sustainability of the results of the research projects or in setting up long-term research partnerships between R&D organisations and enterprises. The institutional sustainability of the results obtained in collaborative R&D projects was safeguarded by the partnership scheme. The enterprise beneficiary was the sole owner of the intellectual property rights over the research outputs and solely entitled to go further in the registration of the patent.

The evaluation process found that the consolidated administrative capacity of the target public RTOs and HEIs led to elaborating other project proposals, either submitted under the COP 2014-2020 or to other programmes, including FP7 and H2020. However, it can be emphasised that the implementation of PA2 of SOP IEC represented a source of lessons learnt and a more solid foundation for planning and implementing the subsequent OP in the second programming period. The pioneering implementation teams at the beneficiary level later acted as a resource centre for their organisation. There was also a multiplier effect, with the impact of a consolidated institutional memory.

[2] Romanian Government Decision no. 252 of April 15, 2015 for the amendment of the GD no. 475/2007 regarding the approval of the National Plan for research-development and innovation II, for the period 2007-30 June 2014

The educational infrastructure investments provided an interesting example of the possible synergies that could be developed with the Sectoral Operation Programme's further assistance on Human Resources Development (2007-2013 SOP-HRD).

Coherence

SOP IEC was aligned with the Lisbon Strategy. It was also aligned with a set of EC initiatives concerning research and innovation, global competitiveness of universities and research institutes, development of entrepreneurial skills, and knowledge transfer in products and services, such as the Framework Programme for Research (FP7). Regarding coherence with national policies (SME policy, tourism, R&D policy and energy policy), the SOP IEC approach appeared to be well coordinated.

The priority axes of SOP IEC were designed in full compliance with the lines of action of the Commission's proposal regarding the framework for Competitiveness and Innovation 2007-2013, and responding to the guidelines put forward by the EU Council for cohesion policy for 2007-2013.

The synergies and complementarities of the interventions financed by SOP IEC were foreseen through the mechanisms defined in NSRF and SOP IEC, based on the national development priorities and the main strategic connections for their realisation established through NDP 2007-2013. Some institutional mechanisms were also developed that aimed to ensure a good correlation and coordination of the funds.

Major coherence issues only appeared when viewing the Sectoral Operational Programme Human Resources Development (SOP HRD) interaction about the capacity building aspects. However, there was no systematic verification of the complementarities of the financed projects in the implementation process. This was mainly because of the absence of national sector strategies to establish the orientations and objectives pursued in the medium and long term, establish action and monitoring plans and a realistic timetable for implementation, or identify the correspondences between national development priorities targets set at the EU level. As a result, the strategic correlations remained at a static level. The lack of prioritisation determined the concentration of interventions in certain areas and the low complementarities of the investments made (SOP IEC FIR, 2018).

Because of internal complementarity and to avoid duplication of funds investment, the programme measure planned to support poles of excellence has been excluded.

Complementarities were also ensured between the programme measures of the KAIs within PA2. Thereby, the beneficiaries from 2.1.1. – Collaborative R&D research – were eligible for submitting follow-up projects to the open calls organised under 2.3. – RDI support for enterprises – to raise further financial support for projects in operational manufacturing environment and mass production.

EU added value

At the level of policy and decision making, the ERDF support brought:

- A change of the paradigm about the need to introduce multiannual public policy financing programmes, rather than annual budgets, to ensure predictability and sustainability;
- Consolidation of strategic planning skills, with an emphasis on developmental vision in the medium and long-term, rather than a focus on short term results;
- Uniformity and homogeneity of managerial skills in the programmes and projects within the institutional system;
- Greater transparency and fairness in governing the public funds;
- Governance of ESIF funded programmes built on partnership with stakeholders.

At the level of beneficiaries and other stakeholders, it brought:

- A different management style based on projects;
- Changes in raising financing for carrying out the research themes within the annual work plan;

- A better mutual understanding by RTOs and HEIs of the needs of enterprise and a re-orientation of approach to the demand side rather than the supply side;
- A consolidated capacity to meet the continuous higher project's competition requirements, and a broad understanding of the EU funded OP goals;
- Changes in organisational, institutional culture, and consolidation of the partnership culture and social capital increase within society;
- Greater accountability and responsibility in using public funds either from the national central or local budgets or from EU funds.

In conclusion, the first EU funded OP generation was a challenging pioneering worksite where all parties have simultaneously tested, corrected and learnt, but a secure foundation for the second programming period.

1. INTRODUCTION

This case study has been carried out in the framework of the Evaluation of investments in Research and Technological Development (RTD) infrastructures and activities supported by the European Regional Development Funds (ERDF) in the period 2007-2013. The evaluation's main objective is to identify the effectiveness of RTD infrastructures and activities, their coherence with other policies, their efficiency, relevance, and EU added value. The evaluation covers 53 Operational Programmes (OPs) selected by the European Commission, covering a substantial amount of the RTD funding (EUR 14.64 billion, or about 85% of the EU total for the relevant themes) provided during this programming period.

As part of the evaluation process, a total of seven case studies (CS) have been carried out to illustrate the substantial effects of ERDF-supported RTD policy instruments. Case studies were designed to examine the use of funding for different policy instruments in the selected Member States and the specific context in which they were implemented, their rationale, their effectiveness, and their long-term sustainability.

The case study focuses on the ERDF support for RTD activities and infrastructures delivered in Romania between 2007 and 2013 within the Sectoral Operational Programme 'Increase of Economic Competitiveness' (further referred to as SOP IEC). Specifically, the evaluation has been conducted based on a Contribution Analysis (CA) approach and the underlying development of Theories of Change (ToC) for selected policy instruments. This involved disentangling the complex causal relationships between different stages of implementation and the production of these policy instruments' results to identify the contributions made by the ERDF to improving RTD in specific regions and MS. This approach aimed to build a detailed narrative of the ToC 'at work' in a specific region/MS and context, addressing the specific conditions influencing the policy rationale (further explored in the cross-case analysis), the interplay of different stakeholders, their expectations, and observed effects as a result of the policy instruments. The selected policy instruments were the following:

- Infrastructure investments for research under Measure 2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres);
- Collaborative science-industry R&D projects under Measure 2.1.1. - Joint R&D projects between universities/research institutes and enterprises;
- Internationalisation of research under Measure 2.1.2 Complex research projects fostering the participation of high-level international experts.

As a result of the participatory evaluation methodology, 31 stakeholders were consulted to prepare this report. These stakeholders represented eight groups: national authorities involved in the oversight of ERDF funds, key national RTD funding ministries or agencies, the Managing Authority (MA) of the selected OP, managers of selected policy instruments, the intermediate body and national/regional agencies for RTD investments, business associations, direct beneficiaries of selected instruments or major projects, and final beneficiaries of selected instruments or major projects. The stakeholders' consultation was done through face-to-face and distance interviews between 28 September and 20 October 2020. These interviews were complemented with a site visit at the National Institute of Physics and Nuclear Engineering – Horia Hulubei (Institutul Național de Cercetare-Dezvoltare pentru Fizică și Inginerie Nucleară Horia Hulubei - IFIN-HH) research platform in Măgurele held in January 2020, during the completion of Task 1.

It should be mentioned that the case study was prepared in the absence of any independent final performance analysis or ex-post evaluation of SOP IEC. In order to mitigate this absence, a comprehensive number of other key documents (e.g. strategic policy documents, the ex-ante evaluation report, the mid-term evaluation report, annual and final implementation reports, minutes of the Monitoring Committee, independent studies and analysis, etc.) have been reviewed. The interviews carried out were crucial for checking the experts' assumptions and documenting the findings and conclusions. It

is also true that the interviews provided useful qualitative insights rather than highly aggregate quantitative and factual data, considering that a long time has passed since the OP administrative closure and the completion of has funded projects. Therefore, the analytical reliability is safeguarded by the reliance on the official monitoring data.

2. ANALYSIS OF THE POLICY CONTEXT AT THE NATIONAL LEVEL

2.1. National RTD objectives and strategies

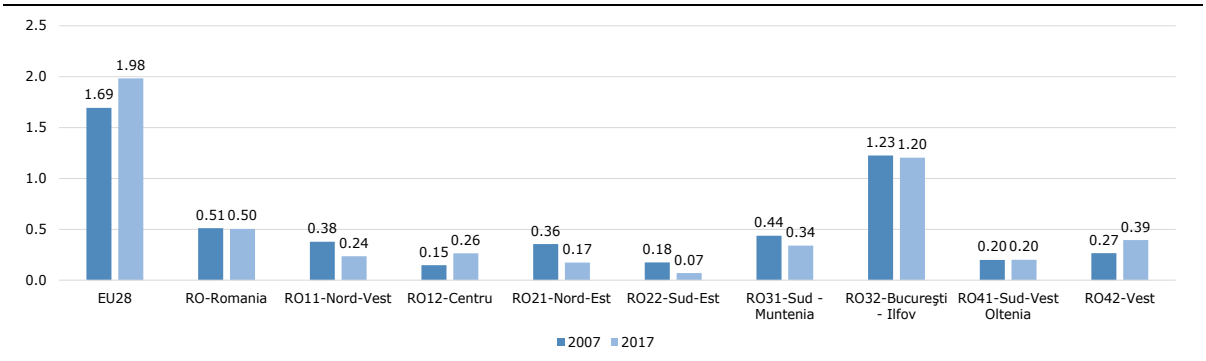
2.1.1. Analysis of the national RTD context

Romania joined the EU on 1 January 2007 as the seventh-largest economy in the EU (after Germany, France, UK, Italy, Spain and Poland) and with a population of approximately 21.5 million inhabitants (4.3% of the total EU population). The 2007-2013 programming period represented the first programming cycle implemented by the country. The design of the 2007-2013 Operational Programmes (OPs) under the European Structural and Investment Funds (ESIFs) relied on the pre-accession preparation process of the country's strategic policies and framework, during which the country preparation benefitted from EU expertise.

During the pre-accession period (2004-2008), the country had witnessed positive GDP growth and was one of the fastest-growing EU candidates of the new wave of MS. However, the GDP growth rate fell dramatically from 7.3% in 2008 to -7.1% in 2009 (Eurostat) due to the economic crisis that hit Romania in the fourth quarter of 2008. This followed the sharp decline of three key factors that had generated economic growth in the previous years: exports, internal consumption demand, broadly supported by imports and financed by external debt, and foreign direct investments (FDIs).

As shown in the ERAWATCH Country report 2010–Romania, the RDI sector was seriously affected by the financial and economic crisis's budget cuts. After a notable increase from 0.45% in 2006 to 0.52% in 2008, GERD expenditure relative to the GDP went down to 0.47% in 2009 (Eurostat), reversing the estimated growth to 1% of the GDP by 2010 that the government approved in pursuance of the Lisbon Agenda target. The effect of these budget cuts was still visible at the end of the programming period. In most of the regions, the total R&D expenditure recorded in 2017 had remained unchanged or had even decreased compared to the 2007 level.

Figure 1. Total R&D expenditure over GDP by region – 2007 and 2017

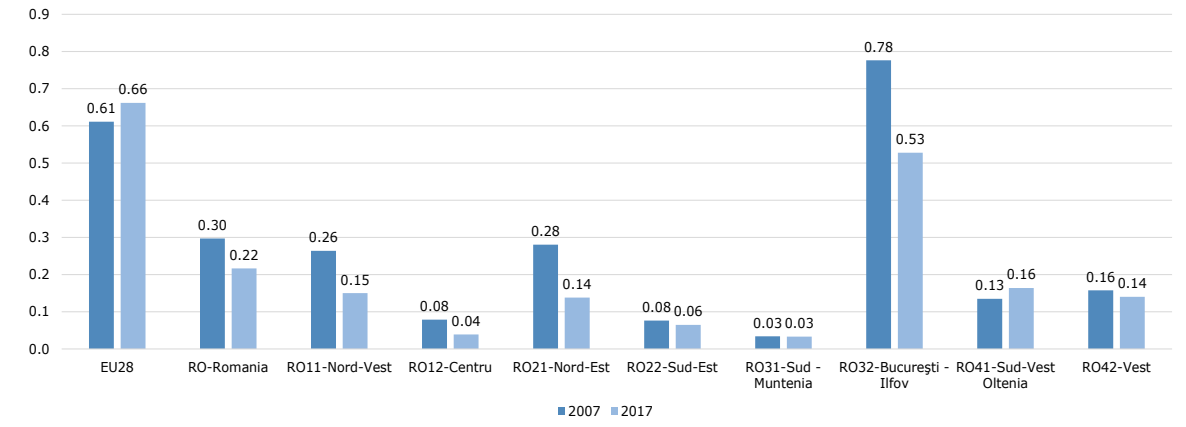


Source: CSIL elaboration based on EUROSTAT data.
Note: Values are expressed in percentage of GDP.

Consequently, the public funding for national RDI programmes managed by the National Authority for Scientific Research (NASR) dropped by 27.6% in 2009 (NASR, 2009). This cut had important negative consequences, including a significant loss of qualified researchers in R&D institutions, especially in the national R&D institutes, a weaker capacity to attract young researchers and stop researchers' migration abroad or better-paid sectors, and a weakening of public-private partnerships. Overall, this situation annihilated the improvements achieved in the previous few years with increased RDI funding. In addition, approximately 30% of the research infrastructure investment planned for 2007-2009 was cancelled because of budgetary limitations at the end of 2008 (NASR, 2009). In 2010, the effects of the economic crisis continued to be felt, so that the public R&D expenditure increased only by 8.6% relative to 2009, getting closer to the values of 2008, but remaining still considerably lower than the funding planned in

the 2007-2013 National RDI Plan (NASR, 2010). In 2007-2017, the country's most developed region had also registered a significant decrease in public R&D expenditure.

Figure 2. Public R&D expenditure over GDP by region – 2007 and 2017

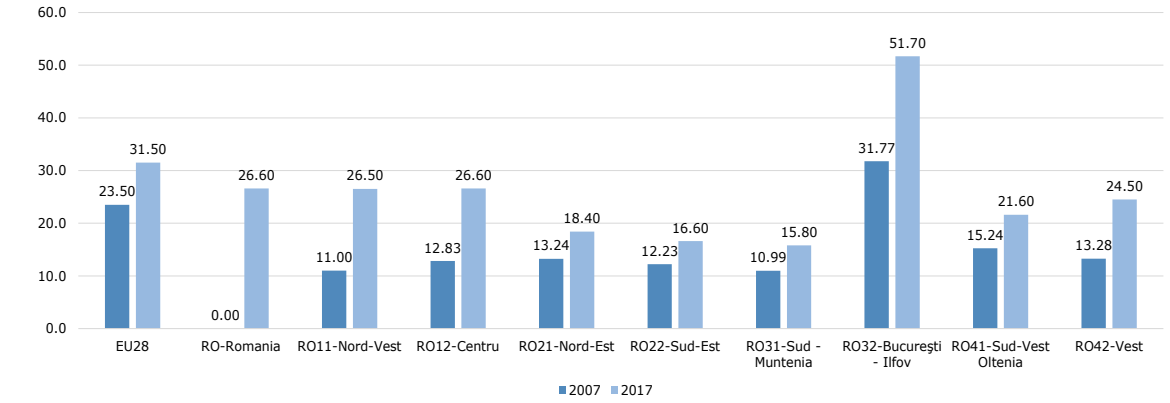


Source: CSIL elaboration based on EUROSTAT data.
Note: Values are expressed in percentage of GDP.

When Romania joined the EU, public research institutions (including universities) mostly had an outdated infrastructure. They had sustainability problems as a result of the scarce mobilisation of public financial resources for research. Public investments were focused on other priorities, such as restructuring the still state-owned companies or the rehabilitation of the national road infrastructure. In order to survive, most of them were forced to generate additional revenues by renting part of their premises to newly established enterprises or business development support facilities (e.g. business incubators). Moreover, the chronic instability at the macro-economic level characterising the country until 2004 did not attract FDI into this activity sector. As a result, it was extremely difficult to conduct advanced research to address the most important socio-economic needs and challenges of the country, although the number of research staff was high at that time. This situation contributed to a further concentration of RDI activities in the stronger higher education centres and RTD entities, especially in the capital city, where more than 50% of the total research infrastructures were located and the policy pursued by the regime in force until 1989. Such finding is also evidenced by the percentage of the population aged 25-64 having completed tertiary education, or employed in science and technology, or as R&D personnel (Figure 3, Figure 4 and Figure 5). The high average in the București-Ilfov region is above that of EU-28: the capital city and surrounding area (Ilfov county) is the most important RDI pillar. This region is followed by Nord-Vest, Centru, and Vest regions, whose targets are either slightly above or very close to the country average.

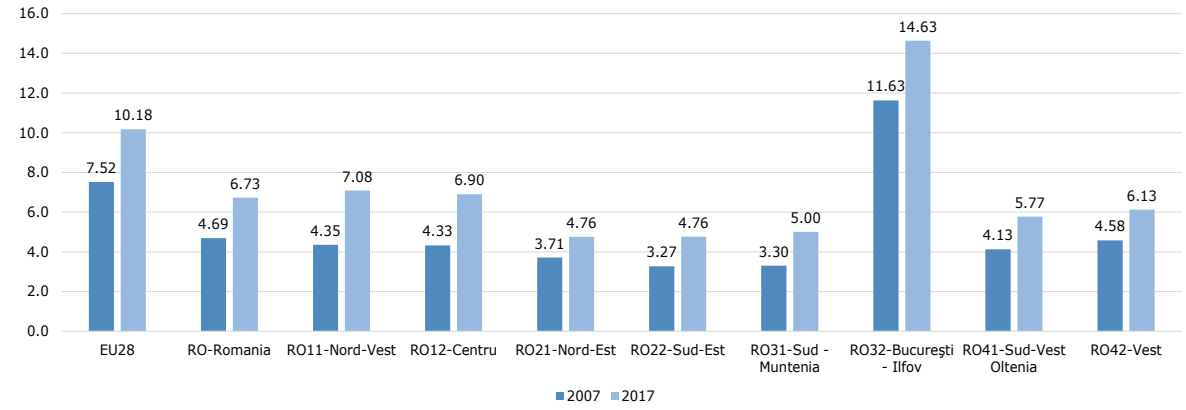
Overall, specialised research equipment dispersal also caused difficulty in conducting large R&D projects with an international dimension and with international researchers' participation.

Figure 3. Percentage population aged 25-64 having completed tertiary education by region – 2007 and 2017



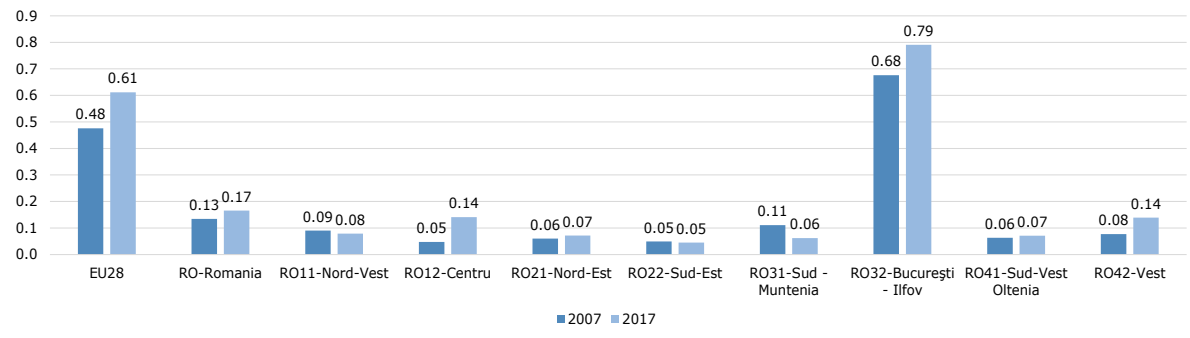
Source: CSIL elaboration based on EUROSTAT data.
Note: Values are expressed in percentage of total population aged 25-64.

Figure 4. Employees in science and technology in percentage of total population, by region – 2007 and 2017



Source: CSIL elaboration based on EUROSTAT data.
Note: Values are expressed in percentage of the total population.

Figure 5. Total R&D personnel in percentage of total population, by region – 2007 and 2017



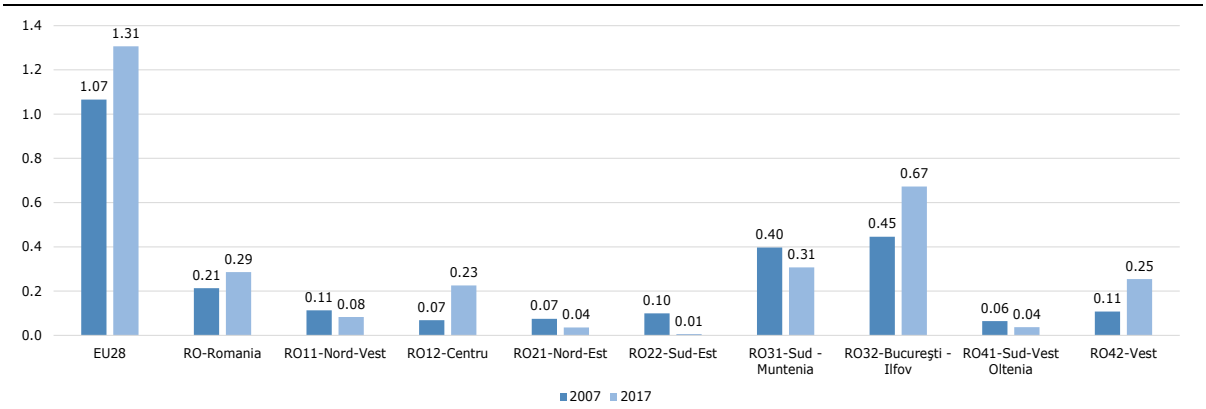
Source: CSIL elaboration based on EUROSTAT data.
Note: Values are expressed in percentage of the total population.

Financial shortages affected the private sector, as well. Companies were not motivated to invest in domestic R&D and preferred to import new technology acquisitions. Moreover, most Romanian companies, especially emerging small and medium-sized enterprises (SMEs), did not show any interest in working with academia. Meanwhile, scientists primarily focused on fundamental research, which was regarded as more prestigious. A better indicator of scientific excellence aimed more at supporting the advancement of

academic staff in their professional teaching careers than on applied R&D. There was also a low emphasis on knowledge-intensive sectors, considering the low valued-added, the fact it was mainly services-oriented, and the small number of enterprises in the so-called high-tech manufacturing sector and knowledge-intensive services (KIS). There also was difficulty in accessing bank loans. This issue was directly linked to the banking sector's hesitance to assume higher risks associated with R&D activities and its reluctance to deal with the small-sized emerging enterprises.

As shown below, business R&D expenditure over GDP–2007 was much lower than the EU-28 average, but over ten years, the trend has slightly increased. The country's average has been enhanced by the increase recorded in three developmental regions: București-Ilfov, Vest, and Centru.

Figure 6. Business R&D expenditure over GDP by region – 2007 and 2017



Source: CSIL elaboration based on EUROSTAT data.
Note: Values are expressed in percentage of GDP.

The evolution of RTD performance during the 2007-2013 programming period was very different between the Romanian regions, as shown in the table below. Between 2007 and 2017, only three regions improved their RTD performance, namely the București-Ilfov region from 'moderate-' to 'moderate+', and Vest and Nord-Est regions from 'modest-' to 'modest +'. Conversely, the other five less developed regions have shown stagnation in the same category ('modest-').

Table 1. Evolution of RTD performance in Romania from 2007 to 2017

Development Region	2007	2017	Evolution 2007-2017
RO11-Nord-Vest	Modest -	Modest -	—
RO12-Centru	Modest -	Modest -	—
RO21-Nord-Est	Modest -	Modest +	↑
RO22-Sud-Est	Modest -	Modest -	—
RO31-Sud - Muntenia	Modest -	Modest -	—
RO32-București - Ilfov	Moderate -	Moderate +	↑
RO41-Sud-Vest Oltenia	Modest -	Modest -	—
RO42-Vest	Modest -	Modest +	↑

Clusters: Modest -; Modest + ; Moderate -; Moderate +; Strong Business ; Leaders.

Source: CSIL elaboration based on the results of the Cluster analysis performed under Task 1.

2.1.2. National RTD strategies

The most important RDI policy document in Romania during the first programming period 2007-2013 was the National Strategy for Research Development and Innovation (NSRDI)[3], which defined nine national priority research areas: ICT, energy, environment, health, agriculture and food, biotechnologies, innovative materials, processes and goods, space and security, and socio-economic and humanistic research.

NSRDI and its state budget funded implementing instrument, the 2007-2013 National RDI Plan (NRDIP II)[4], were defined through a broad consultation with the main RDI stakeholders, within the first national foresight exercise in Science and Technology organised in 2005-2006 by the National Authority for Scientific Research (NASR) within its Sectoral R&D Plan. RDI funding instruments envisaged for the sector policy implementation were direct and indirect, with a strong reliance on the latter's former and poor development. The indirect instruments for supporting the RDI sector consisted only of a few tax incentives and some deductible costs set under the Fiscal Code adopted through Law no.571/2003.

The country's National System of Research and Development (NSRD) has a complex structure, organised on several levels, from Parliamentary working commissions to RDI performers (see ANNEX I for more details). The key governmental institutions with the major role in sector policymaking were:

- The Commission for Education, Science, Youth and Sport;
- The National Council for Science and Technology Policy;
- The Ministry of Education, Research, Youth and Sport;
- The National Authority for Scientific Research (NASR);
- The Executive Unit for the Financing of Higher Education, Research, Development and Innovation (Unitatea Executivă pentru Finanțarea Învățământului Superior, a Cercetării, Dezvoltării și Inovării - UEFISCDI);
- Other consultative bodies established under MERYS coordination.

Although relatively stable, the large size and multilevel structure of the governance structure put in place for the design and implementation of RDI policies often created important gaps in the horizontal and vertical coordination and communication between the actors and policy and implementation incoherencies. Even though RDI policies were recognised as a priority of all government programmes after country accession to the EU, they had little visibility and importance in overall government policy, considering the low public budget directed to the RTD field and funding cuts as a result of the economic crisis and government austerity programme.

During the 2007-2013 period, the defined national public policies were implemented mainly by mobilising the Sectoral Operational Programme 'Increase of Economic Competitiveness' (SOP IEC), funded by ERDF the NPRDI II, funded by the state budget. The SOP IEC, which is under investigation in the present case study, was the first integrated set of support measures addressing the challenges faced by the R&D sector targeting both public and private RTD entities and partnerships between the emerging private sector with research organisations.

The 2007-2013 NSRF aimed to reduce the disparities in economic and social development between Romania and the other EU Member States by generating an additional increase of 15-20% of GDP by 2015.

In this regard, four thematic priorities and one territorial priority were identified:

- Development of basic infrastructure to European standards;
- Increasing the long-term competitiveness of the Romanian economy;

[3]Approved by the Government Decision (GD) no. 217/28 February 2007
[4]Approved by the GD no. 475/23 May 2007 with subsequent amendments and completions.

- Development and more efficient use of human capital in Romania;
- Strengthening an efficient administrative capacity;
- Promoting balanced territorial development - as a territorial priority.

2.2. The links between national, regional and European objectives and strategies in the field of RTD support

This section describes the role of the ERDF investments for RTD in the national and regional RTD policy mix as well as with respect to European framework programmes.

2.2.1. Linkages between national RTD policies and ERDF support

In order to address the RDI system failures, Romanian policymakers designed interventions based on a policy mix scenario consisting of a range of measures. The use of the term 'mix' refers to the intended synergic combination of different direct financial instruments.

Direct financial instruments for sectoral public policy implementation included:

- The 2007-2013 National Plan for R&D and Innovation (with its six programmes: Human Resources, Capacities, Ideas, Partnerships in Priority domains, Innovation, and Sustaining institutional performance);
- The complementary core R&D Programmes and Sectoral R&D Plans;
- Several Sectoral Operational Programmes that address in a complementary manner the RDI objectives, targeting both public and private RDI performers: Increasing Economic Competitiveness (Priority Axes 1 and 2), Regional Development (Priority Axis 4), and Human Resources Development (Priority Axes 1 and 3).

Considering the low level of public funding targeting R&D during the 2007-2013 programming period, the financial sources allocated to Romania from the ESIF, especially from the ERDF, were crucial in order to address the sector needs and developmental challenges. In this respect, SOP 'Increase of Economic Competitiveness' 2007-2013 was the most important EU funded programme which aimed to address the RTD sector needs. Its general objective was to increase Romanian companies' productivity, comply with the principles of sustainable development, and reduce the disparities compared to the EU average productivity. The programme's third specific objective targeted more explicitly the need to increase R&D capacity, stimulate cooperation between RDI institutions and enterprises, and enhance the enterprises' access to RDI. The ambitious target was to reach 55% of the average European productivity by 2015.

In order to achieve the third specific objective, SOP IEC included Priority Axis 2 'Research, Technological Development and Innovation for Competitiveness' and three Key Areas of Intervention (KAI):

- KAI 2.1. - R&D partnerships between universities/research institutes and enterprises for generating results directly applicable in the economy;
- KAI 2.2. - Investments in RDI infrastructure and related administrative capacity to ensure further operations and maintenance of the newly built/upgraded infrastructure and long-term technical, financial and institutional sustainability;
- KAI 2.3. - RDI support for enterprises aimed at increasing access to RDI activities (especially of SMEs).

At the strategic level, the EU Structural Funds OPs stimulated changes within the national legal framework in 2007-2013. The aim was to ensure an alignment with the rules and requirements of ERDF support and enhance the effectiveness of public interventions.

New institutions like NASR were established at the operational level, and new financial mechanisms were introduced based on NPRDI II. Most of these were pioneering instruments in Romania. Other financial instruments, such as venture capital, private equity, and business angels, widely known in many other countries, were almost unknown

in Romania around the time of 2007-2013. Science-industry collaboration in the innovation system was a relatively rare phenomenon at the beginning of the first programming period as a result of limited exchanges between the research and business community.

Overall, it can be concluded that the country's RTD policies mainly relied on the provision of ERDF support to overcome the main RTD challenges.

2.2.2. Linkages between regional RTD policies and ERDF support

Based on Law no. 151 from June 1998, Romania is organised into eight developmental regions (Nord-Est, Sud-Est, Sud-Muntenia, Sud-Vest Oltenia, Vest, Nord-Vest, Centru, and București–Ilfov). The regions were defined only as territorial units (corresponding to NUTS2 classification of regions) created by the voluntary association of 4-7 neighbouring counties. They were not established as a legal entity with an administrative status.

Therefore, at the regional level, eight Regional Development Councils and eight Regional Development Agencies (RDAs) ensured the RTD policy coordination. However, despite major regional disparities between the capital region București-Ilfov and all the other regions, Romania had no formal regional RDI policy. The regions did not have a role in RDI policy-making. RDI policies were designed and coordinated at the national level by MERYS, without any specific regional focus. In fact, the NASR set up within the MERYS structure had a very limited role in spurring regional research and innovation potential and exerted little territorial coordination of RDI. However, its mandate included the task 'to stimulate regional and local development' (Innova Europe, 2010).

The NASR has adopted a new regional focus in the implementation of national RDI policy since 2008. It consists of monitoring the regional distribution of projects funded by the 2007-2013 NPRDIII, nine regional Research Exhibitions, and the creation of Innobarometer in 2008, by NASR, as an annual analysis of regional and national innovation through several regional innovation indicators. These were quite new initiatives focused on RDI regional development.

Furthermore, a regional innovation instrument that emerged in Europe in the early 2000s, in the form of the formally adopted Regional Innovation Strategy (RIS), was missing in Romania at the time of SOP IEC design. There was only one pioneering region (Vest developmental region) that had sketched its regional policy document. Five other regions (București-Ilfov, Nord-Est, Nord-Vest, Sud-Est and Sud-Muntenia) followed and have experienced their exercise.

It has to be acknowledged that for the first time, Romanian developmental regions were obliged to prepare the integrated RIS3 to be eligible to access the financial resources from 2014-2020 Regional Operational Programme (its Axis One: Technological Transfer), also funded by ERDF in the second programming period. In 2013, the Nord-Est region had already finalised its Regional Innovation Strategy on Smart Specialization (RIS3), following the EC's methodology, where they identified the region's domains with smart specialisation potential. Therefore, if we consider both programming periods, there is no doubt that ERDF support has played an important role in raising public awareness and in the adoption of the regional RTD policies.

2.2.3. Linkages between ERDF support for RTD and FP7/Horizon 2020

As highlighted in the previous section, the most important RDI policy document in Romania at that time was the 2007-2013 National RDI Strategy (NRDIS), which was structured around six specific themes, similar to the EU FP7: People, Capacities, Ideas, Partnerships in priority domains, Innovation and institutional performance. Its main objectives were to consolidate the 'Romanian Research Area' and facilitate integration into the European Research Area (ERA).

In line with the strategic alignment expected between NRDIS and FP7, the 2007-2013 SOP IEC, the main investment programme mobilised for the implementation of the NRDIS, was aligned with a set of EC initiatives concerning research and innovation,

global competitiveness of universities and research institutes, development of entrepreneurial skills, and knowledge transfer in products and services, such as the Framework Programme for Research (FP7).

However, in the implementation of the NRDIS and the SOP IEC, no specific coordination mechanisms were established to ensure an effective synergy with the FP7. Nevertheless, Cordis data shows that a total of 44 institutions benefitting from ERDF support in the field of RTD participated in 342 projects for a total EU contribution of EUR 49 million (see Table 2). Considering that the total number of Romanian institutions which participated in FP7 was 364 for a total of 1,021 projects and EUR 129.5 million, this means that ERDF beneficiaries accounted for 12% of the institutions, participated in 33.4% of the projects, and received 35.5% of the total contribution at the national level.

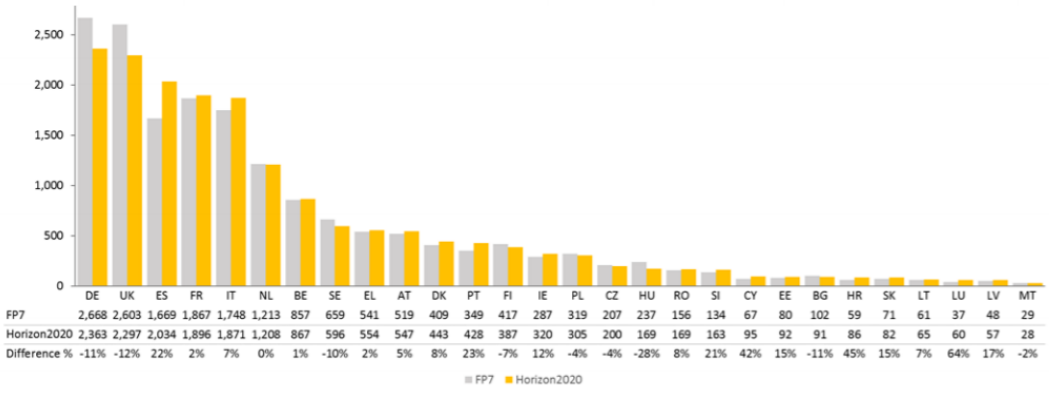
Table 2. ERDF beneficiaries participating in FP7 and H2020 projects[5]

	ERDF recipients benefitting also from FP	Number of FP projects	Total FP contribution
FP7	44	342	49,896,395.63 €
H2020	45	243	48,344,260.63 €

Source: CSIL elaboration based on Task 1 DB Beneficiaries and Cordis data.

Overall, it should be noted that Romania records weak participation in EU Framework Programmes compared to the old and new (Poland, Czech Republic and Hungary) Member States. However, it can be noticed that the number of applied projects has slightly increased in the H2020 programme compared to the FP7, while other new MS have recorded a decrease. This positive evolution might be linked with the higher visibility of these two European funded programmes and the improved capacity of Romanian research organisations to meet programme requirements and selection criteria and submit better-prepared project proposals.

Figure 7. Number of participations to Horizon 2020 and FP7 per year per Member State of beneficiaries



Source: European Commission, DG RTD, based on CORDA data.
Note: cut-off date 1st July 2018.

2.3. Implementation of ERDF funds for the years 2007-2013 in Romania

For the first programming period after its EU accession, Romania was allocated EUR 19.21 billion for its Cohesion Policy, of which EUR 8.98 billion from the ERDF

[5]The total number of FP7 projects during the period 2007-2013 amounted to 25,581 for a total contribution of EUR 50.7 billion. Instead, the total number of H2020 projects during the period 2014-2020 amounted to 27,017 for a total contribution of EUR 52.5 billion.

(representing 46.7% of the total ESIF allocation). The NSRF underlines the breakdown of the country's financial allocation of EUR 19.21 billion from the European Structural and Investment Funds (ESIFs) such as the European Regional Development Fund (ERDF), the European Social Fund (ESF), and the Cohesion Fund (CF). The ESIF allocated budget was supplemented with national co-financing estimated at EUR 5.6 billion.

The breakdown of the EU allocation by those three financing sources and the seven Operational Programme within the Convergence Objective is presented in the next table.

Table 3. The financial allocation from ESIFs to Romanian OPs by funding sources

Operational Programme	Total ESIFs allocation, EUR billions	ESIFs allocation by funding source					
		EUR, billions			% from Total NSRF		
		ERDF	CF	ESF	ERDF	CF	ESF
Increase of Economic Competitiveness	2.55	2.55	-	-	13.3	0.0	0.0
Transport	4.57	1.29	3.28	-	6.7	17.1	0.0
Environment	4.51	1.24	3.27	-	6.4	17.0	0.0
Regional	3.72	3.73	-	-	19.4	0.0	0.0
Technical Assistance	0.17	0.17	-	-	0.9	0.0	0.0
Human Resources Development	3.48	-	-	3.48	0.0	0.0	18.1
Administrative Capacity Development	0.21	-	-	0.20	0.0	0.0	1.1
Total NSRF	**19.21**	**8.98**	**6.55**	**3.68**	**46.7**	**34.1**	**19.2**

Source: Authors elaboration based on the NSRF 2007-2013 Executive Summary

The implementation of ERDF funds for the 2007-2013 programming period in Romania could not be carried out without an appropriate governance and management institutional system.

During the first programming period, the management and control system was comprised of several entities: managing authorities (MA) set up within a line ministry organisational structure, the intermediate bodies (IB) being either public institutions (e.g. NASR) or private entities (e.g. Regional Developmental Agencies set up as non-governmental organisations of public interest). The oversight entity for all ESIF OPs was, in the beginning, the Authority for Structural Instruments Coordination (*Autoritatea pentru Coordonarea Instrumentelor Structurale* - ACIS), set up under the Ministry of Finance. From December 2011, it became the Ministry of European Affairs, with a name change one year later to the Ministry of European Funds.

The Managing Authority (MA) in charge of the SOP IEC implementation was set up within the Ministry of Economy and Public Finance. In contrast, the Intermediate Body (IB) in charge of implementing the PA2 was assigned to the NASR within the organisational structure of the MERYS. A programme Monitoring Committee (MC) was also established, representing the key stakeholders from the public sector and business associations, trade unions, and key public policy institutes. This comprehensive structure illustrates the participatory features of the supervision and decision-making process.

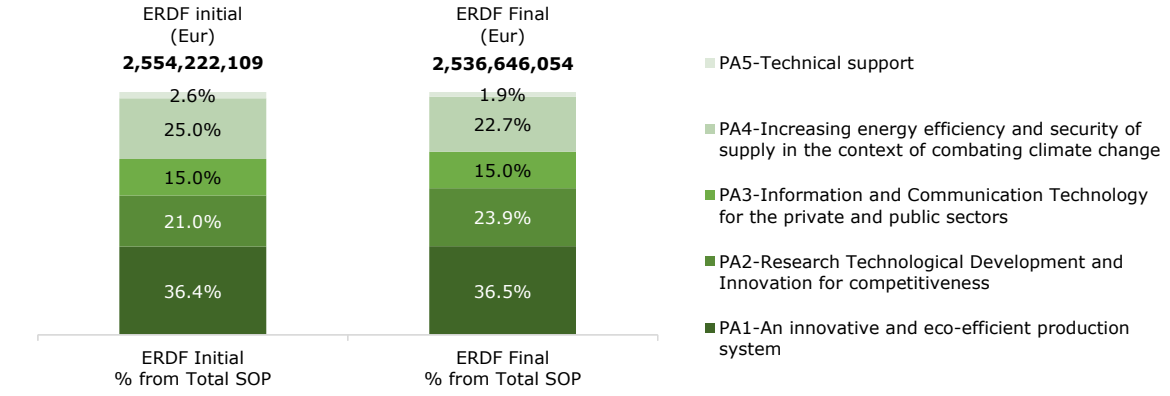
The auditing function was the full responsibility of the newly established Audit Authority set up within the Romanian Court of Accounts structure, and the Central Authorization Payment Unit was set up within the Ministry of Public Finance.

2.3.1. *Volume of ERDF financing for RTD-related activities and supported OP.*

The total budget of SOP IEC for the period 2007-2013 was EUR 4.25 billion, of which EUR 2.55 billion were ERDF funds, representing approximately 13.3% of the allocation related to NSRF. The programme was implemented through 5 priority axes, which included 11 KAIs. As shown in Figure 8, the weight of ERDF financial allocation for PA2 was initially planned at 21.0%, while the final allocation shows an increase of the specific weight to 23.9%.

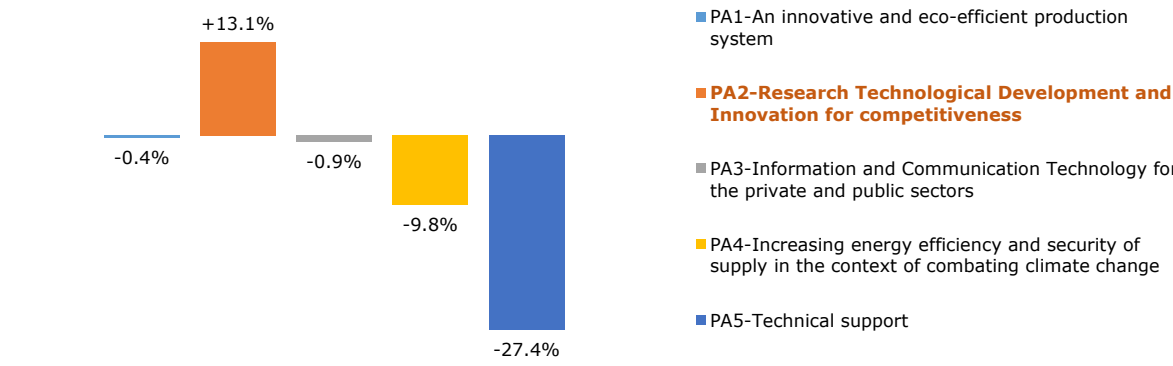
The initial ERDF allocation to Priority Axis 2 'RTD and Innovation for Competitiveness' amounted to EUR 536.4 million. As shown in Figure 9, with the closure of the programme in 2014, the ERDF allocation to PA2 had increased by 13.1% (from EUR 536.4 million to EUR 606.9 million). This increase is the result of an internal adjustment process between SOP IEC priority axes, following the introduction of a single major project whose budget amounted to EUR 180 million, representing 29.6% of the ERDF allocation to the whole OP. This re-allocation decision between priority axes of the programme was made following the EC decision to include Romania in the ELI-NP project's network. The reshuffle of funds between priority axes was also a managerial decision to speed up absorption, taking into consideration that under PA4, initially allocated funds were not fully used due to the lack of mature pipeline projects and weak demand of the eligible applicants.

Figure 8. RO SOP IEC - ERDF Initial (2007) and Final (2014) distribution of financial allocation by Priority Axes



Source: Authors elaboration based on data provided by RO-SOP IEC MA

Figure 9. RO SOP IEC - ERDF: Changes in ERDF financial allocation, Final (2014) vs Initial (2007) by Priority Axes (% from initial allocation)

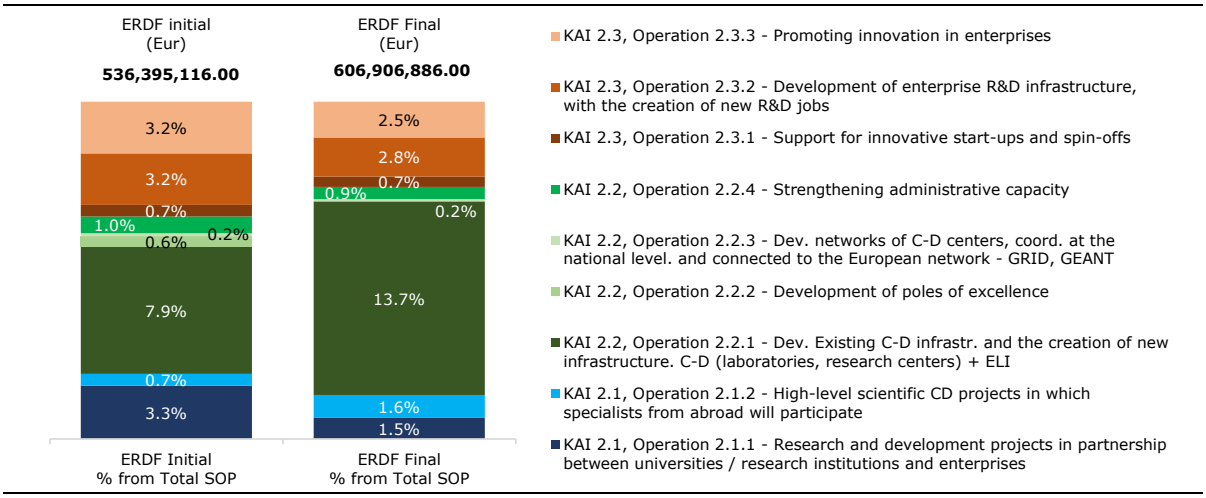


Source: Authors elaboration based on data provided by RO-SOP IEC MA

The following figure shows the breakdown of initial and final ERDF allocation of PA2 by its operations, highlighting that subsequent allocation was large to KAI 2.2, operation 2.2.1. – 'Investments in RDI infrastructure and administrative capacity development'. Financial

allocation adjustments between the programmes' SOP IEC priority axes and within the KAIs of PA2 made at the end of the year 2011 influenced the structure of PA2 operations. The operation's weight, referring to further development of R&D existing infrastructure and creation of new RTD infrastructure, increased by almost six percentage points (from 7.9% to 13.7% of the total ERDF allocation to the OP), whilst the weight of the other operations decreased.

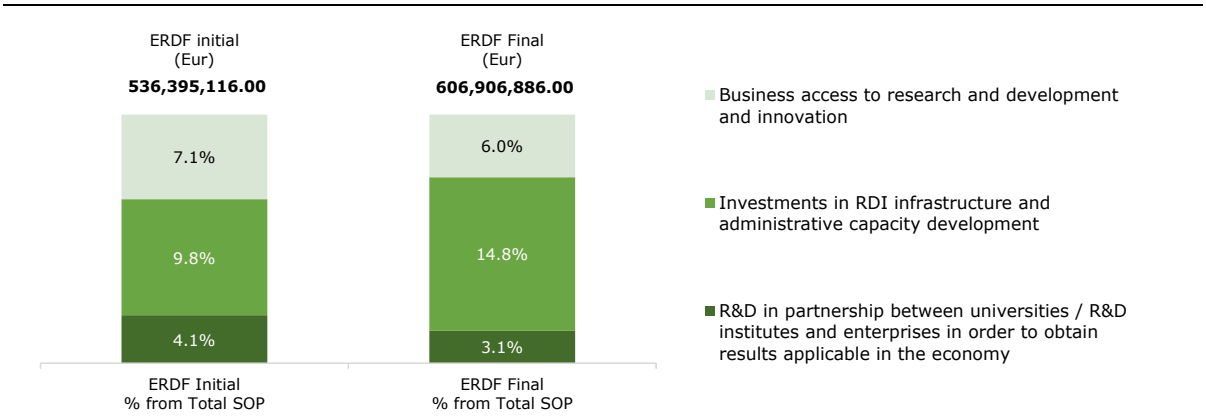
Figure 10. ERDF Initial (2007) and Final (2014) distribution of financial allocation for PA2 - by operations



Source: Authors elaboration based on data provided by RO-SOP IEC MA

Specifically, the beneficiary of the reallocations was the KAI addressing investments in RDI infrastructure and administrative capacity development (KAI 2.2), whose allocation increased from 9.8% to 14.8% of the total allocation SOP IEC (see Figure 11).

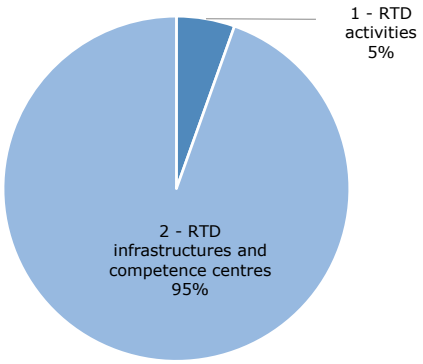
Figure 11. ERDF initial (2007) and final (2014) financial allocation and its breakdown by PA2 Key Area of Interventions



Source: Authors elaboration based on data provided by RO-SOP IEC MA

The total used ERDF contribution to RTD activities within the OP Increase of Economic Competitiveness accounted for EUR 560.5 million. EUR 180 million were directed to the ELI major project, representing more than one third (32.1%) of the total ERDF financial contribution. The figure below shows that the large majority (almost 95%) of ERDF funds, and implicitly the Romanian state budget providing 15% of the co-financing contribution, has been invested in RTD infrastructure development, including the creation of new infrastructure, and only 5% has been directed in measures referring to RTD activities.

Figure 12. Share of RTD themes in ERDF funding for RTD in Romanian OP Increase of Economic Competitiveness (2007RO161PO002), % of total ERDF contribution to RTD themes



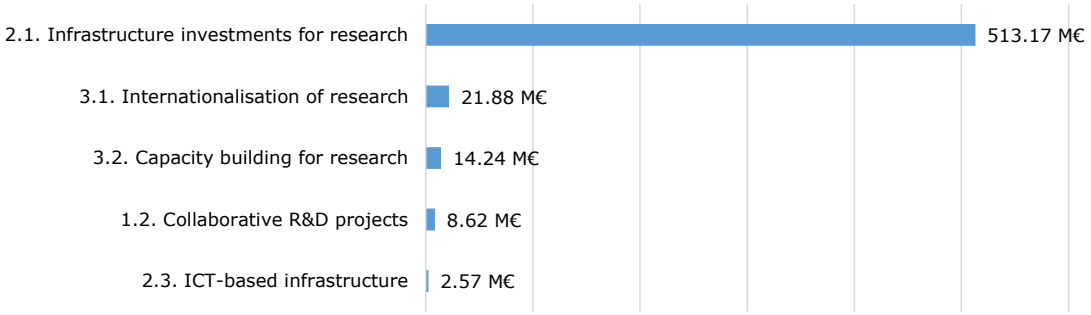
Source: CSIL elaboration based on Task 1 DB Projects and Beneficiaries.

2.3.2. The ERDF RTD support policy mix: key instruments and rationale for selection

The overview of ERDF funding by policy instruments in Romania illustrated in Figure 13 demonstrates the points below.

- There was a **primary focus on investments for research infrastructure development**. This type of investment was generally supported in all regions regardless of whether they were a more developed region (București Capital City and surrounding Ilfov county) or the seven less developed regions. The overall strong focus on infrastructure investments stemmed from the chronic and profound shortage in adequate RTD infrastructure, facilities and material equipment (technologically outdated), which had been inherited from the previous economic regime;
- There was a **secondary focus on the internationalisation of the research** conducted by RTOs, HEI research centres, large enterprises, and emerging SMEs. The principal aim was to attract from abroad well-known researchers in their area of specialisation, willing to join project research teams' activities. This type of investment's subsidiary objective was to stimulate further institutional collaborations and networking after the funded projects were completed. The end objective was to re-connect the Romanian research community to European and international ones;
- A third focus which is very much linked with the primary one, was the **administrative, institutional capacity building** aimed at operating and maintaining RTD newly built infrastructure in a sustainable manner (technically, financially, and institutionally) after the projects were completed and finance was over;
- Despite the **smaller amount of funds directed to collaborative R&D projects,** this instrument aimed to strengthen cooperation partnerships between private sector companies, including SMEs, RTOs and universities' research units.

Figure 13. Overview of ERDF funding/expenditures by policy instruments in Romania in the OP Increase of Economic Competitiveness (2007RO161PO002)[6]

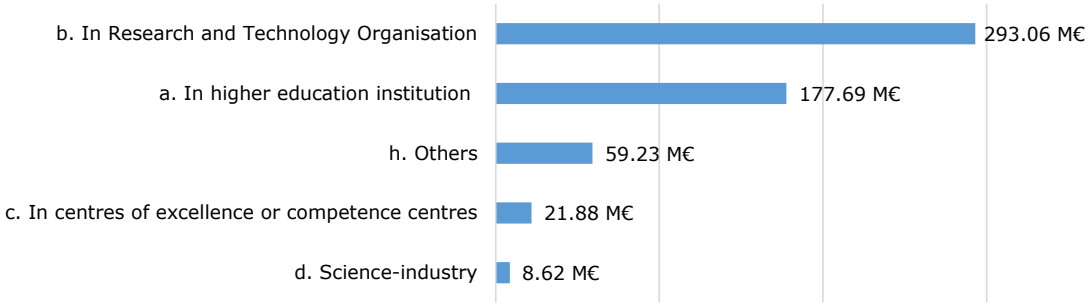


Source: CSIL elaboration based on Task 1 DB Projects and Beneficiaries.

The eligible applicants for the infrastructure investments for research measure were public RTOs and HEIs without any preference or focus. All target applicants were required to meet the administrative and eligibility criteria cumulatively. Considering the demand-driven feature of the operation, the market has proven that RTOs were better prepared and had a greater need than HEIs to apply and submit qualitative and competitive proposals.

The overview of ERDF funding breakdown by the target beneficiary in Romania (shown in Figure 14) highlights that the investments mainly targeted Research and Technology Organizations (RTOs), followed by HEIs. The centres of excellence or competence centres mentioned in the chart are those funded under internationalisation measures.[7]

Figure 14. Overview of ERDF funding/expenditures by target beneficiary in Romania in the OP Increase of Economic Competitiveness (2007RO161PO002)



Source: CSIL elaboration based on Task 1 DB Projects and Beneficiaries.

When the ELI-NP major project (whose budget for its first phase implementation accounted for EUR 180 million) is excluded from the projects' sample, the hierarchy looks reversed. The leading financed beneficiaries are HEIs, followed by RTOs, and in the third-place are institutional beneficiaries from the health sector. This picture shows a more general distribution across the categories of financed beneficiaries. These findings are even better substantiated by analysing the absolute figures of the typologies of institutions where ERDF investments are concentrated (see Table 4).

[6] Effective paid amount

[7] The Development of poles of excellence operation under Priority axes 2 (OP 2.2.2) had an initial allocation of EUR 19.9 Million (ERDF and state budget). By Monitoring Committee Decision no 14/24.11.2011 the entire amount was reallocated to ELI project under OP 2.2.1 – Development of R&D Infrastructure. There were no projects financed under OP 2.2.2 – Development of poles of excellence.

Table 4. Typologies of institutions where ERDF contribution is concentrated in the SOP IEC

Type of direct beneficiary	ERDF contribution (EUR)	ERDF contribution as % of the Total ERDF contribution
Research and Technology Organisation	294,599,395.41	52.56%
Higher education institution	186,577,319.16	33.29%
Hospital (including university hospital) or treatment centre	61,312,739.53	10.94%
Enterprise	14,905,464.99	2.66%
Others: Military unit	2,786,234.76	0.50%
Public administration authority	304,861.51	0.05%
Total	**560,486,015.36**	**100%**

Source: CSIL elaboration based on Task 1 DB Projects and Beneficiaries.

Table 5 also shows that the main ERDF beneficiaries were three HEIs with a long tradition and well-known reputation (Polytechnic University of Bucharest; Gheorghe Asachi Technical University of Iași; Victor Babeș University of Medicine and Pharmacy Timișoara), three RTOs, and three institutes belonging to the Academy of Medical Sciences (AMS).

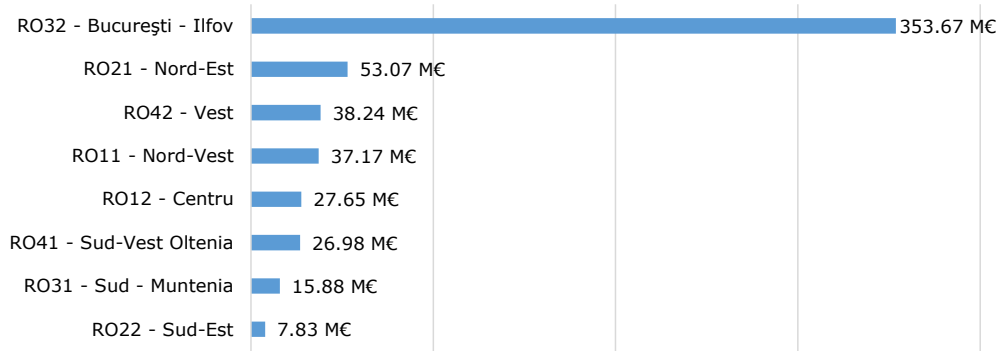
Table 5. Top 9 institutions where ERDF contribution is concentrated in the SOP IEC

Institution	Type of direct beneficiary	ERDF contribution (EUR)	ERDF contribution as % of the Total ERDF contribution in the country
Polytechnic University of Bucharest	HEI	37,244,190.19	6.64%
National Institute for Research and Development Isotopes - I.C.S.I. Rm.Vâlcea	RTO	14,519,246.67	2.59%
National Institute of Information and Documentation	RTO	10,912,160.54	1.95%
Academy of Medical Sciences (AMS)	Excellence research- oriented	10,249,259.04	1.83%
Institute for Mother and Child	RTO belonging to the AMS	9,930,363.86	1.77%
Institute of Cellular Biology and Pathology 'N. Simionescu '	RTO belonging to the AMS	9,258,480.59	1.65%
National Research Institute of Materials Physics	RTO	8,897,856.55	1.59%
Technical University Gheorghe Asachi	HEI	8,797,262.05	1.57%
Victor Babeș University of Medicine and Pharmacy Timisoara	HEI	8,726,260.73	1.56%
Total contribution to top 10 institutions (The major project ELI-NP is not included)		**118,535,080.22**	**21.2%**
Total contribution to the OP		**560,486,015.36**	

Source: CSIL elaboration based on Task 1 DB Projects and Beneficiaries

From another perspective, Figure 15 highlights that all developmental regions had access to RTD infrastructure investments, but their capacity to attract RTD investments was very much differentiated. Therefore, it can be noted that the ERDF investments were concentrated mainly in the capital city (Bucharest) and Ilfov county.

Figure 15. Regional concentration of RTD investments in Romania in the SOP Increase of Economic Competitiveness (2007RO161PO002)



Source: CSIL elaboration based on Task 1 DB Projects and Beneficiaries.
Note: data are retrieved from the location of the beneficiaries receiving ERDF financing.

This finding is not surprising in light of the specificities of the Romanian RTD system. As shown in Section 2.1.1, most RTD infrastructures were located in the most developed region București-Ilfov, where there was a prevalence and readiness of eligible applicants to apply for funding. Most of the RTD institutions located in this region were also able to access either technical assistance from the national funded TA programme (e.g. IMPACT Programme) or gain finance from other donors in the pre-accession period (2004-2007) aimed at acquiring better organisational capacity. Overall, they were better prepared and had more developed managerial skills to submit project proposals. Consequently, funded beneficiaries located in this region succeeded in attracting the most important RTD investments volume, followed, at a significant distance, by the Nord-Est region. This finding might be explained by the fact that in this region, there is the second-largest academic environment in Romania (Iași university centre, with a long history and proven tradition, including in engineering and medical sciences higher education institutes).

The Vest and Nord-Vest developmental regions, with strong industries and higher education communities, succeeded in attracting quite a similar RTD investment volume, placing them in the third and fourth positions in the top ten recipient regions. However, with an economy strongly focused on naval, maritime, agricultural, and touristic sectors, the Sud-Est developmental region lacked regional research entities and premises and a strong technical/scientific university environment. This is why it attracted the lowest level of investment.

The regional concentration of RTD investments in Romania illustrates that there were differences in terms of RTD performance across developmental regions. Although the regional differences were known, the philosophy underlying the financial instrument's design did not provide a mechanism for pre-allocating ERDF resources to developmental regions. According to programme managers, a pre-allocation mechanism would have meant fragmentation of funding, considering that the ERDF resources allocated to PA2 were quite limited (initial allocation accounted for EUR 560 million). Moreover, the promotion of a pre-allocation mechanism for developmental regions should have been done on the basis of a set of objective criteria. The statistics at the time of the programming preparation did not provide accurate data with disaggregation by developmental regions. The contribution of the regions to the country's GDP was not known either.

Overall, the decision to exclude a pre-allocation mechanism might be linked to a strategic approach strongly focused on promoting excellence rather than pursuing an objective of territorial cohesion within the country. This is a completely different approach compared to other countries characterised by strong regional disparities in RTD performance, such as Italy.

SOP IEC 2007-2013 did not even promote the principle of positive discrimination in favour of regions with an RTD performance gap, either through the targeting mechanism

of the potential eligible applicants or through regionally-originated project proposals providing incentives in terms of a bonus awarded within the evaluation and selection procedures. Instead, it was expected that the regions could be supported in reducing RTD performance gaps through broad, equal and transparent access to ERDF resources.

3. CONTRIBUTION ANALYSIS OF SELECTED POLICY INSTRUMENTS / MAJOR PROJECT

As mentioned in the introduction of this report, three policy instruments funded by the SOP IEC have been selected for a deep dive analysis. The selected policy instruments are:

- Collaborative science-industry R&D projects under Measure 2.1.1 'Joint R&D projects between universities/research institutes and enterprises';
- Internationalisation of research implemented under Measure 2.1.2 'Complex research projects fostering the participation of high-level international experts';
- Infrastructure investments for research under Measure 2.2.1 'Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'.

The analysis of these policy instruments was conducted based on a CA approach, which has been developed based on a ToC defined for each policy instrument. The aim of this chapter is thus threefold:

- To present the OP under which the three policy instruments were funded;
- To present an overview of the policy instrument ToC developed for this evaluation then used as the basis to carry out the CA presented in this section;
- To describe the observed effects of the policy instrument based on the expected results identified in the ToC, and based on the data collected by the evaluation team (primary and secondary), and to provide an assessment of the observed effects as direct results of the ERDF funding and support for the policy instruments, as well as an analysis of the extent to which the overall ToC materialised as initially expected.

Section 3.1 below presents an overview of the national SOP IEC under which the policy instruments have been implemented. This overview outlines the rationale of the OP and the policy instrument and its links to other measures and ambitions established by the programme.

The subsequent sections (3.2-3.4) present the comprehensive analysis of each of the selected policy instruments for Romania. Each section includes the subsections outlined below.

- The first subsection presents the Theory of Change of the policy instrument. The case study team developed theories of Change to conduct the contribution analysis. Theories of Change are an ex-post reconstruction of the intended goals and purpose of the policy instrument and the causal package intended to generate such goals. However, it is worth noting that the ToCs presented in each chapter present a snapshot of policymakers' intentions at a given point in time. ToCs generally adapt to the realities of specific territories and the acting agents. As such, the ToCs presented here often underwent gradual changes, which the case study team tried to reflect both in the design of the ToCs and the final depiction of the ToC testing.
- The second subsection presents the results of the contribution analysis conducted based on the ToC for each instrument. This section explains what happened when the policy instrument was implemented and why and how this happened. The contribution analysis was carried out by assessing the extent to which the different components identified in the ToC took place and how they influenced the instrument's effectiveness. As such, the contribution analysis assessed each of the elements given below.
    - The extent to which expected result thresholds were achieved: this involved identifying specific ambitions for each type of result (e.g. outputs, immediate outcomes, intermediate outcomes, final outcomes and impacts) and assessing whether these thresholds were reached based on the

available data. This section also presents any identified intended or unintended results.

  - The extent to which activities were implemented according to the intended plans, rules and procedures.
  - The extent to which identified pre-conditions took place: this involved assessing whether the necessary pre-conditions existed in reality, as well as the extent to which their existence or absence played a role in achieving intended results.
  - The extent to which supporting factors took place and their role in achieving the instrument's intended goals.
  - The extent to which identified risks materialised and whether they effectively managed or mitigated, or limited the instrument's effectiveness.

- The combination of the results obtained for each of the previously described assessments led to establishing a contribution claim for the different results observed and verified by the case study team. On this basis, in the third subsection, it was possible to establish one of the following contribution claims for each type of intended result.
  - The intended threshold was achieved, and the policy instrument was likely to be the main contributor to this result.
  - The intended threshold was achieved, and the policy instrument was only one factor contributing to this result.
  - The intended threshold was not achieved or only partially achieved for one of the reasons given below.
    - The activities were not implemented as originally foreseen, or there were flaws in the activities' design.
    - The necessary pre-conditions did not take place.
    - The necessary supporting factors did not take place.
    - Some risks materialized, effectively hampering the effectiveness of the instrument.

  The third sub-section is thus structured around each of these elements and the results of their assessment. A final conclusion is provided on each policy instrument that presents the overall contribution analysis results and the underlying explanation of this result.

3.1. Overview of the Operational Programme Improvement of Economic Competitiveness

3.1.1. The strategic objectives of the OP

The general objective of SOP IEC is to increase Romanian companies' productivity, comply with the principle of sustainable development, and reduce disparities compared to the average productivity of the EU. The target was to achieve an average annual growth of GDP per employed person by about 5.5%. It was assumed this target would allow Romania to reach approximately 55% of the EU average productivity by 2015. An increase in the value of total R&D expenditure (GERD) to 2% of GDP in 2015 was also planned.

The SOP IEC was organised along with the following priority axes (PA):

- PA1: An innovative and eco-efficient productive system;
- PA2: Research, Technological Development and Innovation for competitiveness;
- PA3: ICT for private and public sectors;

- PA4: Increasing energy efficiency and security of supply, in the context of combating climate change;
- PA5: Technical Assistance (designed as a horizontal axis whose aim was to assist in implementing and monitoring the programme).

The Key Areas of Intervention (KAI) of the PA2 and their corresponding operations are instead presented in the box below.

Box 1. Priority Axis 2 – The Key Areas of Intervention and Operations

2.1 KAI: R&D partnerships between universities/research institutes and enterprises for generating results directly applicable in the economy;

Operation 2.1.1. Joint R&D projects between universities/research institutes and enterprises;

Operation 2.1.2. Complex research projects fostering the participation of high-level international experts.

2.2. KAI: Investments in RDI infrastructure and related administrative capacity;

Operation 2.2.1. Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres);

Operation 2.2.2. Development of poles of excellence;

Operation 2.2.3. Development of networks of R&D centres, nationally coordinated and linked with European and international networks (GRID, GEANT);

Operation 2.2.4. Strengthening administrative capacity.

2.3. KAI: RDI support for enterprises.

Operation 2.3.1. Support for high-tech start-ups and spin-offs;

Operation 2.3.2. Development of R&D infrastructure in enterprises and the creation of new R&D jobs;

Operation 2.3.3. Promoting innovation in enterprises.

Source: Authors based on OP documentation

As shown in the policy context analysis at the national level, the R&D infrastructure in Romania was obsolete and provided poor RTD performance compared to similar EU infrastructures. Therefore, one of the main concerns was the need for the improvement of R&D infrastructure to reduce the large gap between the Romanian R&D entities and similar ones in the EU. The participation of Romania in European research networks and the construction of pan-European infrastructure was another objective.

The national budget and resources of the HEIs and RTOs were limited and insufficient to provide financing for these sizeable infrastructure investments. In response to this challenge, the PA2 - Research, Technological Development and Innovation for Competitiveness – was designed with the specific goal of increasing R&D capacity, stimulating cooperation between RDI institutions and enterprises, and increasing enterprise access to RDI. It was also estimated that achieving this goal would contribute to an increased value of total R&D expenditure (GERD) up to 2% of GDP in 2015.

In terms of sector approach, the thematic priorities of the PA2 were aligned with those mentioned in the NSRDI 2007-2013 (ICT, energy, environment, health, agriculture and food, biotechnologies, innovative materials, processes and goods, space and security, and socio-economic and humanistic research).

3.1.2. The main results achieved by the OP

The list of Priority Axis 2 indicators, their targets and final results achieved are summarized in Table 6.

Table 6. The indicators related to RTD interventions funded by ERDF through SOP Increase of Economic Competitiveness (2007RO161PO002)

Indicators	Target	Result	Level of achievement
Achievement indicators			
Projects carried out in partnership by R&D institutions and enterprises	200	41	⚠
Supported R&D projects (number)	600	558	⚠
Financially assisted SMEs in projects	225	289	✓
Large enterprises financially assisted in projects	25	41	✓
Start-ups and spin-offs	30	116	✓
Public expenditures in assisted RDI projects (million lei)	2,136.28	4,091.73	✓
Result indicators			
Newly created jobs (number)	500	1945	✓
Private expenditures in assisted RDI projects (million lei)	567.45	1,035.03	✓
Patent applications resulting from assisted projects (number)	50	285	✓
Developed innovative structures - poles of excellence	50	0	⚠
R&D centres connected to GRID structures	10	11	✓
Newly created research laboratories	100	893	✓
Modernized research laboratories	100	367	✓
Supplementary indicators			
Number of specialists from abroad employed	30	71	✓
Number of articles in scientific publications	250	1,000	✓
Number of CDI results transferred	0	110	✓
Institutions supported to increase administrative capacity (number)	21	81	✓

***Legend**:* ✓ Achieved ⚠ Not achieved

Source: Authors data processing based on SOP IEC FIR (August 2018).

Under the challenging long-term financial constraints illustrated in Sub-section 2.1.1, ERDF funding was perceived to function as a trigger for the Romanian RDI system's performance increase.

Five years after SOP IEC was financially and administratively closed, there is no doubt that ERDF did not improve the target regions' innovation performance but has contributed to the maintenance of research capacities and researching personnel capabilities. The fact that the regions remained within the same category of regions in terms of innovative performance (Innovation Barometer 2007-2017) supports this finding. Moreover, for one of the developmental regions (with a higher industrial potential, the Vest Region), there is progress on the RTD performance score, according to the same documentation sources.

On the other hand, the expected over-ambitious final outcome of the PA2 - the increase in the value of total R&D expenditure (GERD) to 2% of GDP in 2015 - was not achieved. This increase would have been meant a giant leap possible only in the context of the fast-growing economic development which had been recorded before the outbreak of the financial crisis in 2008. Approximately 15 years after the SOP IEC was designed, it can be pointed out that this target was overestimated because risk factors were not properly considered. However, it should be mentioned that statistical data published by the National Institute of Social and Economic Statistics (Institutul Național de Statistică din Romania - INSSE) indicate that, in terms of absolute figures between 2007 and 2017, the expenses with R&D activity increased from RON 2.177 million to RON 4.317 million. The share of R&D expenditure over GDP has registered a slight decrease from 0.54% in 2007 to 0.50% in 2017.

There is no clear evidence in terms of data regarding the increase of the whole RDI system's research performance and the breakdown of the performance increase by its enhancing factors. Nevertheless, all stakeholders interviewed admitted that ERDF funding and SOP IEC financial instruments played a pivotal role in this context, being 'a gold mine' in transforming the RDI system. The leverage obtained through financing from the national programme, supported by the public budget, also contributed to some extent to maintain a constant/stagnant state and moderate performance improvements.

The ERDF support pioneered the first generation of OPs and demonstrated that development and competitive participation in the RTD sector could attract financial resources on merit and not through policies and policy instruments to direct funds to the regions.

3.2. Policy Instrument: Infrastructure investments for research

3.2.1. Theory of change of the policy instrument

Similar to other new Member States, upon accession to the EU on 1 January 2007, the research infrastructure gap between Romania and the old Member States was identified as one of the major factors affecting the optimal use of the country's existing research infrastructure, consisting of a significant number of R&D entities. According to the 2007-2013 National Development Plan (NDP), in 2003, there were 719 institutions and entities conducting research and development activities, including universities. Out of these, 120 were public institutions subordinated to the Ministry of Education and Research and other line ministries, 37 were entities under the coordination of the Romanian Academy and the Academy of Agricultural and Forestry Sciences, 86 belonged to Higher Education Institutes (HEIs), 25 were set up as non-profit private organisations, and only 212 were private enterprises whose domain of activity included research and development. The public sector carried out sixty per cent of the research and development activities.

In this context, ERDF investments in Research Infrastructures (RIs) aim to upgrade and replace the obsolete and outdated ones. According to programme managers, such an intervention would have had a direct impact on economic competitiveness and social cohesion by boosting scientific knowledge and accelerating technology development. To this end, non-reimbursable grants were mobilised to fund the procurement of new modern research equipment with a significant financial value for the modernisation of the existing public HEI and RTO infrastructure and the creation of new infrastructures (laboratories, research centres).

Support was also directed to the Extreme Light Infrastructure – Nuclear Physics (ELI-NP) major project included in 2012[8]. The project started as an initiative of the European scientific community and was designed as part of a three-pillar project: ELI Romania, ELI Czech and ELI Hungary. The inclusion of this major project increased the total allocation for this PI from EUR 202.1 million (ERDF contribution) to EUR 348.4 million.

Box 2. ELI-NP Project at a glance

The ELI-NP Romania project's history started in 2006 when it was included in the European Strategic Research Forum Roadmap of the European Strategy Forum for Research Infrastructures (ESFRI). This project marked a historic shift, considering that for the first time, three out of four lasers would have been built in Eastern Europe, specifically in the Czech Republic, Hungary and Romania (in Măgurele).

After the three-year preparatory phase (2008-2010), the negotiations with the European Commission started. Funding should come from the ERDF in the context of Priority Axis 2 of the SOP IEC. The final decision to finance the project was officially taken in December 2011. The construction in Romania of the most powerful laser in the world would have benefitted from EUR 180 million under the SOP IEC, for total funding (including co-financing) of about EUR 300 million.

The ELI-NP project was designed in two phases. The first phase (Phase I) should finance the facility's construction, the big power laser part, and partially, the gamma beam part. The project and the financial

[8]Approved by EC Decision C (2012) 6270 of 18 September 2012.

contribution for phase one were approved by Decision C (2012) 6270 final of 18.09.2012. The total amount allocated for the first phase of the project was EUR 179,988,881 (EUR 149.39 million from the ERDF plus EUR 30.60 million state budget). The second phase (Phase II) should finance further developments of the facility with the additional EUR 113 million from the ERDF during the 2014-2020 programming period.

The main objective of the ELI-NP project was to create a new European laboratory with a wide range of scientific fields, covering basic frontier physics, nuclear physics, and astrophysics, as well as applications in the field of nuclear materials, radioactive waste management, materials science, and life sciences.

The project is a complex research infrastructure, which involved 40 academic and research institutions from 13 European countries. By implementing the project, the Institute of Nuclear Physics on the Măgurele platform is going to host in its laboratories a wide range of scientific disciplines and researchers from around the world, who can study from new ways of treating nuclear materials and radioactive waste to new applications in the medical field.

Source: Authors based on the conducted interviews.

It was also recognized that the upgraded and modernised RIs would not have been enough to address the major need for a paradigm change to better link the research sector to the real emerging economy. Limited investment in soft type activities (approx. EUR 75 thousand maximum ceilings per project) was eligible as part of the financing. The aim was to facilitate access to consulting services for project management and promotion, access to databases and publications, and support project staff remuneration during the completion of the projects' activities.

Overall, the improved research infrastructure was expected to provide an adequate framework for the fundamental/experimental research activities and the educational process and the creation and/or maintenance of jobs in R&D activity. Based on these, and with the support provided by the increasing public and private spending for R&D activities, the financed beneficiaries were supposed to increase both their administrative and technological capacity to deliver high-level R&D services to enterprises and their offer of knowledge (publications, patents, technology transfer).

As a result of increased collaboration with enterprise and increased scientific production, public R&D organisations would ensure their sustainability and capacity to use and provide specialised scientific and technological services in high technology fields. This would contribute to increasing the economic competitiveness and productivity of the Romanian economy.

In order to achieve the intended objectives, support was provided based on several pre-conditions. It was expected that financed beneficiaries had the capacity to manage the project from a technical, organisational and institutional perspective. In this respect, the in-place institutional system responsible for programme management also had to have the capacity to ensure timely and efficient implementation. The increase in the capacity of HEIs and RTOs to deliver high-level R&D service to enterprises also depended on macro-economic stability. Moreover, their research capacity's sustainability was linked to an increased demand for R&D in fundamental and applied areas.

In the case of the major project ELI-NP, scientists and qualified personnel's availability was the pre-condition for the international collaborative projects' expected development. Effective coordination between the infrastructure building projects at the European level was also necessary to fully integrate the ELI-NP in the ELI distributed facility at the European level (foreseen for Phase II of the project). It was expected that once integrated into the jointly operated ELI-European Research Infrastructure Consortium (ELI-ERIC), ELI-NP would trigger a multiplier effect considering its linkages with knowledge-intensive sectors (based on the supply of goods and services to the research facility and associated activities). Therefore, it would have created an opportunity to develop an international pole of excellence related to science and technology.

The intervention was designed without a project pipeline. The whole financing programme and its interventions were scheduled to be driven by the demand arisen from the target eligible applicants and properly substantiated within their Financial Request submitted for evaluation and selection on competitive bases. However, the independent evaluations of projects gave priority to those infrastructures fulfilling a number of criteria, such as number and quality of researchers, publications, capacity to integrate national

and international R&D networks and previous participation in the FP7. Moreover, in the case of universities, priority was given to centres achieving excellence in research.

In order to ensure timely implementation of the calls, the MA prepared and published the Applicants' Guidelines (AGs)[9] along with the list of eligible expenses approved by the Ministry of Economy and Finance[10].

In brief, the infrastructure investments for research mobilised by the OP were characterised by:

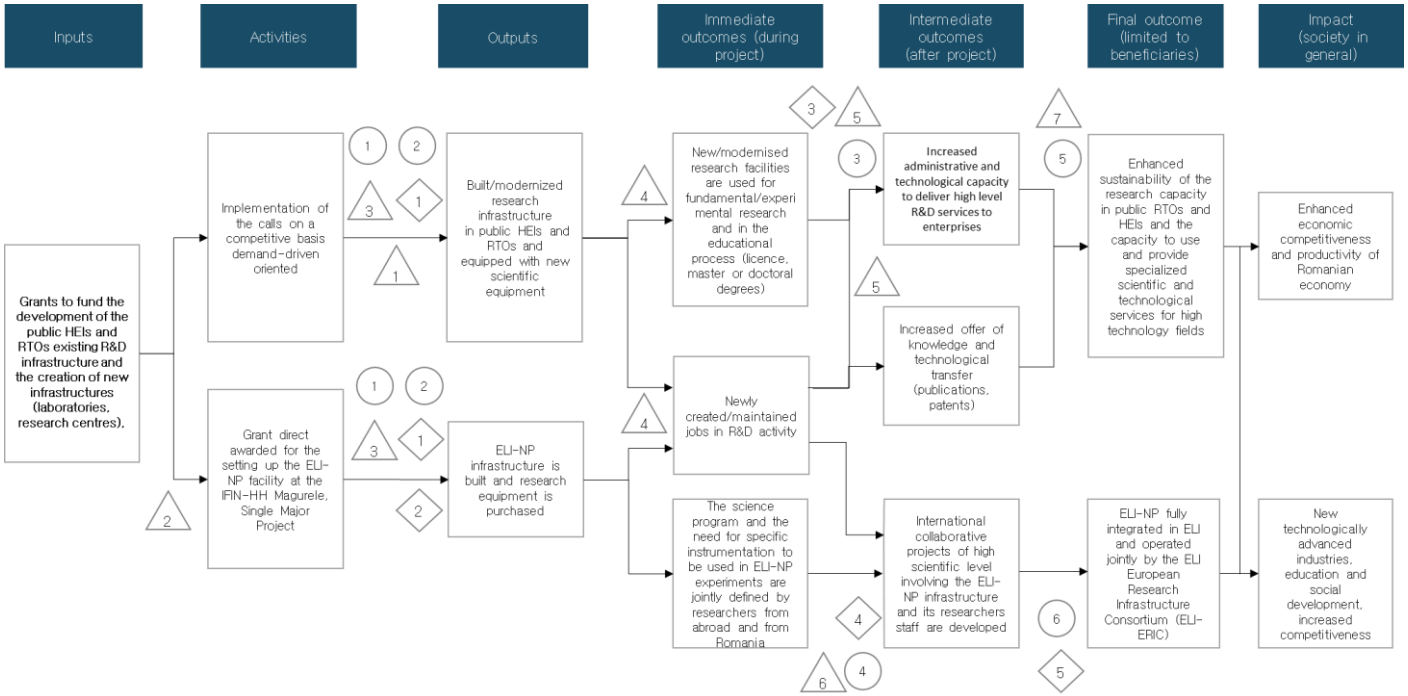
1. An orientation towards high-level scientific research (excellence in research) rather than towards regional needs;
2. a demand-driven approach based on the identification of the needs to be addressed within project proposals, based on a grassroots initiative of the eligible applicants;
3. Competitive selection of finance approvals, except for the major project;
4. Full compliance with the horizontal principles.

Under this policy measure, the first call offered non-reimbursable financing ranging between EUR 489.7 thousand and EUR 14.7 million per project. With the second call, the minimum threshold was doubled. A maximum ceiling of the grant for the administrative capacity-building component was also established.

The following figure presents the ToC of the infrastructure investments. It is meant to illustrate the Infrastructure investment's intended results for research policy instrument and linkages between them.

[9] Decision of NASR President no. 9439/10.12.2007.
[10]Order of the Minister of Economy and Finance no. 3388/17.11.2008.

Figure 16. ToC for Infrastructure investments for research



Pre-conditions

1. The financed beneficiaries have the capacity to manage the project from a technical, organizational and institutional perspective
2. The in-place institutional system responsible for the programme management has the capacity to ensure a timely and efficient implementation
3. Macro-economic stability, especially the annual average inflation rate is controlled and aimed at leading to a relative stability of the market unit costs of the goods, works and services
4. Availability of scientists and qualified personnel, including further cohorts of graduates and doctoral students, postdoctoral fellows, trainees, and young scientists
5. There is an increased demand for R&D in both areas - basic and applied
6. Effective coordination between the infrastructure building projects at EUROPEAN level

Supporting factors

1. Availability of the national funded programmes providing consultancy for HEIs/RTOs to develop eligible project proposals
2. EC strategy on the development of the "ELI" landmark project foresee Romania as the host of the third pillar, ELI-NP
3. The availability of technical assistance aimed at supporting major stakeholders (implementing entities and target applicants)
4. Access available for RTOs and HEIs to other (i.e. SOP HRD and national funded programmes) support measures
5. Increasing public and private spending for R&D activities
6. Romanian Government support for strengthening the integration of the infrastructure into both the local and European socio-economic environment
7. Public support for collaborative R&D is sustained over time

Risks or threats

1. Difficulties manifested during the public procurement process of works, equipment and services lead to delays in project implementation
2. Increased shortage of qualified research personnel due to poor incentives under which researchers operate
3. The lack of the contractors for highly specialised works lead to delays in public procurement or jeopardize projects implementation
4. Delays in commissioning due to equipment failures
5. Emerged competition on the national and international research markets

3.2.2. Contribution analysis of the policy instrument

Verification of intended intervention implementation

The interviews and data analysis did not reveal the existence of major deviations concerning the implementation of foreseen activities of this policy instrument. However, many challenges occurred at the level of the whole OP and its management system[11].

These managerial difficulties led to a late kick-off of the operation's implementation. Thus, the first call was issued in December 2007 after almost one year from the SOP IEC start and a submission deadline foreseen in March 2008. The second call opened in June 2009, and the deadline for the submission of proposals was set out in October 2009. Then, the third opened in July 2013 with a deadline for proposal submission in August 2013. The last eight projects from the third call's reserve list were approved in 2015, the last possible year for implementation considering the n+2/n+3 rule.

Another issue during project implementation was a large number of appeals against public procurement procedures. This situation further delayed implementation, considering the long time needed for issuing the National Council for Appeals Resolution (CNSC) decision and the Court of Appeal final decision.

It is worth mentioning that the sets of criteria and sub-criteria for evaluating proposals have also registered subsequent refinements. The formulation and re-classification of sub-criteria were improved in the third call based on the lessons learnt either from the previous evaluations and/or from interaction with the target eligible applicants during the established time interval for clarifications. Overall, a comparison of the sets of criteria and sub-criteria established by the three different calls shows a progressive emphasis on the relevance, quality, and maturity of the proposal and the applicant's sustainability and operating capacity.

These improvements with a special focus on quality and sustainability reflected the concerns of the programme management system to ensure speedy and quality implementation. Activities were finally implemented within the planned period, and despite the difficulties, SOP IEC did not suffer from any reprogramming during the implementation period. The implementation of these activities led to the competitive funding of 110 projects for a total of EUR 330.6 million.

Achievement of intended and unintended effects at the level of the expected threshold

In terms of the intended achievements, the evaluation highlights the findings given below.

- There is no evidence available regarding the achievements of each organised call. Overall, 311 applications were submitted, out of which 111 projects were contracted (including the major project ELI-NP), accounting for 90% of the total ERDF contribution under the PA2. The fact that each eligible applicant was entitled to submit only one application, corroborated with the call success rate (3/1), indicates that competition was open and accessible to ensure a portfolio of quality projects and avoid frustration level of non-winning candidates. Since there is no data concerning each call, it is unknown how many non-winning applicants in the first call continued to compete in the following ones.
- All financed projects and the corresponding awarded contracts were physically completed in the light of project output and their immediate outcome indicators and financially closed.

[11]Ministry of European Funds - Managing Authority for SOP IEC (2018): Revised Final Implementation Report, Section 2.3

Although the definition of achievement indicators had various deficiencies from the scientific point of view, it can be assessed that in terms of output (number of supported projects), this policy instrument contributed with 18.5% to achieving the target of the priority axis. The total budget of the implemented projects under this measure reached EUR 1 billion. This figure is almost double compared to the target of EUR 523.08 million of public expenditure in assisted RDI projects, as a result of leveraging with co-financing by public financed entities for covering non-eligible expenditures linked with infrastructure projects or other financial commitments.

Regarding immediate and intermediate outcomes, indicators were available only at the priority axis level. Nevertheless, considering that a significant portion of the Priority Axis budget for research projects was devoted to the OP measure funding under evaluation, a substantial part of the outcome is probably due to the measure itself and can be considered a starting point for an assessment on achievements. Overall, these indicators show that the planned targets for immediate outcomes were significantly exceeded:

- The planned number of newly created research laboratories was 100, and the achieved value was 893;
- The target of modernised research laboratories was 100, and the achieved value was 367;
- The planned target for newly created jobs was 500, and the achieved value was 1,945.

Moreover, interviews confirmed that infrastructure projects led to some gains in terms of administrative and technological capacity to deliver high-level R&D services to enterprises. First, funded infrastructure further opened the way for applied and industrial research and improved, in some cases, their capacity to respond to enterprises demands. Second, ERDF investments also allowed some improvements in managing projects of such complexity, not only regarding the elaboration of application but also in conducting public procurement processes and monitoring and reporting project progress.

Consulted stakeholders also pointed out the existence of an unintended effect. This related to the comprehensive learning process in terms of acquired knowledge and programme/project management skills by all parties involved in the implementation processes.

On the final outcomes, the appraisal of the achievements of intended effects relied only on the qualitative indications gathered as a result of the conducted interviews. Interviewees provided some evidence concerning the improvement of the RTO and HEIs research sustainability and their capacity to deliver specialised services for industry. Both RTDs and HEIs mentioned, for instance, the increase in the level of their scientific and educational activities and the enhanced cooperation with other national and international research organisations. Furthermore, in most cases, funded research infrastructures were able to create a framework for the diversification of their portfolio of R&D services for high-technology-oriented enterprises, thus leading to additional revenues and economic value. However, in the absence of quantitative data confirming its full materialisation, it is not possible to provide an assessment of its materialisation.

The interviews carried out also provided some qualitative evidence with regard to the longer-lasting effects and 'soft type' impact. Thus, in most cases, the effects and further impact at the micro-level (implementing organisations, their professional and/or local community) were perceived as even stronger and more visible than the impact achieved at the macro-level (the economy or society as a whole).

In order to substantiate the above conclusions, the box below briefly presents the grassroots achievements at the level of a part of the implementing organisations of the ERDF funded projects included in the sample selected for in-depth interviews. The integral list and full details are presented in ANNEX II and ANNEX VI.

Box 3. Examples of achievements at the level of selected projects

The infrastructure development project '**Expansion and modernisation of research infrastructure in order to increase competitiveness in the field of cardiovascular disease, diabetes and obesity'**[12] implemented by the Nicolae Simionescu Institute of Cellular Biology and Pathology - a flagship medical research organisation - revealed up to date sustained effects based on project achievements consisting of:

- setting up new special research units;
- intensified unforeseen collaboration with other medical institutions;
- gained experience in working with outsourced consulting suppliers during project implementation with the impact on strengthening project management capacity;
- higher employment attractiveness for the fresh graduates and PhD graduates.

This last effect is so great that the institute cannot respond to demand. Whilst the attractiveness and interest have visibly increased among young researchers, the long-term retention of researching staff is facing difficulties due to the legal constraints regarding public wage policy and lack of other HRD incentives. Therefore, only further EU supported financing opportunities would provide the comparative advantage to the publicly-owned research entities to retain the promising researchers within their team and to avoid their re-orientation to under-qualified employment opportunities (such as much better-paid jobs in sales at pharmaceutical trading companies or other private corporations). In the last two decades, this phenomenon has acquired the dimension of an internal 'brain drain'. This is a loss for the research sector and for society as a whole.

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The project '**Development of ICSI's CD infrastructure by creating a low-temperature laboratory for energy applications of cryogenic fluids – CRYO-HY'**[13]**,** implemented by the National Research and Development Institute For Cryogenic and Isotopic Technologies (ICSI), located in Rm. Vâlcea, almost 200 km from the capital city, contributed to the achievement of a significant local impact, with increased research capacity aimed at ensuring the transition to the next level at a different scale and dimension and increased visibility and reputation within the international research community. In addition, this medium-sized formal industrial town gained a higher employment attractiveness for promising young researchers, despite a lack of cultural venues *(theatres, cinemas, philharmonic etc.*), educational options (*e.g. HEIs*), health infrastructure (*clinical hospitals belonging to universities, private medical clinics*), housing infrastructure, or employment opportunities for other members of their families.

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In the case of the project '**Centre for Advanced Research on New Materials, Products and Innovative Processes – CAMPUS'**[14]**,** implemented by The Polytechnic University of Bucharest (UPB), the major output was successfully achieved. The construction of CAMPUS was the foundation for further achievements, including the UPB's advanced research & development centres for multi - and inter-disciplinary technologies. Apart from research, CAMPUS is also becoming a quality research-oriented educational centre for undergraduate and postgraduate studies and e-learning.

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Another example illustrating the stronger sustainable effect at the micro-and sector levels is the case of the **AngioNET**[15] project, successfully implemented by the Romanian Academy of Medical Sciences. The achievements gained went beyond built infrastructure and purchased high-tech equipment, leading to creating an integrated medical research platform to the building of a pioneering integrated team (such as the HEART-Team) of researchers and medical doctors. These follow-up effects lead to a qualitative leap in medical practice, focusing on cardiology disease prevention and treatment. The achievements also include knowledge transfer from central to regional and local research teams and a gain in terms of national and international recognition of the academic medical applied and experimental research.

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The **CEUREMAVSU** project, **'Euro-Regional Centre for the Study of Advanced Materials, Surfaces and Interfaces'**[16]**,** implemented by the National Institute of Materials Physics – Romania (INCDFM) located on Măgurele research platform, highlighted the following achievements:

- collaboration with new partners from EU member countries;
- a significant increase of scientific results outreach activities, with impact on visibility and recognition;
- a significant research staff increase as a result of attractiveness in terms of better premises and equipment;
- career development opportunities;
- an improved working environment resulted from the induced unintended chain changes in the organisational culture and management style.

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In the case of **'Establishment of the National Research Centre for Food Safety (NRCFS)'**[17] run by the Faculty of Industrial Chemistry at the Polytechnic University of Bucharest (UPB), the major sustainable achievements were:

- increased cooperation with research organisations from Europe;

[12] http://www.icbp.ro/static/en/en-networking_grants-grants-international/cardiopro.html
[13] https://www.icsi.ro/cryohy/
[14] http://campus.pub.ro/
[15] https://angionet.ro/#
[16] http://www.ceuremavsu.infim.ro/
[17] http://www.foodsafety.upb.ro/index.php/en/

▪ increased scientific support for the real economy as a result of the better capacity to provide research services to enterprises;
▪ Improved higher education quality with a future improved qualification of the technical engineering workforce, narrowing the gap between education and labour market demand.
Additional achievements included:
▪ an increased level of scientific production based on research themes proposed by the business environment;
▪ gains in scientific performance recognised at the international level, which built a sound foundation for academic teaching career advancement.

Source: Authors based on the conducted interviews.

Regarding the ELI major project specifically, all the established targets for Phase I of the major project[18] have been achieved, except for a 5-month delay in completing civil constructions. As a result of the Preparatory Phase, the 'ELI White Book' has been compiled, comprising the coordinated efforts of more than 100 scientific authors from 13 countries under the leadership of the ELI initiator and the guidance of an international Steering Committee.

The first experiments at ELI-NP for the study of the interaction of high-power laser pulses with matter started in March 2020, as a result of Phase II of the project, which aimed to finalising the construction works and installation, commissioning and testing of the equipment. However, considering the project has been phased, and Phase II is still ongoing, the achievement of the full integration of the infrastructure in the ELI and the full operation of the European Research Infrastructure Consortium (ELI-ERIC) is only partial.

Verification of assumed pre-conditions

Most of the pre-conditions identified in the ToC took place to a full extent or limited extent.

Some of them (e.g. pre-condition 1 and 2) applied to both impact pathways identified – general infrastructure investments and the ELI major project. In the first case, however, the first pre-condition showed a different evolution. In the implementation of general infrastructure projects, not all beneficiaries had **the capacity to manage the project from a technical, organisational and institutional perspective**. Although the monitoring system indicates that the majority of the beneficiaries implemented the projects within the allocated timeframe[19], interviews highlighted that public institutions succeeded in project implementation by having substantial support from administrative departments (finance and public procurement). In most cases, the institution's financial backstopping ensured proved to be decisive in keeping the project on track when reimbursements were delayed.

Conversely, in the context of the ELI major project, the National Research-Development Institute for Physics and Nuclear Engineering 'Horia Hulubei' (IFIN-HH) already had the most advanced research infrastructure for nuclear physics in Romania. It provided almost 10% of Romania's scientific output. Therefore, this beneficiary had the necessary capacity to implement the project and the scientific expertise to participate in international collaborations and institutions in which Romania is a party (e.g. IUCN Dubna, FAIR Darmstadt, CERN Geneva, IAEA Vienna).

During implementation, the **in-place institutional system responsible for the programme management did not always have the capacity to ensure a timely and efficient implementation** (pre-condition 2). The establishment of the institutional

[18] - Realization of a research infrastructure on an area of 137075 m2;
- Laser-2 arms of 10 PW;
- High intensity gamma beam production system;
- Experiments with technological transfer in nuclear physics, laser physics, materials engineering and the medical field.

[19] 24 months for projects aiming only to acquiring new and high-performance scientific equipment and 36 months for projects which included building constructions/renovations

structure for the management of SOP IEC covered 2007 and 2008, and its conformity was certified by the EC only in January 2009. The staff recruitment process, as well as the delivery of specialised training, had a positive impact on further management of the OP, but it required additional time. Moreover, the staff fluctuation caused by the high workload and by the high degree of responsibility for the activities carried out by the MA/IB staff caused delays in[20]:

- Developing guidelines for applicants and contracting technical assistance;
- Completing the preparation of major projects;
- The implementation of projects with a direct impact on the degree of absorption;
- Verifying reimbursement requests and making payments to beneficiaries.

Therefore, the policy instrument's effectiveness was significantly impacted by the implementing entities' limited evaluation capacity. This finding is documented by the long duration of the evaluation and selection process, as reported by the final implementation report and interviews. This weak evaluation capacity led to very long delays in starting projects. The main shortcomings that generated delays were related to the insufficiency of the staff for project evaluation, the lack of experience of some applicants in drafting projects, as well as the high degree of complexity of the requested documentation.

The management capacity shortage was also visible during the advancement of the next stages of the implementation cycle. Overall, there was a weak processing capacity of the reimbursement claims. The main shortcomings that generated such delays were related to the lack of staff verifying, in the field, physical and financial project implementation, the lack of experience of financed beneficiaries in preparing reimbursement claims, and the high degree of administrative, bureaucratic burdens requested by the operational procedure. In order to speed up payments, in 2013, a second mechanism was introduced, consisting of paying the infrastructure works and equipment providers directly, against justified documentation. These two mechanisms were in place and fully functional until the end of OP implementation. The beneficiaries had to further decide at each step which mechanism to use - the reimbursement mechanism or the payment mechanism. The payment mechanism has shown its advantages in speeding up payments and, most importantly, easing the cash flow availability of grant recipient research organisations. The interview findings show that strong financial HEIs continued to pre-finance the project activities and have continued to use the reimbursement claims, while most RTO beneficiaries have chosen the payment mechanism.

During implementation, **macro-economic stability was ensured. The annual average inflation rate was controlled only since 2011**, thus leading to relative stability of the market unit costs of goods, works and service (pre-condition 3)**.** After a sharp and deep contraction during the financial crisis, the Romanian economy recovered somewhat quickly, showing moderate growth from 2011 onwards, as a result of the improvements of the export-import balance. The GDP annual average growth rate reached 3.6% per year in 2014-2015. The annual unemployment rate between 2007 and 2015 was maintained at around 7%, below the EU27 average. The public deficit, which jumped to nearly 10% of GDP in 2009, was reduced markedly to below 1% of GDP in 2015. This resulted from the EU Treaty regarding stability, coordination, and governance, which had established common prevention rules for fiscal balances and further financial support of three consecutive EU/IMF financial assistance programmes (EC, Task3 Country Report Romania, 2016).

During the recovery period, Romania has also somewhat managed to keep under control of the annual average inflation rate and reverse its ascending trend. According to INSSE data, the inflation rate changed from 4.8% in 2007 to 7.9% in 2008 and stayed at around 6% until 2011. In 2012 it fell to 3.3%, and, after a rise to 4% in 2013, decreased to -1.5% in 2016. The fact that the inflation rate was under control influenced the

[20] MA FIR, 2018

relative stability of the market prices of supplies needed for further provision of research and related services using newly built or upgraded R&D infrastructures.

It is worth noting that the economic instability between 2007 and 2015 had a limited effect on public RTO and HEI beneficiaries because the public contribution for investment in research infrastructure within this policy instrument covered 100% of the eligible costs. Moreover, interviews revealed that competition between public procurement tenderers was higher than foreseen due to the financial crisis and severe cuts in public investments due to the adoption by the Government of austerity measures. Therefore, bidding prices were lower than planned within the procurement ToR. The obtained savings were used for the acquisition of supplementary equipment based on prior approval from the MA.

Once built, the modernised and newly built infrastructures could also rely on the **availability of scientists and qualified personnel, including further cohorts of graduates and doctoral students, postdoctoral fellows, trainees, and young scientists** (pre-condition 4). This held especially in the context of the major project. Despite the scarcity of the specialised workforce in Romania, IFIN-HH, the host institution for ELI-NP, attracted top researchers from within the country and abroad. An ELI-NP project representative mentioned in an interview that interest and competition were high, and they employed about 10% of applicant candidates. The new entrant structure by area of origin shows that one third was from Romania. Another third were Romanian high-level specialists returning from abroad, and the remainder were researchers from other EU countries.

However, the expected enhanced sustainability of the other infrastructures receiving ERDF support suffered from a **limited increase in the demand for R&D in both basic and applied research** (pre-condition 5). While an increase can be detected for public research infrastructures, the same cannot be said for enterprises. Statistical data published by INSSE indicate that between 2007 and 2017, there was a significant shift from fundamental to applied and experimental R&D. This was, to some extent, a structural change, endorsed by the share of expenses. With applied research, the total amount of expenses with R&D activity increased from 45% to 62%; the share of expenses with experimental development increased from 10% to 18.7%; with fundamental research, the share of expenses decreased from 45% to 19.3%. From the point of view of the financing structure of the total research-development expenses by main sources, in 2017, the own financial sources of the enterprises represented a share of 53.2% compared to 26.9% in 2007, while the share of public funds decreased to 34.8%, compared to 67.1% in 2007. These data show a significant reversal.

The ELI major project's integration in the distributed infrastructure, although still partial (see section above), was ensured by **effective coordination between the infrastructure building projects at the EUROPEAN level** (pre-condition 6). This pre-condition was an enhancing factor for ensuring the timely completion of the infrastructure works as scheduled for Phase I.

Coordination between infrastructure building projects at the European level was and still is ensured by the ELI-Delivered Consortium (ELI-DC)[21], founded in 2013 as a non-profit organisation under Belgian law. It aims to promote the sustainable development of ELI as a pan-European research infrastructure, support the coordinated implementation of the ELI research facilities, and preserve the consistency and complementarities of their scientific missions. The evaluation found that the next step in the ELI projects is focused on setting up a coordination mechanism that will be in charge of the future operation of ELI - The European Research Infrastructure Consortium (ELI-ERIC). The currently submitted ELI-ERIC application excludes Romania, but it does not prevent ELI-NP from future participation[22]. There are ongoing discussions regarding the roles and

[21]https://eli-laser.eu/organisation/
[22]https://www.europarl.europa.eu/doceo/document/P-9-2020-004017-ASW_EN.pdf

responsibilities of partner states. Moreover, the full onboarding of all ELI sites is still in process.

Verification of supporting factors

The implementation of the policy instruments was, in some cases, favoured by the materialisation of some supporting factors.

The **availability of the national funded programmes providing consultancy for HEIs/RTOs to develop eligible project** proposals (supporting factor 1) took place. It positively influenced the timely implementation of the calls on a competitive basis. Based on a proactive approach, MERYS promoted a preparatory technical assistance programme before the official launch of the ERDF supported OPs. The IMPACT programme represented an *upfront* investment of the national budget to prepare the forthcoming SOP IEC implementation. It aimed to support potential eligible applicants for the future ERDF funded OPs in the preparation of necessary documentation (e.g. feasibility studies, economic documentation, business plans).

The IMPACT programme was financed from the state budget, based on GD no. 918/2006. The programme was implemented by the NASR, a wing of MERYS, and lasted from 2006 to 2010. It worked in a similar competitive manner to the one foreseen for SOP IEC, launching calls for applications aimed at supporting the procurement of technical assistance to prepare technical documentation required by SOP IEC.

The findings gathered indicate that up to the end of 2009, there were 950 applications, from which 630 projects were selected to be funded by the IMPACT technical assistance programme (Ministry of Education, Research and Innovation, 2009). The interviewed representatives recognised that the IMPACT programme's implementation was a useful exercise for SOP IEC potential beneficiaries and the Intermediate Body, ensuring the necessary conditions for further implementation. The programme facilitated the understanding of procedures and requirements imposed by accessing the ESIF and constituted a mechanism for their promotion among the potential beneficiaries.

Box 4. Highlights of the IMPACT Programme[23]

Programme objectives:
- ensuring the necessary conditions for the implementation of SOP IEC – research-development and innovation component, for which the National Authority for Scientific Research has been designated intermediate body;
- consolidation and extension of partnerships in the process of elaborating project proposals for SOP IEC – research-development and innovation component, in accordance with European Union regulations and Community regional principles and policies.

Programme duration: 2006 – 2010
Source of financing: National Budget
Program management authority: The National Authority for Scientific Research, as designated Intermediate Body for Research within SOP IEC
Eligible applicants:
- units of public law, with legal personality, included in the research-development system of national interest;
- units and institutions of public law with R&D in their object of activity;
- units and institutions under private law with R&D in their object of activity:

Types of financed projects:
- Type A - projects that will finance specialised consultancy activities elaborating feasibility studies or their components, for the preparation of investment project applications for innovation and R&D infrastructures;
- Type B - projects through which specialised consultancy will be provided to realise the necessary documentation for the preparation of applications - business plan, market studies, impact studies, economic analyses, etc.

Grant value: Type A projects – maximum RON 100 thousand; Type B projects – maximum RON 40 thousand.
Results: 950 submitted applications, of which 630 projects financed.

Source: Authors based on the desk review of OP documentation and interviews

[23] Excerpts from the IMPACT Program information package, Annex to Decision nr.9309/02.08.2006 and MERI, 2009.

The **availability of technical assistance** to support implementing entities and target applicants (supporting factor 3) also contributed to increasing the administrative and technological capacity of funded infrastructures to deliver high-level R&D services to enterprises. Amongst eligible expenditures, a fixed amount was also provided (in a single instalment), up to the maximum ceiling of EUR 73.4 thousand, for the development of the administrative capacity. The beneficiary was allowed to use these funds to acquire consultancy services or other services. This supporting factor was aimed at better safeguarding sustainability and the financed beneficiary's capacity to attract additional financing after the infrastructure project was completed. Specifically, for the ELI-NP major project, the technical assistance was provided by the coordinated efforts of more than 100 scientific authors from 13 countries, under the guidance of an International Steering Committee.

The implementation of the major project was possible thanks to the **EC strategy on the development of the ELI landmark project** (supporting factor 2). On 3 December 2009, the EU Competitiveness Council adopted the Declaration of the Czech Republic, Romania, and Hungary on the implementation of the ELI project as an infrastructure distributed in the three countries using structural funds allocated to those countries. The project and the financial contribution for Phase I were approved by Decision C (2012) 6270 final of 18.09.2012.

The materialisation of immediate outcomes was also favoured by **the availability of other support measures**, such as the Sectoral Operational Programme Human Resources Development (SOP HRD) and national funded programmes (supporting factor 4). NDP 2007-2013 defined the national development priorities and the main strategic connections for their implementation. Further, the NSRF and SOP IEC defined institutional mechanisms meant to support interventions' complementarity and ensure a good correlation and coordination of funds. Specifically for this policy instrument, the foreseen synergy was with SOP HRD (funded by ESF). The main complementarity was envisaged with the following key areas of intervention within SOP HRD 2007-2013:

- KAI 1.2 - Quality in higher education, with the aim of improving university management and increasing the capacity of higher education institutions to provide higher qualifications adapted to the changing requirements of the labour market;
- KAI 1.3 - Human resources development in education and vocational training;
- KAI 1.5 - doctoral and post-doctoral programmes in support of research.

In the implementation process, there was no systematic verification of project complementarity, and there is no evidence regarding the level of use of these opportunities by the SOP IEC beneficiaries. However, some of the consulted stakeholders from RTD and HEIs mentioned they implemented projects financed by SOP HRD, mainly within KAI 1.5.

Another supporting factor taking place and positively influencing the policy instrument's effectiveness was the **availability of Romanian Government support** for strengthening the integration of the infrastructure into both the local and European socio-economic environment (supporting factor 6). Commitments made by the Romanian government in 2012 included taking measures to create the conditions for (i) transforming ELI-NP in a knowledge-based economy cluster fostering regional and national competitiveness, (ii) strengthening the integration of the infrastructure into the local socio-economic environment, (iii) ensuring financial support for the operational phase, especially in the context of the severe underfunding of the research system, and (iv) monitoring the compliance of the research infrastructure with the state aid rules (WB Laser Valley, 2018). The National RDI Strategy 2014-2020, approved in 2014 and modified in 2017, reaffirms Romania's leading regional role in the ELI-NP project, support innovation clusters and multi-stakeholder geographical agglomerations around the major infrastructure, and states that integration at global level represents an opportunity for Romania, which may have a central place in international research initiatives.

More limited is the materialisation of the **constant provision of public support to R&D** (supporting factor 7). In 2014, Romania adopted its new sector policy document, the NSRDI 2014-2020. The new strategy was designed mostly based on a top-down approach at the national level. It contained a brief component dedicated to smart specialisation (S3) by identifying four areas with S3 potential. A separate component was dedicated to the areas of investments in RDI, planned to be co-financed by the 2014-2020 National Programme on RDI (NPRDI III), the ERDF through the COP 2014-2020, and other financial donors. The objectives defined by the new strategy were, to a high degree, coherent with the previous ones. Still, the implementation mechanisms were more focused on the increase of economic competitiveness and public-private partnerships.

An independent analysis of the progress made based on the achievements of the NSRDI III targets (INCSMPS, 2019), whose cut-off date was the end of 2017, indicates that, in general, the baseline gap registered in 2014, compared to the targets foreseen for 2017, is still significant. The progress made was below the planned targets. A low level of financing for RDI activities reduced institutional efficiency, and a lack of strategies aimed at increasing collaboration with the economic sector were found to be required areas of improvement. The supporting factor 'Increasing public and private spending for R&D activities' (supporting factor 5) did not materialise, negatively influencing effectiveness. Statistical data published by INSSE indicate that between 2007 and 2017, the expenses with R&D activity increased from RON 2 177 million to RON 4 317 million while the share of R&D expenses in GDP has slightly decreased from 0.54% in 2007 to 0.50% in 2017.

Verification of risks and threats

Regarding risks, **difficulties during the public procurement process of works, equipment and services** (risk 1) led to delays in project implementation and increased the beneficiaries' vulnerability. However, it was, in some cases, mitigated. Most of the interviewees and the SOP IEC annual and final implementation reports highlighted that the procurement process was the most difficult part of the project implementation. The difficulties covered all stages of the public procurement procedure, from the elaboration of the procurement documentation to the ex-post verification performed by the Audit Authority set up under the Romanian Court of Accounts and finalised in some cases with financial corrections. The legal provisions regarding public procurement issued for the first time in 2006 changed several times during the programming period, thus contributing to the difficulty of this process.

Delays in public procurement and difficulties in project implementation (risk 2) materialised to some extent in the case of very complex infrastructure projects, especially relating to work contractors and appeals from unsuccessful candidates. The long time needed by the National Council for Appeals Resolution (CNSC) to take a final decision led to delays in the construction/rehabilitation works and impeded physical project progress. As a result, the beneficiary was forced to notify the MA and ask for prolongation of deadlines, with corresponding amendments in the financing contract. Despite the world-class complexity and, in some cases, the uniqueness of the products and services required for the ELI-NP project, the risk regarding the lack of specialised contractors did not materialise. Instead, in the context of the ELI major project, such difficulties arose in the procurement of highly specialised equipment, especially in implementing the contract for the gamma source.

The increased shortage of qualified research personnel due to poor wage incentives (risk 3) is another risk that materialised to some extent. However, it was adequately managed and mitigated. Given the scarcity and the unpredictability of RTD funding from the state budget, the research and medical system remained heavily underpaid compared with EU28 and with other national categories of personnel (judges, local administration, police, army) working in the public system (JRC, 2017). As a result, the national research labour market remained poor. The consulted stakeholders also mentioned actual difficulties in the retention of research staff. But they appreciated that the ERDF investments in the research infrastructure increased their attractiveness for young HEI graduates, candidates to doctoral studies, and even PhD holders and even

offered many examples of Romanian researchers returning from abroad. Overall, statistical data from INSSE indicate that the total number of employees in RDI activities increased from 42.484 in 2007 to 44.801 at the end of 2017, while in the same period, the number of researchers decreased from 30.740 to 27.367 persons.

The risk of **delays in commissioning due to equipment failures** (risk 4), associated with the major project due to its complexity and novelty, did not materialise. . Interviews endorsed that the risk did not arise in Phase I of the project completion, implemented within SOP IEC.

Competition on the national and international research markets (risk 5) emerged to some extent, but this risk was mitigated. The interview with the ELI-NP representative highlights that, in recent years, the domain competition significantly increased. This is a result of the fact that some countries (e.g. France, Italy, and the United States of America) relaunched their national programmes regarding the development of high-power laser facilities for research. This might be the multiplier effect of the pioneering EU funded ELI projects. Interviews also indicated that two of the three pillars of the ELI project (the Czech Republic and Hungary) had formally applied to the European Commission for establishing the new, pan-European organisation known as the Extreme Light Infrastructure ERIC (ELI ERIC), without ELI-NP as initially planned. At the time of this evaluation, the Commission was examining the ELI-ERIC application's compliance with the ERIC Council Regulation 723/2009 and the application's administrative preparedness. It is also finalising the Grant Agreement for the EUR 20 million Impulse project to transition to ERIC for all three facilities and support scientific and technical cooperation between the partners[24]. Meanwhile, the three ELI sites are moving forward with a joint Horizon 2020 project set to officially kick off common research activities in all three facilities. ELI-NP has a EUR 4 million stake in the project.

3.2.3. General assessment of the policy instrument

Based on evidence collected, it can be appraised that this policy instrument has effectively implemented its activities and achieved outputs and immediate outcomes. However, additional supporting factors beyond the implemented activities influenced the achievement of these results. Between intermediate outcomes and final outcomes and impacts, the picture is less clear. Most of the pre-conditions were verified, but the materialisation of some risks and the absence of some supporting factors prevented the intervention from fully delivering the expected results and broader impacts.

It is clear that the infrastructure investment policy instrument was very popular and addressed the needs of the eligible public RTOs and HEIs. This conclusion is proved by the significant number of submitted applications and the high volume of requested funds. All 110 financed projects were technically and financially completed despite the difficulties met and risks that arose.

The measure's intended outputs were achieved as a result of the effort and strong commitment of financed beneficiaries to succeed in their first attempt to use ERDF funds for their infrastructure development or upgrading effort. The accomplishment of the outputs was also facilitated by the verification of some supporting factors. The availability of the national funded programmes providing consultancy for HEIs/RTOs and technical assistance helped beneficiaries develop eligible project proposals. The foreseen risk linked with public procurement activities materialised in many cases, but it did not jeopardise the entire project portfolio's implementation. This was doable as a result of mitigation measures and the guidance provided by the management system, especially that of the IB (NASR) and its territorial offices.

Immediate outcomes fully materialised, but the availability of additional support measures, such as the SOP HRD and national funded programmes, also contributed to

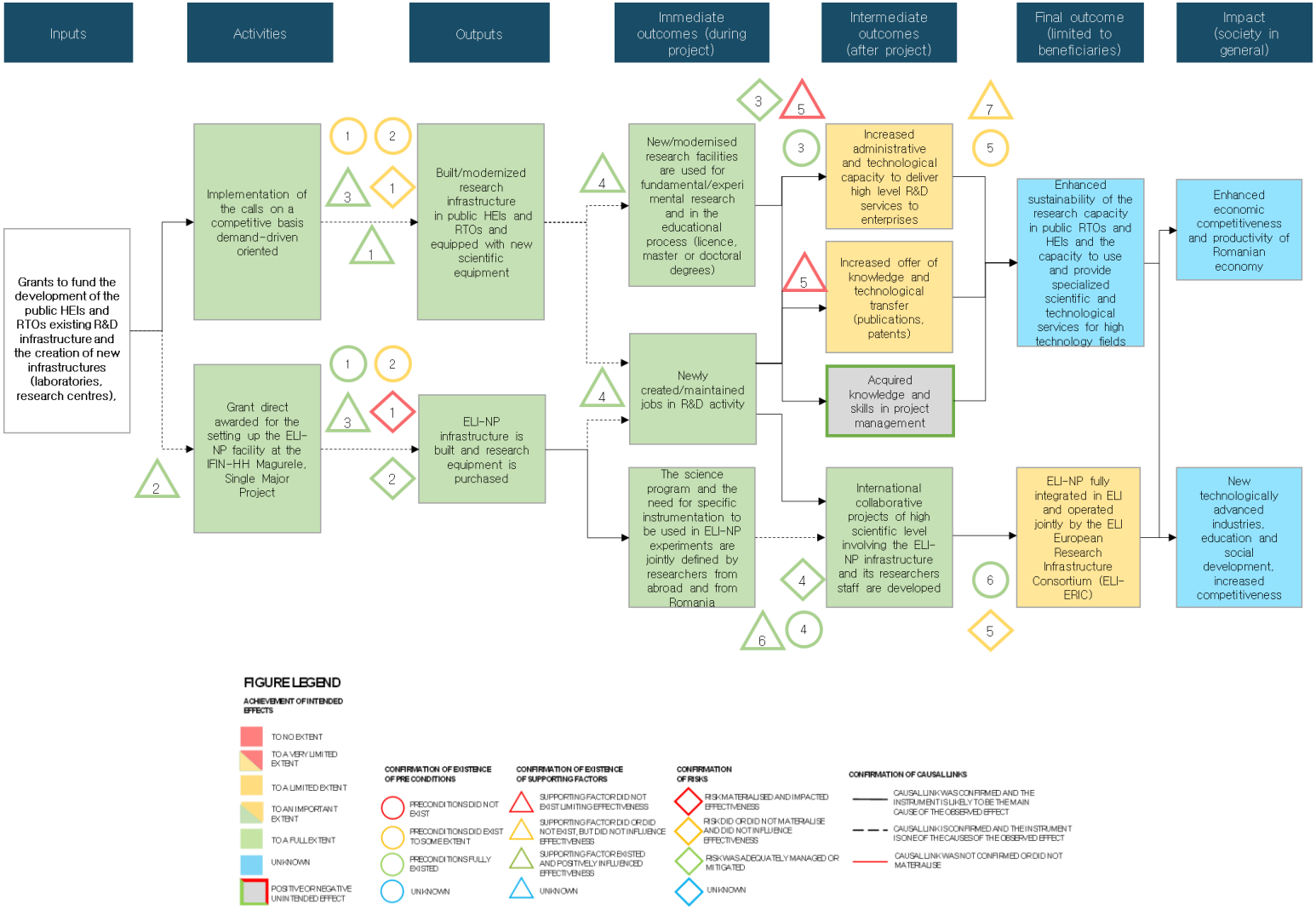
[24] https://www.europarl.europa.eu/doceo/document/P-9-2020-004017-ASW_EN.pdf

this achievement. In terms of intermediate outcomes, meanwhile, a full achievement was recorded for the major project only. However, in this context, also an additional supporting factor took place and influenced effectiveness. Conversely, general infrastructure investments did not lead to a significant increase in the administrative and technological capacity to deliver high-level R&D or offer of knowledge and technological transfer (i.e. publications, patents) since the level of public and private spending for R&D remained limited.

In terms of final outcomes, it should be noted that it has been difficult to provide a final assessment of these infrastructure investments' sustainability. At the same time, the operationalisation of the major project is still an ongoing process. Moreover, the achievement of broader impacts is even less evident.

Regarding the major project, monitoring activity proved that the beneficiary the challenges and risks were correctly identified from the development phase of the project application and led to implementation with realistic objectives and compliance with deadlines and budget. The difficulties related to the application of public procurement legislation, the recognition of international diplomas and university degrees, and the development of procurement contracts for works, goods and services uniquely of world-class complexity and technicality were overcome the expected results were achieved. Overcoming these difficulties was possible due to the project director's leadership and the professionalism and cohesion of the implementation team built around him. There were excellent collaboration and coordination with all project stakeholders, especially with the relevant scientific community (lasers and nuclear physics), national (including MA and IB) and local authorities, and the European Commission. It is also worth mentioning that the International Scientific Advisory Committee of ELI-NP's support was valuable in prioritising the implementation of the scientific case.

Figure 17. Representation of the results of the contribution analysis for the policy instrument Infrastructure investments for research



3.3. Policy instrument: Collaborative R&D projects

3.3.1. Theory of Change of the policy instrument

This policy instrument's goal was to contribute to building collaborative partnerships between research and innovation-oriented private enterprises and scientific research entities. Support for collaborative research and development during 2007-2013 was particularly important for the innovation-oriented transformation of Romania's RDI system. This transformation should have contributed to shifting the thematic focus from predominantly fundamental scientific research to applied and experimental development.

In order to ensure the full ownership of research results to beneficiary companies, the policy instrument was designed in a peculiar way. In the light of the AGs requirements, the eligible project activities did not imply a direct collaboration of the enterprise with its research partner/s. The research organisation (either RTO/HEI or enterprises whose main domain of activity was R&D) performed the research on behalf of the enterprise based on a contractual relationship. In such a way, the enterprise, in its role of beneficiary, had sole ownership of the research results. It bore the risk of a possible failure to get the formal patent registration or to avoid further disputes concerning IPR ownership. This means that private enterprises were the leading applicant, fully responsible for the execution of the awarded financing contract, and that research entities carried out research to respond to a need of the enterprise, delivering research results based on the contractual relationship.

The design of such a peculiar instrument of collaborative R&D stems from the consideration that:

- Private enterprises would be empowered to take further initiatives based on the results of applied research, experimental development and innovation.
- Enterprises would be exposed to a unique 'window of opportunity' that they were invited to capitalise on by looking for research partners in order to match their development needs.
- The 'in vivo' responsibility of enterprises for assuming financial responsibility and project management would be increased.
- Examples of good practice would be generated, whose dissemination would lead to a demonstration and multiplier effect. In was also envisaged to encourage the commercial banking system to get involved in financing RDI projects with a higher degree of intrinsic risk by granting bridge loans.
- A 'leverage effect' would be pursued between public funding (ERDF) and co-financing share from the beneficiary in accordance with the state aid scheme for research and 'de minimis' rules.
- Differently from other instruments supporting RDI, such as the NPRDI II or the FP7, enterprises would be the primary beneficiary.

Therefore, based on two competitive calls, the policy instrument offered non-reimbursable ERDF funds for enterprises to contract industrial research and experimental development projects carried out by HEI/RTOs.

The initial allocation amounted to EUR 113.9 million (including both ERDF and co-financing budget). However, in light of the financial crisis's effects, which had limited the co-financing capacity of private enterprises, the allocated budget was diminished to EUR 45.6 million. In order to ensure coherence with the NSRDI, the eligible priority thematic areas were also established: (i) health, (ii) agriculture, food safety and security, (iii) energy, (iv) environment, (v) innovative materials, products and processes.

The eligible applicants were enterprises, including SMEs, whose main domain of activity according to the CAEN (Clasificarea Activităților din Economia Națională - National Classification of the Economic Activities) did not represent R&D. Only project proposals with a minimum final score were admitted to co-financing.

The ERDF grants were offered based on three main pre-conditions aimed at facilitating the achievement of the intended outputs:

1. Private sector readiness to address their high-tech needs and to foster the demand for experimental and applied research;
2. Quality portfolio projects ensured through a competitive procedure and transparent and clear evaluation and selection criteria;
3. The reimbursement claim paid in due time to allow the timely implementation of the selected R&D collaborative projects.

In order to ensure the timely selection and quality projects, the AGs required the preparation of a business plan as part of the full application. In this respect, the availability of the national funded programmes, providing consultancy for HEIs/RTOs/enterprises with R&D activity to develop eligible project proposals (i.e. IMPACT technical assistance programme), was expected to be one of the main supporting factors contributing to meeting formal administrative and eligibility criteria, as well as evaluation criteria regarding project coherence and maturity.

Specifically, the collaborative R&D projects were targeting a cluster of immediate outcomes:

- Technological advancement and improved knowledge regarding the products/ processes/ services in identified strategic sectors;
- Submission of patent applications for formal registration;
- Newly created jobs at the level of both partners (financed enterprises) and retention of R&D personnel at the partner organisations.

In order to achieve the immediate targeted outcomes, the beneficiaries had to be able to organise the procurement process in compliance with financing contracts provision and with the State Aid or 'De Minimis Aid' rules. Moreover, to effectively exploit commercial results of R&D projects, the latter should have been based on a realistic demand and the real market need for the project's solution. In this context, macroeconomic stability was also seen as a pre-condition necessary to achieve final outcomes in terms of an increased volume of further private enterprise investment in R&D and innovation activities and an enhanced administrative capacity in contracting and managing R&D projects.

A cluster of three other factors was taken into account as supporting the achievement of the policy instrument’s immediate outcomes. For instance, the achievement of technological advancement and improved knowledge of products/processes/services in identified strategic sectors was found to be linked with:

- Availability of beneficiaries’ resources;
- Access to affordable bridge-loans;
- Organisational (HR, infrastructure) and managerial capacities to ensure collaborative project implementation promptly.

Submission of applications for patent registration was linked with the availability of R&D service organisations (project management, IPR) supporting the beneficiary enterprises for efficient and timely project implementation. In fact, the creation of new sustainable jobs, and retention of employees, were found to be connected with available access to other human resources development (i.e. SOP HRD and national) support measures targeting enterprises and R&D institution staff.

Another supporting factor contributing to the improvement of enterprise competitiveness was the complementarities with other SOPs and national RDI budgeted programmes. Their synergic action had to gain economic benefits from the commercial valorisation of the R&D project results and from a strengthened administrative capacity in contracting and managing follow up R&D projects by both partners.

The enhanced competitiveness and productivity of the Romanian economy depended on the synergic contribution of all programme policy instruments and a favourable

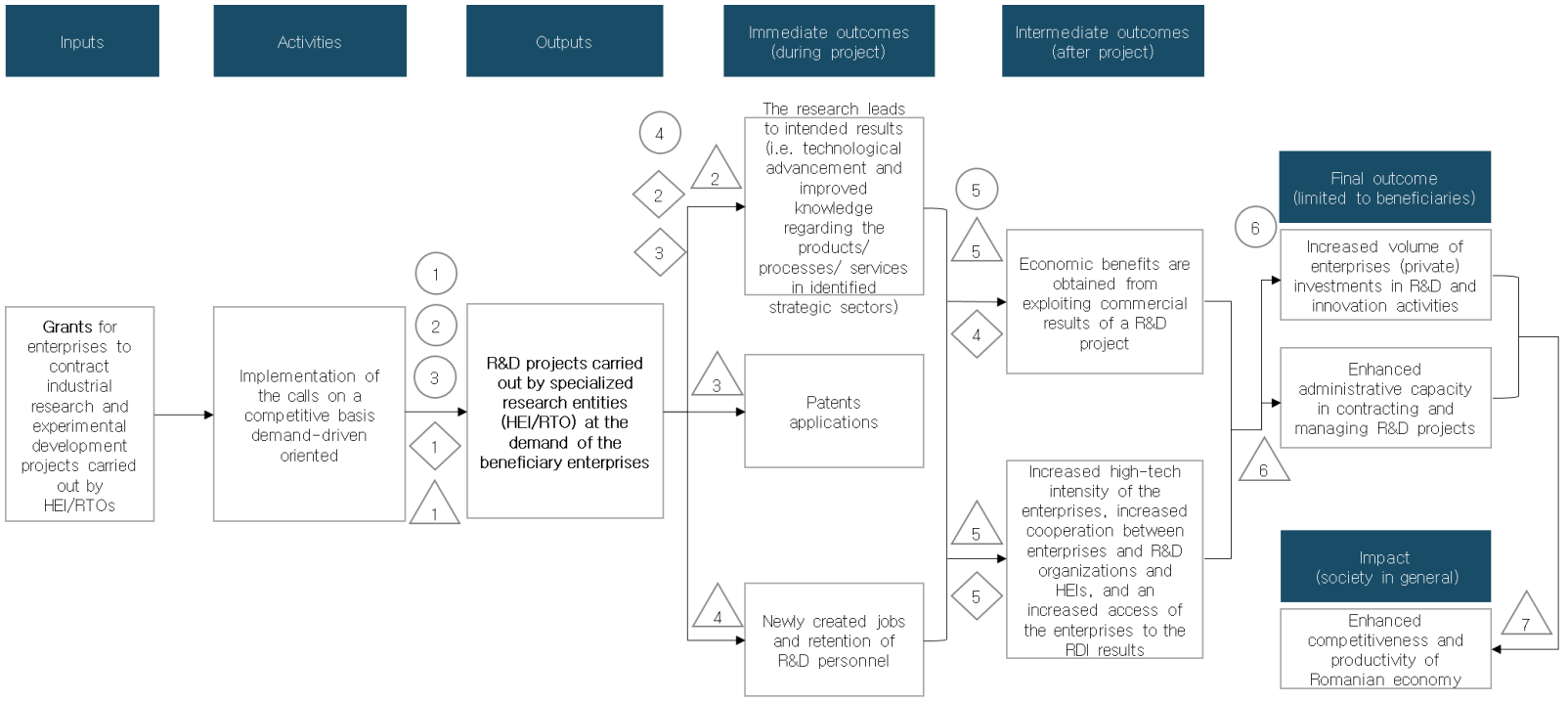
macroeconomic environment and the stable provision of public support for collaborative R&D.

A cluster of risks was associated with the obstructive potential in the completion of good quality projects. Among the main risks were contextual economic factors (crisis, hampered access to credits) and the high level of enterprise contribution implied by state aid regulations, reducing enterprise eagerness to implement the financed project. Moreover, in light of the nature of the collaborative R&D projects, the full materialisation of immediate outcomes could also be jeopardised by the inherent risks of experimental development and applied research projects (i.e. research project risks). A delay in launching calls and the long duration of the evaluation process could lead to changes in the economic status of enterprises to hit their capacity to sustain the project financially.

Moreover, it was assumed that projects were not sheltered from risks even after their completion. Intermediate outcomes could have been affected by technological, social, regulatory, or economic changes that could render the research results irrelevant and commercially unappealing or unviable. Last but no less important were the enterprises' increased high-tech intensity, increased cooperation between enterprises and R&D organizations and HEIs, and increased access for enterprises to the RDI results. All these outcomes could be affected by a continued migratory flow of highly qualified and skilled researchers and other employees' categories.

The following figure presents the ToC of the Collaborative R&D projects. It means to illustrate the intended results of the policy instrument as well as the linkages between them.

Figure 18. ToC for Collaborative R&D projects



Pre-conditions

1. Private sector readiness to address their high-tech needs and to foster the demand for experimental and applied research
2. Quality portfolio projects is ensured through a competitive procedure and transparent and clear evaluation and selection criteria
3. Reimbursement claims are paid in due time
4. Projects are carried out in compliance with procurement and State Aid or 'De Minimis Aid' rules and procedures.
5. Application of the R&D results in industry is realistic and stems from the real market need for the solution subject of the project
6. Macroeconomic stability

Supporting factors

1. Availability of the national funded programs providing consultancy for HEIs/RTOs/ Enterprises with R&D activity to develop eligible project proposals
2. The beneficiaries have the necessary own resources and capacities in terms of organisation, management, human resources and infrastructure to ensure the collaborative project implementation in a timely manner
3. Availability of R&D service organizations (project management, IPR) to support the beneficiary enterprises for efficient and timely project implementation
4. Access available to other (i.e. SOP HRD and national) support measures targeting enterprises and R&D institutions' staff
5. Synergies and complementarities with other SOPs and national budgeted programs on RDI aiming to improve enterprises' competitiveness
6. Sustained and improved national policies framework in support of innovative enterprises
7. Public support for collaborative R&D is sustained over time

Risks or threats

1. The economic contextual factors (crisis, hampered access to credits) and the high level of enterprise contribution implied by the state aid regulations reduce enterprises' eagerness to implement the financed project
2. Inherent risks of experimental development and applied research projects (i.e. research project risks)
3. Changes in the economic status of enterprises lead to their incapacity to financially sustain the project
4. Technological, social, regulatory or economic changes render the research results irrelevant and commercially unappealing / unviable
5. Enterprise and/or R&D staff turnover

3.3.2. *Contribution analysis of the policy instrument*

Verification of intended intervention implementation

The interviews and data analysis revealed no major deviations concerning the overall logic or the implementation of foreseen activities under the collaborative R&D policy instrument (PI), although many challenges occurred at the level of the whole OP and its management system.

Delays in setting up the institutional structure for the management of SOP IEC, and the long time needed for preparation and approval of the list of eligible expenses, and for the decision regarding the State Aid Scheme (approved in November 2008), resulted in a late launch of the implementation of the operation. The activity started with a two-year delay from the beginning of the programming period. The MA launched two calls for applications under this measure: the first one started on 3 March 2009 and set out a submission deadline of 4 June 2009. The second started on 14 October 2010 and foresaw continuous submission within the budget limits, with evaluation sessions organised periodically.

In the case of the first call (2009), the Applicant's Guidelines (AGs) required a single type of project implementation arrangement based on a pre-established partnership at the time of submitting the project proposal. The two partners, the enterprise and the research partner, had to conclude a partnership contract, which became an accompanying document for the project proposal (funding application). This type of project (type one) was funded under the State aid scheme for research, development and innovation. To stimulate participation in the competition, the AGs of the second call (2010-2012) introduced, as an alternative to the pre-established partnership, another type of project arrangement (type two), through which the beneficiary enterprise could acquire research services at a later stage of project implementation, from one or more research institutions, in compliance with the procurement rules established by the Grant Agreement. The type two projects introduced in the second call were funded under 'De minimis aid' scheme[25], and their maximum ceiling was lower than that for the type one projects in order to stimulate businesses to apply (implicitly the enterprise's financial contribution being lower, about 10% of the eligible project costs).

Until the launch of the first call, the IB organised a large number of workshops, training sessions, and information and promotion activities and participated in activities initiated by other organisations to promote the programme and its measures. The information and promotion activities were held in all of the developing regions of the country.

However, despite the promotion activities, the achievements in submitted applications were weak, even after organising two calls for proposals. These results below the estimated targets might be linked with:

- The outbreak of the financial crisis;
- Insufficient own financial sources of the eligible enterprises;
- Prudential commercial banking policy in dealing with small customers in granting bridge-loans for EU funded projects.

Achievement of intended and unintended effects at the level of the expected threshold

The policy instrument supported only a limited number of collaborative R&D projects compared to the target set ex-ante. The evidence from the SOP IEC monitoring system indicates that, compared to the PA target of 200 projects carried out in partnership by R&D institutions and enterprises, only 37 were completed before the programme closure,

[25] Order of the Minister of Economy, Trade and Business Environment no. 1628/2010 for the approval of the de minimis aid scheme called 'De minimis aid to support research projects in partnership'.

all within this programme measure, for a total ERDF contribution of EUR 13.7 million, below the total allocated budget From the 111 projects selected for financing approval, only 62 financing contracts were finally concluded. However, later on in the implementation phase, 25 other financed beneficiaries required project termination and closure of contracts since they were unable to get a bank guarantee letter and to ensure pre-financing or co-financing (the payment application mechanism had not been put into operation.)

Overall, compared to the initial target, the achievement of this policy instrument's output is limited. However, it is also true that the projects financed under this policy instrument brought a proportional contribution to other PA achievement indicators, as follows:

- 6.6% to the achievement of the intended number of R&D projects;
- 2.6% to the achievement of public expenditure in assisted RDI projects (whose target was EUR 523.08 million at the level of entire PA2, and the projects under this PI contributed with EUR 13.7 million).

The final achievements show that out of the 37 projects fully completed, 27 were implemented by small-sized enterprises, eight by medium-sized enterprises, and two by large enterprises. Most of the completed collaborative R&D projects were in the manufacturing sector (14), with nine in the high added value services sector (in professional, scientific, and technical activities). There were six projects in the ICT sector, five in wholesale and retail trade, and one each in three other sectors - agriculture, electricity, and waste management. The breakdown of achievements by size category of the implementing enterprises and sector of their main domain of activity highlights interesting findings. Despite the small number of completed projects, beneficiaries were mainly from the manufacturing sector, whose chances to operationalize R&D results could be assessed as higher than those in other activity sectors. This shows that the pioneering opportunity given to SMEs to implement projects in partnership with R&D institutions was capitalized upon. This intended achievement was facilitated by the MA decision to reduce in the second call the grant ceiling up to the maximum regulated by 'de minimis' the state aid legislation.

Concerning the projects' immediate outcomes, evidence collected shows that the enterprises generally achieved the expected results (scientific production in terms of experimental models, prototypes and/or services). However, some of the results of the funded research projects remained in a pending application on an economic scale for various reasons:

- A long duration (years) of the formal regulatory process to get the patent that secures intellectual property rights;
- A lack of financial or technological maturity for the transition from prototype to production;
- The incipient stage of development of technology transfer centres correlated with non-existent or insufficient legislation on this subject;
- Reduced follow-up funding opportunities to support industrial production.

Even though the leading partner (the enterprise) did not formally collaborate in the research activities, the collaborative R&D project policy instrument and the particular way the partnerships were designed, with the enterprise as a leading applicant, favoured a knowledge exchange during the research process, as well as at project completion, when the research production was delivered to the enterprises.

Experimental research in the operational manufacturing environment and mass production was not compulsory due to the early stage of technological maturity of the research results. Still, it was mandatory for the submission of the patent registration. The number of patent applications submitted for formal registration was one of the PA output indicators whose target exceeded almost six times (see Table 6 in Sub-section 3.1.2).

Moreover, the interviews conducted within this ex-post evaluation have shown unintended achievements, such as those listed below.

- Implementation of the project was accelerated, not only by ensuring the institutional framework for carrying out the research activity for the benefit of the economic agent but also by creating the opportunity to finance, in a relatively short time, research-development activity at a high scientific level.
- Experienced project management teams, able to propose to follow up applications, were created within beneficiary organisations. The interviewees pointed out that some of the financed beneficiaries have applied follow-up proposals, and they won financing either in the programme measures of the 2.3. policy instrument of SOP IEC and/or in the next COP 2014-2020.
- There was a mutual gain for the partners in terms of newly acquired knowledge, trust, and reputation.

In order to substantiate the above conclusion, the box below presents the grassroots achievements of a selection of the implementing organisations of the ERDF funded projects included in the sample for in-depth interviews. The integral list and full details are presented in ANNEX III and ANNEX VI.

Box 5.Selected projects - Collaborative R&D

REMOVED[26] - ***Reducing environmental impact by optimising the conversion chain at biogas energy recovery facilities in landfills.*** The project developed by SC ECOBIHOR SRL in partnership with Polytechnic University of Bucharest (UPB) – Department of Power Production and Usage. It aimed, inter alia, for the identification and realisation of a solution for the neutralisation/stabilisation of residues, for the realisation of the experimental model and prototype installation, to develop the company's production capacity, and for cost reduction related to pollution emission reduction systems. BIHOR SRL, an experienced and research-oriented private enterprise, has operated and managed for 20 years the county ecological waste landfill in Oradea, the recyclable waste sorting station, the composting station for vegetable waste, and the mechano-biological treatment station for household and similar waste. The project created an experimental model of an installation for new generic technology to recover and use thermal energy, for which the beneficiary has the right for future development and production. The project also realised a prototype for tested and certified bioprocessing subassembly with heat recovery and a software application to calculate biogas production. The beneficiary also reported results in scientific publications and job creation. The project implementation also prompted the need to improve the legislative framework regarding waste management – especially regarding the selective collection; a joint task force of the sector professional association (Romanian Compost Association), and UPB as a partner organisation, were actively involved in the provision of inputs for drafting and advocating the adoption of the Law on the management of compostable non-hazardous waste (Law no. 181 has been approved at 19 August 2020). ECO BIHOR established a research department within the enterprise and won financing under COP 2014-2020 for a follow-up project (PROVED) with the same partner. The lessons taught by this collaboration helped the entrepreneur to stay focused on research activities. The project's implementation and practical results contributed to the improvement of the university curriculum on solid waste management. Also, they opened new ways for further involvement of the university in joint projects with enterprises.

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RENAULT TECHNOLOGIE ROMANIA [27]**(RTR)**- ***Solutions to obtain parts with non-stick properties for ice and dirt, made of polypropylene and polycarbonate***. The project was developed in partnership with the National Institute for R&D in Chemistry and Petrochemistry Bucharest (ICECHIM)[28]. RTR is the single complete automotive engineering centre in Eastern Europe and the largest Renault engineering centre outside France. RTR is the reference centre for vehicles in the Global Access range worldwide. The project aimed to find and develop innovative materials with special properties, antifouling anti-depositing ice for use in the automotive industry, and solutions for those materials' mass production. Project results included four new materials, two patent applications, one that was already issued in France, and scientific articles published. The ERDF played the role of research accelerator - financial assistance had the effect

[26] https://www.ecobihor.ro/proiect_removed.htm
[27] https://www.gruprenault.ro/tags/renault-technologie-roumanie
[28] https://icechim.ro/en/

of accelerating the implementation of the project not only by ensuring the institutional framework for carrying out the research activity for the benefit of the economic agent but also by creating the opportunity to finance, in a relatively short time, research-development activity at a high scientific level. RTR had a clear definition of the research theme and its expected results, and the partner research organisation was chosen following several rounds of discussions with different RTOs and HEIs. Renault Company has exclusive intellectual property rights on the newly obtained materials and keeps them at hand for future use. By participating as a partner in the project, ICECHIM has proven its scientific competence and ability to carry out such a demanding project. ICECHIM's prestige has increased both in academia and in the private economic environment. The transfer of knowledge and innovative scientific production to the beneficiary took place based on both sides' participatory process. Collaboration between partner organisations was strengthened.

Source: Authors based on the conducted interviews.

Verification of assumed pre-conditions

The materialisation of the identified pre-conditions is quite varied.

Evidence collected pointed out that **enterprises were generally ready to address their high-tech needs and to foster the demand for experimental and applied research** (pre-condition 1). Interviews with programme management stakeholders, beneficiaries, or the research partner's representatives showed that the target eligible enterprises were overall able to observe the basic principles of the needed research concept. Moreover, either alone or with the help of a pre-identified research partner, they were also able to formulate it within the project applications. In the implementation stage, they were neither passive nor only reactive. They provided needed basic technical data, and they participated in the experimental proof of concept for its validation in the laboratories of the research partner. They also hosted experimental proof for the prototype/experimental models in their industrially relevant operational environment. This ensured research was complete and qualified to meet the requirements of the patent application.

In addition, **selected projects were generally of high quality** (pre-condition 2). Quality was ensured through a competitive procedure and transparent and clear evaluation and selection criteria. The evaluation and selection process took place in three stages (AGs): formal verification and eligibility verification, evaluation of proposals, final selection. The first two stages were performed by the IB research staff with implementation responsibilities from the regional offices. The third stage was organised by the central implementation unit (NASR) and performed by groups of three specialists (scientists) in the project field with research experience. The list of the evaluated proposals, drawn up in descending order of the obtained scores, was sent to the Selection Committee, which elaborated the final evaluation report and the list of selected proposals for financing, and which were submitted for approval to the NASR president. The preliminary results were published, and each applicant was notified and received the fulfilled project evaluation form, with instructions on how to file possible appeals. Information from the annual implementation reports indicates that the number of applications rejected in the first stage (formal verification and eligibility verification) was very low. A high number of projects obtained an evaluation score well above the established quality threshold.

Conversely, **the timely reimbursement claim** (pre-condition 3) was not always ensured. Due to the weak organisational capacity of IB territorial units to organise project site visits and the small number of qualified personnel in charge of the review and processing of submitted reimbursement claims, reimbursements were not always paid within the programme's established 60-day periods. However, as the implementation cycle progressed, this deficiency was corrected. Moreover, to speed up payments, in 2013, an optional mechanism implying direct payments to the works, goods, and services providers upon the financed beneficiaries' claim was introduced. Interviews showed that HEIs, which had a better pre-financing capacity, continued to use the reimbursement mechanism. In contrast, RTOs, which were lacking resources for pre-financing, preferred to use the payment mechanism. Both mechanisms led to the conclusion that this pre-condition functioned well to some extent.

In general, **projects were carried out in compliance with procurement and State Aid or 'De Minimis Aid' rules and procedures** (pre-condition 4). There are no indications from the SOP IEC monitoring system regarding beneficiaries' non-compliance with the state aid rules. Moreover, it should be considered that private enterprises are not subject to public procurement rules enforcement, but only to the procurement rules indicated within their financing contract. Compliance with and enforcement of the state aid legislation did not raise implementation problems. Therefore, it can be stated that this pre-condition took place. However, the biggest issues for the projects financed after organising the first call were linked to the intensity of the research state aid in the case of private enterprise in accordance with their size category. As a result of this barrier to enterprises, the second call was governed by the 'de minimis' state aid rules.

Collaborative R&D projects led to expected research results **because project ideas were realistic and stemmed from real market need** (pre-condition 5). There is a set of taken safeguarding measures meant to substantiate this: (i) the AGs included criteria and requirements referring to eligible sectors of activity for the prospective applications, aimed at ensuring coherence with the NSRDI, which has identified the sectors with the highest growth potential; (ii) the eligible priority thematic areas for the research projects financed under this measure were established[29]; (iii) during the evaluation process, one of the criteria used for ranking the applications was its relevance, appraised according to a set of sub-criteria[30]. The requirement that readiness for application in the operational environment was realistic is also endorsed by the generation of research topic and formulation of research concept, upon the enterprise request, and further improved by the research partner organization. The market requirements and the development strategies of the private enterprises and their business models have a fast-changing dynamic. Therefore, the real application in production remains the decision of owners, shareholders, or top management, as the case may be.

The pre-condition, which did not take place, thus limiting the achievement of final outcome, was **macroeconomic stability** (pre-condition 6). After a sharp and deep contraction during the financial crisis, the Romanian economy has started to recover somewhat quickly, but only after 2011. However, it should be taken into account that most projects whose financing was contracted during 2009 had to be completed before 2011, as the maximum allowed duration of the project was 24 months. Therefore, the evaluation found that enterprises were the most affected by shortages brought by the financial crisis (lack of credit access, higher cost of loans) and economic crisis (turnover decrease as a consequence of the contraction in consumption, loss of markets, reduced exports, etc.). As a result of this ever-changing and unpredictable macroeconomic evolution, the demand for investment projects in research - development and innovation has diminished, enterprises being forced to adopt survival strategies.

Verification of supporting factors

Similar to the first policy instrument analysed, **national funded programmes providing consultancy** (including the 'IMPACT' Programme, presented in the section above) **were also available** and supported enterprises to develop eligible project proposals (supporting factor 1). However, in this context, such a programme did not contribute to the implementation of collaborative R&D projects. The consulted stakeholders mentioned that they developed the application by themselves and supporting the partner research organisation for the scientific element. Therefore, based on documentation, it can be assessed that the supporting factor was available but it is

[29] Health; 2. Agriculture, food safety and security; 3. Energy; 4. Environment; 5. Innovative materials, products and processes.

[30] (1) The contribution of the project to the global development of the economic sector concerned; (2)Extent to which the proposed project will contribute to achieving results directly applicable in the market and increasing the competitiveness of the enterprise; The need for research activities/services;(3) Develop the enterprise personnel skills to use R&D results and activities; (4) The possibility of creating new jobs within the enterprise; (5) Compliance with the promotion of sustainable development and equal opportunities as horizontal principles

unknown if the target beneficiaries used it due to the lack of traceability between the national budgeted programme and SOP IEC.

Overall, **beneficiaries had the necessary resources and capacities in terms of organisation, management, human resources, and infrastructure to promptly ensure collaborative project implementation** (supporting factor 2). Data from the monitoring system indicate that most of the beneficiaries implemented the projects within the allocated timeframe (24 months). In only 4 cases (out of 37), the project duration exceeded 24 months by a few months. Interviews highlighted that beneficiaries had the full support of their administrative departments (finance and public procurement) during project implementation. The enterprise's financial backstopping proved to be decisive in keeping the project on track when the reimbursements were delayed. These findings led to the conclusion that the supporting factor took place and aimed to influence effectiveness.

However, **the availability of R&D service organisations (project management, IPR) to support the beneficiary enterprise for efficient and timely project implementation** (supporting factor 3) also played a role. In 2008, before the launch of the first call, the NARS (the implementing agency of the PA2 policy instruments) estimated a pool of 1,300 eligible organisations, out of which 20% belonged to the public R&D sector (either RTOs or HEIs), and 80% represented private legal entities. The network of specialised institutions for technology transfer and innovation comprised 50 entities, of which 39 were accredited (technology transfer centres, technological information, technological and business incubators), and 4 scientific-technological parks located in various regions of the country. In January 2008, at least 88 agencies specialised in industrial property were registered with the State Office for Inventions and Trademarks. SOP IEC monitoring system indicates that most of the beneficiaries financed within this measure (24 from 37) concluded service contracts for research activities with RDI organisations. Nine beneficiaries used industrial property rights services for patent applications. The findings above led to the conclusion that the supporting factor took place and influenced the programme measure’s effectiveness.

The contribution of **the availability of other (i.e. SOP HRD and national) support measures targeting enterprises and R&D institution staff** (supporting factor 4) is instead more limited. As documented in the sections related to R&D national policies, the national developmental priorities and the main strategic connections for their accomplishment were defined in the NDP 2007-2013. However, even though other programmes targeting enterprises and R&D institutions were available, there is no clear evidence of whether they influenced the effectiveness of the immediate outcomes. The interviews conducted revealed that direct beneficiaries continued to investigate financial opportunities further and even applied to the other calls.

The effect of **synergies and complementarities with other SOPs and national budgeted programmes on RDI aiming to improve enterprises' competitiveness** (supporting factor 5) is unknown. The NSRF and SOP IEC defined the institutional mechanisms meant to support the complementarities of interventions and ensure a good coherence and complementariness in order to ensure ESIF coordination. Specifically for the OP measure under which the policy instrument is funded, the evaluation has identified correlation with:

- SOP IEC Key Area of Intervention (KAI) 2.3 - Enterprises' access to research and development and innovation activities, where funding was available for the implementation of the research project results in production through an eligible innovation project;
- SOP HRD (FSE funded): KAI 3.1- Promoting an entrepreneurial culture where funding was available, inter alia, for developing managerial skills, especially for micro-enterprises and SMEs; KAI 3.2 - Training and support for businesses and employees to promote adaptability.

However, in the implementation process, there was no systematic verification of the complementarities of the projects. The main cause is the absence of sectoral strategies

to establish the aligned strategic vision and objectives pursued in the medium and long term and the lack of 'proper interconnected information monitoring systems or open access to databases'. Moreover, due to the lack of traceability, there is no evidence regarding the level of the joint use of these opportunities by the SOP IEC beneficiaries. The absence of a realistic coordinated timetable for the implementation of different OPs and the NPRDI II, as well as the lack of correspondence between national development priorities and targets set at ESF funded OPs, are the main causes of the poor information about synergies and complementarities. As a result, the strategic correlations remained at a declarative level, showing public awareness about its importance. Still, the lack of prioritisation determined the concentration of interventions in certain areas and a low complementarity of the investments made. (SOP IEC FIR, 2018).

The lack of sustained and improved national policies framework supporting innovative enterprises (supporting factor 6) also probably negatively influenced effectiveness. The first concrete step encouraging enterprises through fiscal incentives to get involved in R&D activities came only in 2008. Under legislation adopted in January 2009, tax incentives were applied on gross profit taxation (additional 20% deduction of research and development expenses when calculating due gross profit tax, subsequently increased to 50% from 1 February 2013), along with the application of the accelerated depreciation method for equipment for these activities. More recent regulatory tax incentive measures were introduced in August 2016 and entered into force in January 2017. They referred to ten years' exemption from paying income tax for the employees working in R&D projects both for newly established companies and those existing at the time of introducing the incentives, which carry out exclusively research and development activities and innovation (KPMG, 2017). However, due to the lack of targets or proper monitoring of the final outcomes, it remained questionable whether this factor supported effectiveness in the long run.

Public support for collaborative R&D was sustained over time (supporting factor 7) but did not influence effectiveness. The reasons explained in Sub-section 3.2.2 also apply in this case.

Verification of risks and threats

The full achievement of expected outcomes was strongly affected by **the materialisation of contextual economic factors, such as the outbreak of the financial crisis in 2008** (risk 1). Two-three years of the implementation period overlapped with the worldwide financial and economic crisis, leading to creating an unfavourable environment for economic growth and RDI investments. This new context was unforeseeable at the programming date (2005-2006) and had a negative impact on the implementation of the programme's measures targeting private enterprises in partnership with RDI entities. The worsening of access to finance for SMEs, because of the additional caution of banks, directly affected this measure's implementation. On the one hand, it led to a waiver by some of the beneficiaries. On the other hand, it led to 'self-selection' of potential private sector applicants in the sense that only the enterprises with a robust financial situation continued to submit and implement investment projects within the SOP IEC.

The decline in economic activity led to major pressure on the state budget. Severe budgetary constraints arose and implied massive reductions in public expenditures. This fact led to a considerable decrease in national public resources to stimulate competitiveness, affecting the principle of complementarity between Structural Instruments and national funds. The tough budgetary constraints within the new emerging country context led to approval by the EC of the 'top-up mechanism' aimed at increasing ESF contributions to 85%, with the corresponding decrease of national fund contributions. The implementation of the whole PA2 was consequently disturbed, as the initial programming envisaged a substantial increase in the national research and development budget. The initial commitment materialised in 2007 and, especially, in 2008. A severe reduction followed. Moreover, budgetary pressure also led to fiscal policy changes, which contributed to the declining private sector net profit to be reinvested. The tax increase policy had direct implications on the capacity of companies, especially SMEs,

to ensure the necessary resources for implementing projects, and negatively affected their interest and the request for financing in SOP IEC calls which were targeting enterprises and their collaborative partnerships

The effects of this risk materialisation could be associated with the low popularity rate of this measure (only 154 submitted applications) and the gradual disengagement of financed beneficiaries. This is fully illustrated by the fact that out of the 111 selected potential financed beneficiaries, 49 gave up in the pre-contractual stage, and 25 concluded the financing contracts because they were unable to get a letter of bank guarantee for pre-financing or co-financing bridge loans. Another four beneficiaries requested termination of financial contracts due to other difficulties in implementation.

Another risk negatively influencing effectiveness was linked to **changes in enterprises' economic status (risk 3),** which led to their incapacity to sustain the project financially. The Final Implementation Report issued by the MA also referred to the gradual disengagement of the beneficiaries described above. This is also linked with changes in their economic status following the submission of their applications for evaluation and selection. The changes emerged due to the long duration of the evaluation process, the intrinsic dynamics of the entrepreneurial environment, and the new general context of the financial crisis. The last influential factor was either limited private enterprise access to credit or significantly increased money price. The subsequent economic crisis affected the enterprise's capacity to support co-financing from their revenues due to the reduction in consumption, loss of markets, and an increase in operational costs (renting, utilities, and other inputs etc.). Depreciation of the national currency at almost 15% in December 2008 was aimed at affecting available cash flow. The above-listed evidence leads to the conclusion that this risk took place with high intensity and negatively affected the immediate outcomes effectiveness. Compared to the materialisation of the other identified risks, it can be stated that this risk materialised and, to the highest degree, negatively influenced effectiveness.

Moreover, the **risk of enterprise and/or R&D staff turnover** (risk 5) also materialised and impacted effectiveness. Interviewees, especially those working in research organisations, mentioned staff turnover as an issue they faced. Looking at the national level, the national research labour market remained poor. Even though there was a slight increase from 25.4% in 2008 to 28.2% in 2016, the share of Human Resources in Science and Technology (HRST) over the total active population remained lower compared with the average EU28 (Eurostat). Overall, statistical data from INSSE indicate that the total number of employees in RDI activities increased from 42 484 in 2007 to 44 801 at the end of 2017, while in the same period, the number of researchers decreased from 30 740 to 27 367.

Aiming to reduce the brain-drain phenomenon, several measures were adopted by the Romanian Government, as follows:

- a new payroll law in the public system was implemented starting in August 2016;
- wages in the health and education sectors increased by 15% from January 2017;
- Government Ordinance 32/2016 (August 2016) stipulated the exemption from annual income tax earned from remuneration by the personnel involved in R&D activities;
- in October 2017, a GD 751/2017 raised the salary ceiling for specialists working in RDI projects financed by public funds.

There is also a more recent JRC report (2017) which highlights that despite the remuneration policy measures taken, 'The staff in HEIs, education, research and the medical system remains heavily underpaid in comparison with EU28 and with other national categories of personnel (judges, local administration, police, army) working in the public system.'

Conversely, **the inherent risks of experimental development and applied research projects (i.e. research project risks)** (risk 2) did not occur. The desk review of the OP documentation showed that all 37 completed projects achieved their research objectives,

although, in some cases, delays were registered. This was possible because of the good definition of research concepts from the formulation of the application, close collaboration between partners in the preliminary phase of entry data provision and later in the testing phases, and the willingness of both categories of partners to overcome inherent vulnerabilities. The findings led to the conclusion that this risk did not materialise as a result of a proactive risk mitigation plan and did not negatively influence effectiveness.

There are no quantitative or qualitative data to confirm that **technological, social, regulatory or economic changes** (risk 4) render the research results irrelevant and commercially unappealing or unviable. Therefore, in the absence of any data to document, it can be concluded that the materialisation of this risk is unknown.

3.3.3. General assessment of the policy instrument

There is a wide consensus and evidence that, despite the small share of projects, the policy instrument played a pioneering role. It demonstrated the need to change the previous approaches towards collaborative R&D, which privileged applied research projects with a strong industrial application carried out by HEIs without enterprises' direct involvement. In fact, the policy instrument managed to give a determinant contribution to the promotion of collaborative science-industry partnerships in the light of this pioneering approach. Despite the limited number of projects finally implemented, the policy instrument was one of the main causes leading to the most immediate outcomes in conjunction with some supporting factors. However, the evidence is limited to the achievement of intermediate and final outcomes and broader impacts.

The intervention was the main cause leading to the implementation of the activities. However, the intended threshold level of planned activities was achieved only to a limited extent. The small number of the signed financing contracts, as opposed to a higher number of quality projects selected for financing, has different causes, outlined below.

- The evaluation process lasted longer than expected by the enterprises;
- The financial crisis outbreak discouraged many applicants from continuing because the initial market conditions were changed, and their cash flow capacity strongly diminished. As a result of the new context, many selected beneficiaries did not take risks to go ahead, and they withdrew from signing the financing contract. Moreover, during implementation, 25 other financed beneficiaries required project termination and closure of the contracts. They were unable to get a bank guarantee letter and to ensure the pre-financing or co-financing (the payment application mechanism had not been put into operation).

The intervention was one of the main causes of the observed immediate outcomes supported by the beneficiary's capacities in terms of organisation, management, human resources, and infrastructure to ensure the collaborative project implementation promptly. However, the lack of macroeconomic stability and the materialisation of some risks led to a generally limited achievement of intermediate and final outcomes.

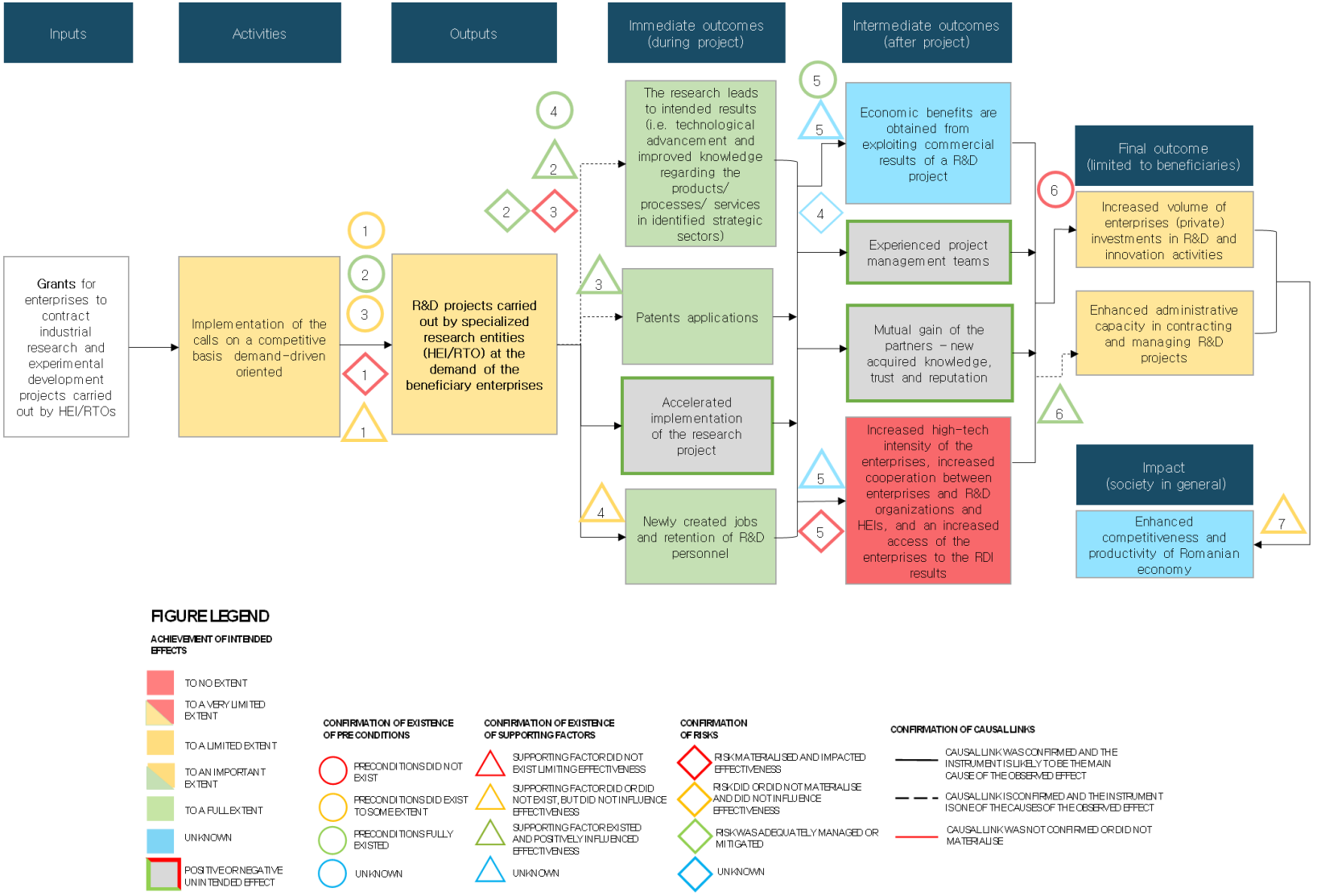
In the absence of any impact evaluation and/or counterfactual analysis of the OP, there is no clear evidence on its impact or even on some indications of observed changes and the extent to which they can be assigned to the support provided within this policy instrument. The policy instrument was probably a contributory cause behind the observed intermediate and final outcomes and impacts.

Overall, the evaluation found three different ways in which this policy instrument brought its proportional contribution to achieving the general objective of SOP IEC. These are:

- Encouraging the partnership between private enterprises and R&D entities (RTOs, HEIs, and private research production providers) for the intensification of R&D activities in support of enterprises and promoting technology transfer, especially in priority scientific fields at the European level, or of interest for Romania;
- Generating results of economic interest and stimulating the transfer of research results and scientific knowledge in the economic environment;

- Raising the level of technological upgrading in enterprises as the first factor to increase their competitiveness.

Figure 19. Representation of the results of the contribution analysis for the policy instrument Collaborative R&D projects



3.4. Policy instrument: Internationalisation of research

3.4.1. Theory of Change of the policy instrument

This policy instrument was implemented under the PA2 and measure KAI 2.1, referring to the increase of R&D capacity, stimulation of cooperation between RDI institutions and enterprises, and increase of enterprises' access to RDI. It aimed to enhance the economic competitiveness and productivity of the Romanian economy by the implementation of complex research projects fostering the participation of high-level international experts. The specific long-term goals of this measure were:

- To generate results of economic interest and to initiate the transformation of the research results into new or improved products, technologies and services;
- To raise the level of technological development in enterprises as the first factor for increasing their competitiveness;
- To develop the capacity of R&D staff through partnerships with international specialists.

As a means to achieve these goals, the measure aimed to create cores of high level scientific and/or technological competence, at European standards, within an R&D institution, a university, or a host enterprise, by attracting specialists from abroad with recognised competence, of any nationality.

Applicant's Guidelines indicated that the eligible applicants were public or private research organisations (HEIs or RTOs) and enterprises having research activity mentioned in their mandate by law. Also, the mandatory eligibility requirements for the international specialist were: at least five years working experience in R&D activity before the date of application submission; at least three of the five years before the date of submission of the funding application to have been working abroad in research (or have been in doctoral or postdoctoral studies); and a PhD in sciences. Moreover, per the call's requirements, the high-level specialist must have covered the project manager position.

In order to safeguard the outcomes of the financed projects, the AGs required the preparation of an impact/market study (applicable for research organisations) or a business plan (for enterprises) as part of the full application. To ensure coherence with the NSRDI, the eligible priority thematic areas were also established[31].

The projects designed and led by international experts were required to address at least one industrial research/experimental development activity aiming to stimulate technological advancement and knowledge improvement regarding products, processes, or services in identified strategic sectors, generate patent applications, and create new R&D jobs. These results were supposed to be capitalised upon by the R&D, and the obtained economic benefits to be used for increasing investments in R&D innovation activities.

At the same time, the leading role of the international experts in the R&D project was expected to represent a key contribution to the creation of high level scientific and/or technological competence centres within the financed R&D organisations. The research activities performed within these centres, eventually with support from other complementary SOPs and national programmes aiming to improve enterprises' competitiveness, were supposed to increase high-tech intensity in HEIs/RTOs. The result should be increased cooperation between enterprises and R&D organisations and HEIs and increased access to the RDI results for enterprises. The foreseen final outcome was enhanced administrative, research, and innovation capacities of HEIs/RTOs and enterprises with R&D activity.

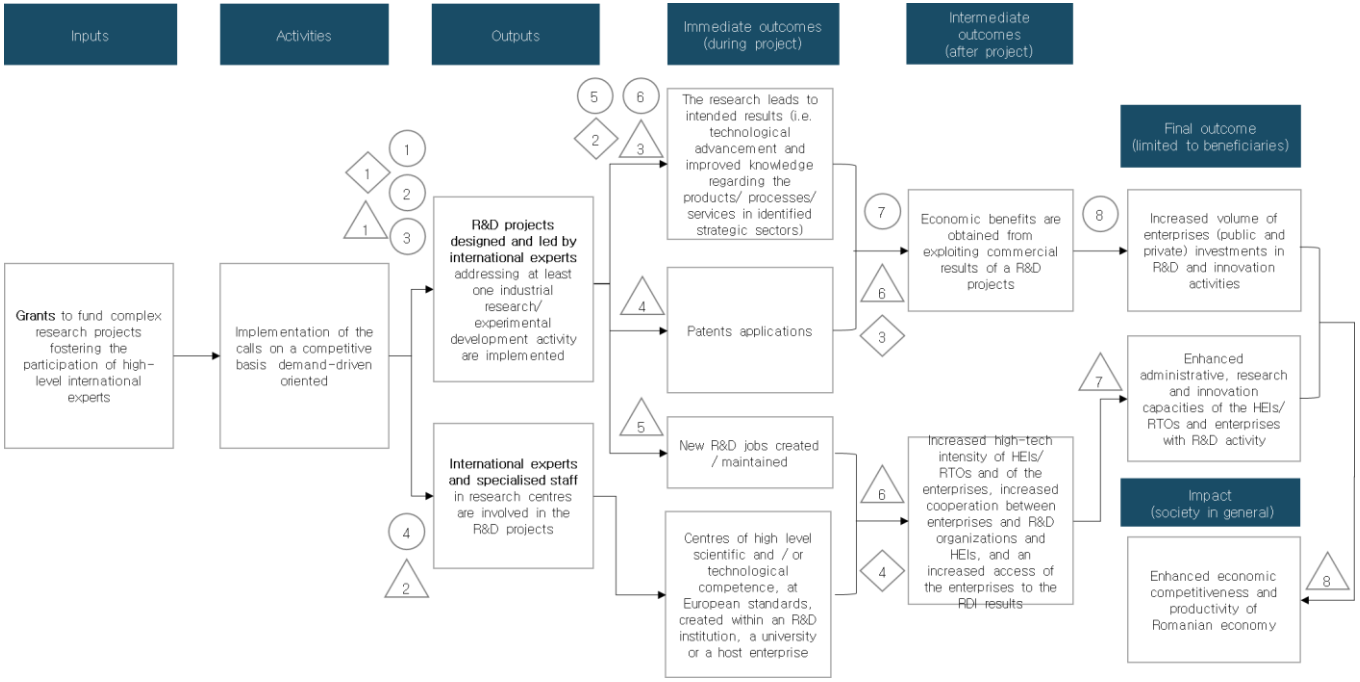
[31] 1. Health; 2. Agriculture, food safety and security; 3. Energy; 4. Environment; 5. Innovative materials, products and processes; 6. Information and communication technology; 7. Biotechnologies; 8. Space and security

In order to achieve the intended objectives, support was provided based on several pre-conditions. First, HEIs, RTOs, and enterprises involved in the R&D activity had to be aware of the strategic sector's priorities (s) in which they operated. Second, there should be local demand for research activities. Third, to secure effective implementation of the projects, the competitive evaluation and selection procedure had to ensure a high-quality portfolio of projects, and funds should be timely disbursed to avoid implementation delays. The projects' success was conditional on the availability of leading scientists with the required international experience and on beneficiaries' capacity to ensure the coordination of public procurement processes related to the project. The achievement of the ultimate goal of enhanced economic competitiveness and productivity of the Romanian economy was subject to macroeconomic stability.

The initial allocated budget was EUR 23.5 million (including both ERDF and State budget). The maximum allowed duration of project implementation was 36 months, and the maximum ceiling of the non-reimbursable financial support was EUR 1.5 million per project. The state aid intensity granted 100% of the eligible spending in the case of public R&D organisations, while in the case of the enterprises, state aid intensity differed in accordance with the size category of the enterprise and the type of activity performed within the project. The eligible activities were industrial research, experimental development to obtain and validate IPR, promotion and publicity for projects (only for R&D organisations), and project management (only for R&D organisations).

The following figure presents the ToC of the Internationalisation of research policy instrument.

Figure 20. ToC for Internationalisation of research



3.4.2. Contribution analysis of the policy instrument

Verification of intended intervention implementation

The interviews and data analysis revealed no major deviations concerning foreseen activities under the research policy instrument internationalisation. However, many challenges occurred at the level of the whole OP and its management system, as they are reported in the Final Implementation Report and already described in the previous sections.

To implement this measure, the MA launched a single call for applications that started on 3 March 2009 and was closed on 11 June 2009. As a result of the single organised call, 195 applications were received (of which 148 from public R&D organisations), for a total requested budget about eight times higher than that available (GEA Strategy, 2010). After a competitive evaluation, 45 projects were selected for financing, accounting for the entire allocated budget.

Despite the belated launch of the call for proposals, the activity led to a larger portfolio of projects than expected, thus showing a positive response to this measure's high popularity among the research community. This policy instrument was highly attractive for R&D organisations due to the level of funding (the maximum grant value per project was EUR 1.5 million) and to the structure of eligible expenses. The latter included expenses for research staff salaries, in addition to those for the acquisition of equipment, technical knowledge, consulting services for project management, and securing intellectual property rights. It should also be noted that especially HEIs had a long tradition of cooperation, teaching staff exchange programmes with similar universities from other countries, and previous chances to participate in international conferences and other events that built connections. Last but no less important, the MA and its IB were gaining implementation experience, and they were able to simplify requirements up until the end of 2008 when the call was organised.

The implementation of the activity led to the full commitment of the available funding from the single call. As a result of the high interest of eligible applicants, at the IB's request, the MA approved the increase of the public allocation by 114.7% (from EUR 23.5 million to EUR 47.3 million) from operation 2.1.1 within the same KAI[32]. The measure within PA2 financial allocation increased from an initial value of 0.7% (in 2007) to a final value of 1.6% in 2014.

This high attractiveness of the measure does not mean a lack of complexity. On the contrary, the call was open with two years' delay from the SOP IEC launch due to the long time needed for preparation and approval of the list of eligible expenses, the decision regarding the State Aid Scheme, and the Applicants' Guide. Both regulatory documents were approved in November 2008, and the AG was finalised at the beginning of 2009.

The upfront investment in communication with the eligible interested applicants counted for its high attractiveness. Prior to the organisation of the call, the IB organised a large number of workshops, training sessions, and information and promotion activities and participated in activities organised by other organisations, aiming to promote the programme and its measures. The information and promotion activities were held in all of the developmental regions and academic centres of the country.

Achievement of intended and unintended effects at the level of the expected threshold

From 45 projects selected for financing approval, only 40 financing contracts were finally completed. The difference has its roots in the delayed start of the measure and the

[32] Minute of the SOP IEC Monitoring Committee from 28 October 2009.

emergence of the financial crisis. As detailed in the previous sections, some enterprises were discouraged from continuing because the initial market conditions changed, and their cash flow capacity strongly diminished.

From the 40 finished projects within this policy instrument, 34 were implemented by public R&D organisations - 18 HEI and 16 RTO. Most of the projects (24) were located in the București-Ilfov region, 7 in the Nord-Vest region, 6 in the Nord-Est region and 1 in each of the Sud-Est, Sud-Vest Oltenia and Vest regions. This regional dispersion looks more homogeneous than in the case of RTD infrastructure.

Regarding the involvement of specialised international experts, monitoring data show that the intended target was exceeded. Thus, a number of 71 high-level specialists from different countries were involved in managing and implementing the financed projects, compared with the expected target of 30. It is interesting to note that the number of specialists from abroad hired as project managers was included only amongst the supplementary result indicators rather than the initial set of either achievements or results indicators. This addition is another indication of the unexpected great interest triggered by this measure.

Implemented R&D projects generally led to the intended results and also contributed to the increase in patent applications in conjunction with other policy instruments supporting R&D. Interviews confirmed that all the beneficiaries fulfilled their commitments at least at the contracted level and that new jobs were created not only in R&D activities but also in project management related areas. The involvement of international R&D staff also led to the creation of centres of high level scientific and/or technological competence within beneficiaries' institutions. All interviewed beneficiaries also reported the creation of high-level scientific core teams in the area of expertise covered by the projects.

The interviews conducted also highlighted useful findings on unintended achievements; for example, specialists contributed to an increased capacity to foster cooperation with other HEIs and with enterprises; specialists contributed to the design of a decision-making planning tool aimed at environment restoration in contaminated dismantled polluting industrial areas; international collaboration was further experienced.

The achievements related to the following intermediate outcomes could not be measured due to a lack of documentation. Only some anecdotal evidence has been collected. Some interviewees indicated that the results of implemented projects had a potential for economic application, but this potential has not materialised so far. Among the reasons, there are the long duration of IPR registration and/or certification according to quality systems requirements and the need for supplementary sources of financing.

Concerning the impact of this policy instrument, it can be assessed that its impact did not spread at the macro level due to the small number of completed projects under this measure. The FIR identified the macroeconomic dynamics given below, which might be to some extent linked with the policy instrument, but no clear evidence was available in this respect.

- Increase of the share of labour productivity per person employed in Romania in productivity per person employed in the EU; in 2008, this share was 48.5%, in 2014 it registered a value of 56.7%, and in 2015 a value of 58.9% was forecasted, thus exceeding the target set of 55% in 2015.
- Increase of the share of GDP per person employed in Romania in GDP per person employed in the EU; although the growth rate of this share has slowed in recent years, there is still an increase from 48% in 2008 to 57% in 2015, 2% higher than the overall target assumed (55% in 2013) (Eurostat, GDP per capita in PPS, index EU28 = 100).
- The increase of Romania's competitiveness index reflected by the decrease of the Global Competitiveness Index's rank. The ranking of Romania's Competitiveness Index decreased from 76 in 2013, to 53, in 2015, rising in 2016 to 62. The reduction of the index value compared to the value registered in 2013 confirms

the trend of increasing Romania's competitiveness, demonstrating the efficiency of implementing increasing competitiveness (World Economic Forum, 2016).

In summary, it is also impossible to find a causal link of the internationalisation of research policy instrument with the overall SOP IEC impact indicator formulated in terms of enhanced economic competitiveness and productivity of the Romanian economy in the absence of any counterfactual analysis. The financed beneficiaries interviewed highlighted soft-type impact at the recipient organisation level, as illustrated in Box 6 and the complete projects fiches attached in ANNEX VI and ANNEX VI.

Box 6. Selected projects implemented - internationalisation of research

Cyberdin - Cyberinfrastructure for Geodynamic Studies Related to the Vrancea Seismogenic Zone[33]. This project implemented by the Romanian Academy Institute of Geodynamics Sabba S. Ștefănescu took the unique opportunity of ERDF financing to set up a High-Performance Computing Cluster (HPCC) together with a Results Visualisation Cluster (HPVC) and an interactive 3D results handling system (Geowall) within the Institute of Geodynamics of the Romanian Academy of Sciences in Bucharest. The project was developed in cooperation with a Romanian expert with a worldwide reputation in this area, from the National Autonomous University of Mexico. This is a pioneering infrastructure in Romania since no such facility is available for geodynamics study in the country. Also, this infrastructure provided a much-needed technological boost at the Institute of Geodynamics of the Romania Academy of Sciences, placing this institution in the ranks of worldwide top research centres. The project generated a new research area in Romania – Numerical Geodynamics. Project results also include a centre for agricultural and ecological research organised by departments and specialised labs, newly created jobs, and scientific communications. Notable follow-up activities include participation in the FP7, H2020, SAFER programmes, and collaboration with the private sector, especially farmers. (More details in Annex V).

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RECOLAND - ***Multi-criteria Decision System for Remediation of Sites Contaminated with Toxic and Persistent Pollutants in Large Industrial Areas[34].*** The project, led by a Romanian PhD with experience in EU funded projects in Italy, implemented by the Faculty of Power Engineering of Polytechnic University of Bucharest (UPB). It developed a multi-criteria decision-making system (computer system) to allow risk assessment of population health and its use as a decision-making criterion in establishing the suitability of soil in historically or accidentally polluted areas. Another result consists of two pilot installations for electro-remediation of contaminated soils. This tool was applied in a project addressed to a 4000 sq. m contaminated site in Copșa Mică. In this industrial area, carbon black, sulphuric acid, and non-ferrous metals, including lead and cadmium, were processed until 2008. The project was one of the first developed within the national strategy for the management of contaminated sites and significantly contributed to the establishment of risk evaluation methodology and elaborating the law on the management of compostable non-hazardous waste (Law no. 181 from 19 August 2020). It has increased the institution's R&D capacity and fostered cooperation between the university and the enterprises around which there have been significant historically contaminated areas. The continuous support in the project completion of a strong HEI was the major enhancing factor. UPB secured the cash flow from its budget due to delays in the processing of reimbursement claims. Project results also include newly created jobs, one patent application, one registered software application, scientific publications, and one research group within THE Faculty in remediation of contaminated soil. The project director remained in Romania after the project closure. (More details in ANNEX VI).

Source: Authors based on the conducted interviews.

Verification of assumed pre-conditions

The high number of submitted applications, as well as the share of the project proposals whose score after the evaluation was greater than the established quality threshold (approximately 50% as indicated by the MA in the AIR 2009), are good indications that the host **R&D organisations were able to define the research concepts** regarding strategic priorities in the research sector in which they operate (pre-condition 1), to

[33] http://cyberdyn.geodin.ro/index.php?req=english
[34] http://energ.pub.ro/

search for the most suitable international specialists in full compliance with the desired profile, and aimed at strengthening their capacity.

Similarly, as a result of a transparent and clear evaluation operational procedure, the submitted projects portfolio met the call organisers' expectations. The established set of criteria and the evaluation and selection process were fully described in the AGs and presented transparently during the upfront information and promotion activities carried out by the IB. Full details about the evaluation and selection criteria are presented in the ToC of the corresponding measure. The success rate of the quality projects approved is also able to document the allocation of available funds based on a transparent and competitive process.

The materialisation of **the timely payment of reimbursement claims** (pre-condition 3) is instead more limited. A review of the OP documentation revealed that the delay in processing reimbursement claims submitted by the beneficiaries was one of the major constraints met by them. This difficulty was recognised by the MA in its annual implementation reports and the FIR and explained by a weak administrative capacity to process the claims in due time, such as a lack of enough monitoring officers able to verify the physical progress in project implementation before payment of grant tranches, a lack of verification staff with a suitable economic background to adequately process the claims, the overwhelming workload, and other causes.

However, these difficulties were mitigated in the subsequent stages of the implementation cycle by hiring suitable personnel and introducing the new payment mechanism. The stakeholders consulted testified that the existence of two mechanisms worked well. The beneficiaries had the chance to select which one (reimbursement claims or suppliers' payment mechanism) to apply, in accordance with their cash flow capability and the stage of the project's advancement.

The MA succeeded in initiating and adopting changes necessary to increase system efficiency. According to programme managers consulted, SOP IEC, as part of the first generation of operational programmes in Romania, was an absolute novelty and a learning opportunity both for the beneficiaries and for the authorities with a role in managing the funds, and its implementation has certainly resulted in increased capacity throughout the chain

As a result of the eligible Romanian host organisations' capacity to search for partners based on their professional connections, many leading scientists working abroad were **interested in joining and participating in research projects** (pre-condition 4) funded under this policy instrument. According to consulted stakeholders, three categories were identified: (i) researchers from abroad who previously participated together with Romanian researchers in the framework of international or bilateral research projects; (ii) researchers from abroad who did not participate in previous common projects but had personal contacts with Romanian researchers based on a common area of scientific interest or expertise (participation to scientific conferences, scientific publications); (iii) Romanian scientists who had worked in research (or had been in doctoral or postdoctoral studies) for at least three years abroad, in the five years before the application was submitted.

Another pillar for achieving effectiveness was the **beneficiaries' ability to coordinate the public procurement process** related to the project (pre-condition 5). Both interviewees and the SOP IEC implementation reports highlighted that the procurement process was the most difficult part of the project implementation. The difficulties covered all stages of the public procurement procedure, from the elaboration of the procurement documentation to the ex-post verification performed by the Audit Authority set up under the Romanian Court of Accounts and finalized in some cases with financial corrections. After the first issuing in 2006 of legal provisions regarding public procurement, which transposed the European specific regulations, the process changed several times during the programming period. The novelty of the legal provisions and the frequent rate of changes, along with the low level of experience of all the involved stakeholders, contributed to the difficulty of this process. However, the project implementation teams

managed to overcome these difficulties and to achieve the expected results. When this pre-condition is appraised, it should also be taken into consideration that internationalisation projects did not imply extensive works procurements compared with the infrastructure projects.

Moreover, since there are no indications from the SOP IEC monitoring system regarding beneficiaries' non-compliance with the rules regarding the State Aid and De Minimis Aid, or with the procurement rules, it can be concluded that **enterprises were able to carry out the project in compliance with public procurement and State Aid rules** (pre-condition 6).

Verification of supporting factors

As with previous policy instruments, in this case, also the availability **of national funded programmes providing consultancy to beneficiaries to develop eligible project proposals** (supporting factor 1) was crucial. Again, it was especially the availability of the IMPACT Programme, financed from the state budget, based on GD no. 918/2006, which contributed to the achievement of timely implementation of the call.

Other **RDI programmes at the European level** (supporting factor 2) contributed to the establishment of collaboration between international experts and local HEIs/RTOs, and enterprises with R&D activity. There is a lot of evidence regarding the collaboration relations established between local R&D organisations and international research entities and experts. For example, the 2008 NASR report on government policies for RDI in Romania cited the statistical data provided by the European Commission on calls launched in 2007-2008, which indicate that 187 532 entities applied to the EU CD Framework Program for 2007-2013 (FP7) and FP7 Euratom, of which 23 160 participations were from Romania. Following the evaluation, 21 497 entities were selected for funding, of which 230 in Romania. The 230 entities in Romania participated in 181 contracts financed by the European Commission, 18 of them as coordinators. Also, ERAWATCH Country reports 2010: Romania provides examples of Romania's participation in intergovernmental research organisations and schemes - COST, EUREKA, and FP7, as well as in intergovernmental research infrastructures (CERN, ESA, DUBNA), and bi and multilateral agreements with other ERA countries.

Moreover, **the availability of R&D service organisations (project management, IPR) to support the beneficiary enterprise for efficient and timely project implementation** (supporting factor 4) was also key. There is a lot of evidence regarding the collaboration between local R&D organisations and international research entities and experts. Full details are included in the ToC. This means the supporting factor did take place.

However, it should also be noted that **not all beneficiaries had the necessary resources and capacities, in terms of organisation, management, human resources and infrastructure, to ensure the project implementation on time** (supporting factor 3). Data from the monitoring system indicate that in 31 out of 40 beneficiaries, the project duration exceeded the allocated timeframe of 36 months. The prolongation of the project duration was analysed and approved by the MA. According to the FIR information, the main reasons for delays are the difficulties encountered in the procurement process and the inherent risks that occurred in the research process. The interviews highlighted that beneficiaries had the full support of their administrative departments (finance and public procurement) during project implementation. Also, the enterprise's financial backstopping proved to be decisive in keeping the project on track when the reimbursement was delayed.

Conversely, other (i.e. SOP HRD and national) support measures targeting enterprises with R&D activity and R&D institutions' staff (supporting factor 5) did not influence effectiveness since there were some complementarities. Still, there is no evidence due to the lack of an interconnected information monitoring system about how much other support was used.

The synergies and complementarities of the interventions financed by SOP IEC were foreseen through the mechanisms defined in NSRF and SOP IEC. Specifically, there were important synergies established between priority axis 2 and priority axis 1. Some enterprises financed under priority axis 2 'RDI for Competitiveness' could also prioritise axis 1 to seek support for productive investments and access to new markets, ideally through integrated projects. Likewise, enterprises supported under priority axis 1 could get support under priority axis 2 as their demand for knowledge grew.

There were also synergies between priority axis 2 and SOP Human Resources Development - priority axis 1 'Education and training in support for growth and development of knowledge-based society', which promotes doctoral and post-doctoral programmes in support of research, and priority axis 3 'Increasing adaptability of workers and enterprises', which supports the development of entrepreneurial skill.

However, in the implementation process, there was no systematic verification of the complementarity of projects. As a result, the strategic correlations remained at a static level, and the lack of prioritisation determined a concentration of interventions in certain areas and a low complementarity of the investments made.

The institutional mechanisms created to ensure complementarities have functioned in a limited way, unable to ensure a high degree of complementarity between the different sources of funding available. On the other hand, the mechanisms for ensuring the demarcation of interventions with IFIs and other programmes, including bilateral programmes, were largely carried out only on the basis of consultations and collaborations between the institutions involved.

The evidence regarding the last two support factors 7 and 8 is the same as the one already detailed in the contribution analysis of the previous policy instruments.

Verification of risks and threats

In contrast with the previous policy instrument, in this context, **the outbreak of the economic and financial crisis** (risk 1) did not influence effectiveness. Similarly, **inherent risks of experimental development and applied research projects** (risk 2) also took place to some extent but did not influence effectiveness. The monitoring system has shown that all the contracted projects achieved their research objectives even though, in some cases, some delays were registered. There is no specific evidence available regarding the reasons for delays. Still, the inherent risk of experimental development and research projects was mentioned within the FIR as one of the causes. It can be concluded that this risk did take place, but in the case of this measure did not influence the effectiveness as a result of safeguarding a risk mitigation plan.

Conversely, there are no quantitative or qualitative data to confirm that technological, social, regulatory, or economic changes render the research results irrelevant and commercially unappealing or unviable (risk 3).

Finally, interviews highlighted that **staff turnover** (risk 4) was a key problem during the project implementation and completion. It is worth mentioning that the internationalisation projects were aimed at attracting Romanian high-level specialists working abroad. Still, the project could not contribute to the reversal of the migratory 'brain drain' phenomenon. In the attempt to reduce the 'brain-drain' phenomenon, or even to reverse it to a 'brain gain', several policy measures have been adopted by the Romanian Government as follows:

- A new payroll law in the public system was implemented starting August 2016;
- The wages in the health and education sectors have increased by 15% from January 2017;
- The Government Ordinance 32/2016 (August 2016) has introduced an exemption from annual income tax earned from remuneration by the personnel involved in R&I activities, aiming to provide tax incentives to staff involved in RDI activities;

- In October 2017, GD 751/2017 raised the salary ceiling for specialists working in RDI projects financed by public funds.

Despite the remuneration policy measures taken, 'The staff in HEIs, education, research and the medical system remains heavily underpaid in comparison with EU28 and with other national categories of personnel (judges, local administration, police, army) working in the public system' (JRC, 2017). However, these measures adopted from 2016 are aimed at influencing the phenomenon in the longer term. At the time of SOP IEC implementation, such policy measures were lacking, and therefore, the risk materialised and impacted effectiveness.

3.4.3. General assessment of the policy instrument

The intervention was a necessary cause leading to the achievement of expected outputs and immediate outcomes, based on the recent history of collaboration between Romanian and foreign researchers, in the framework of RDI programmes at the European level during the pre-accession period of Romania to the EU. However, also, some supporting factors contributed to the achievement of short-term outcomes.

The policy instrument has fully contributed to the restoration of previous connections, dismantled either by the country's previous regime or interrupted due to financial shortages faced by Romanian public RTOs. The policy instrument's effectiveness in terms of outputs and immediate outcomes was facilitated by several pre-conditions (partially 1, 2, 3, 4, 5 and 6). These were the pillars of its proper implementation. However, the pre-conditions' synergic action and the supporting factors (1, 2, 3 to some extent, 4, and partially 5) also contributed to effectiveness. It should also be retained that, despite a set of risks that were taking place, only one (4) has acted in direct opposition to negatively influence effectiveness.

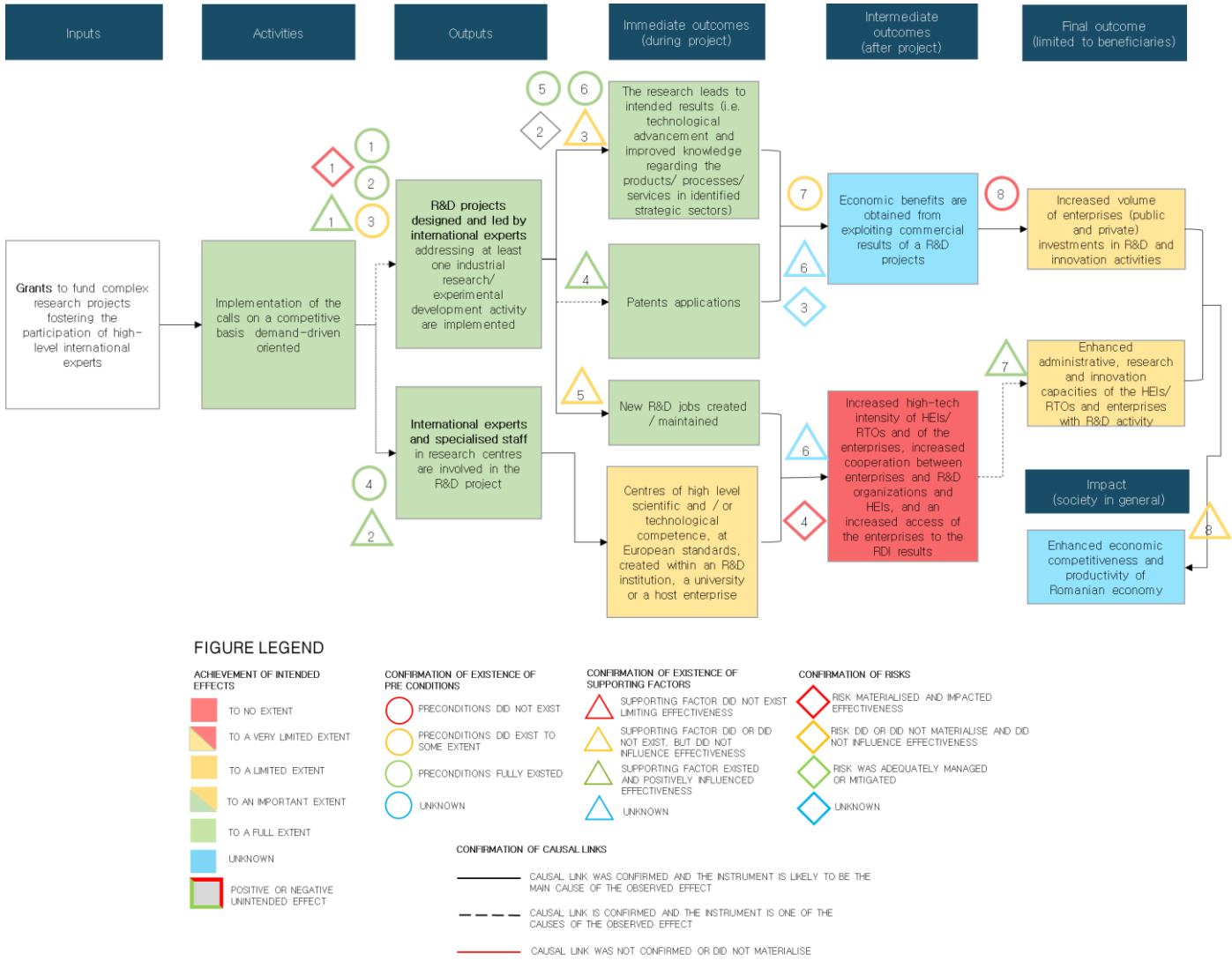
There are no available data at the policy instrument level, but the consulted stakeholders indicated that all the beneficiaries fulfilled their target commitments at least at the contracted level. Thus, it could be assumed that the projects financed under this measure achieved their intended results and contributed to other PA achievement indicators.

The status of the intermediate and final outcomes – defined as the increased high-tech intensity of HEIs/RTOs and the enterprises, increased cooperation between enterprises and R&D organisations and HEIs, and increased access of the enterprises to the economic benefits obtained from exploiting commercial results of R&D projects – is not clear, due to the lack of targets. In the absence of evidence regarding supporting factors linked with the final potential outcomes, it can be assessed that the programme measure had no impact on these specific outcomes.

Moreover, in the absence of any impact and/or counterfactual analysis of the SOP IEC and its corresponding policy instruments, there is no clear picture on impacts, or even on some indications of observed changes and the extent to which they can be assigned to the support provided within the RTD policy instruments.

The interviews carried out highlighted that the medium-term effects of the achieved outputs are sustainable at the micro-level. There is a 'soft type' of impact, such as enrichment of the making planning tools, increased capacity to foster cooperation with other HEIs and with enterprises, increased participation in international collaboration networks, increased capacity to advocate for the adoption of the necessary legal framework, and an established solid background for the completion of further projects.

Figure 21. Representation of the results of the contribution analysis for the policy instrument Internationalisation of research



4. GENERAL FINDINGS AND LESSONS LEARNT

Key achievements of ERDF support in the Member State (i.e. effectiveness)

The general objective of SOP IEC was to increase Romanian companies' productivity and reduce the disparities to the average productivity of the EU.

The absorption rate of the allocated financial resources to SOP IEC was almost 100%. The case study found that the overall performance of the Priority Axis 2 was positive, taking into account that ten from these 13 indicators were achieved, out of which nine exceeded the established targets.

However, the fact that the targets were met does not represent conclusive evidence of objectives' achievement as this is the only existing evidence in the absence of any either performance or counterfactual analysis after SOPIEC was implemented. Additional conditions and policies should have accompanied the programme's initial ERDF investments to have a sustainable impact. These were not made as proven by the fact that the expected over-ambitious final outcome of the Priority Axis 2 - the increase of the value of total R&D expenditure (GERD) to 2% of GDP in 2015 - was not achieved. This increase would have been meant a giant leap possible only in the context of the fast-growing economic development which had been recorded before the outbreak of the financial crisis. In order to achieve an increase in GERD, the national funding to the RDI sector should have been increased as well. The reality has shown that due to slow recovery process and ever-changing policy priorities, the share of R&D expenditure over GDP registered a slight decrease from 0.54% in 2007 to 0.50% in 2017 and continued its declining to 0.46% in 2019 as per the latest Eurostat data. However, the committed target remained 2% of GDP.

Approximately 15 years after the SOP IEC was designed and five years after SOP IEC was financially and administratively closed, it can be pointed out that this target was overestimated since risk factors were not properly taken into consideration and national funding was not contributing with the required resources.

The CS has found that it is difficult to appreciate the extent to which policy instruments generated the intended changes due to the lack of a clearly and appropriately defined set of measurable indicators at the level of the policy instruments and targets to assess them. Overall, it was found that achievements indicators and targets have been specifically defined at the policy measures level for less than 10% of the intended results as defined in the Theories of Change developed for this evaluation.

The ERDF investment in collaborative research activities has facilitated a pioneering institutional arrangement scheme between private enterprises and research partners and contributed, besides the planned outputs, to develop a partnership culture in Romania. As such, ERDF support in the internationalisation of research, based on collaboration with international specialists, allowed a bridging of the gap between Romania and other MS and enhanced Romanian excellence research RTOs' and HEIs' reputation as reliable and trustworthy RTD partner.

The number of applied projects by leading Romanian applicants has slightly increased in the H2020 programme than the FP7, while other new MS have recorded a decrease. This positive evolution might be linked to the higher visibility of these two European funded programmes and Romanian research organisations' improved capacity to meet programme requirements. The real participation was higher than the number of applied projects taking into account most Romanian RTOs have been involved as partners of other European leading applicants. According to the Innovation Scoreboard, the Romanian RDI performance was steady and with high disparities among Romanian regions.

At that time (2007), the allocation of 95% of the ERDF resources into infrastructural investments was the right policy mix taking into account the huge need for the existing RTD infrastructure rehabilitation and its modernization and the need for newly built

research infrastructures in RTOs and HEIs as well as in the health sector. This was considered a pre-condition for more investments in R&D activities to be carried out later when capabilities and more maturity of the system had allowed that. However, despite these assumptions, the challenges that the Romanian R&I system was facing in 2007 are still present[35].

Overall, the ERDF support in RTD infrastructure investments is perceived by all interviewed stakeholders as having 'without any doubt' played a pivotal role in developing and upgrading the country's RTD capacities.

As concluded, the type of investment designed by SOPIEC seemed appropriate for 2007-2013, but in the longer-term did not improve the R&I performance much. It would have been indicated further steps to diversify the policy mix, envisage supporting other types of measures (and not only infrastructure) and enhance strategic thinking, monitoring and implementation capacities (i.e. the same issues related to low capacities for implementation – either at MA or at the beneficiary level are still present now).

In terms of use of funds, the ERDF not only pioneered the financial support of the first generation of OPs but also demonstrated that competitive participation in the RTD sector has the potential to attract financial resources at the region's level by safeguarding equal access and transparent, competitive basis and not through pre-allocation policies and policy instruments directing funds to the regions. It can also be concluded that it had the potential to play a positive role in promoting scientific excellence and quality projects as the only targeting criterion

Relevance

The programme's strategic rationale was fully justified by the comprehensive analysis of Romania's economic situation within its 2007-2013 National Development Plan (NDP) and the National Strategic Reference Framework (NSRF). The ex-ante evaluation report has fully endorsed the programme's solid foundation. The logic of intervention built at the whole programme level matched the country's identified needs and challenges.

The financial and economic crisis which hit Romania starting in the last quarter of 2008, and the scarcity of the RTD national budget expenditures in the subsequent austerity years, and even during the slow recovery period, made ERDF funding allocated for RTD activities and infrastructure development even more relevant for the survival of public RTO and the improvement of public HEI educational infrastructure. The crisis hit the private sector even harder than public entities. Their sources for financing hard and soft investments were cut almost overnight in December 2008. The ERDF funding represented a real 'safety belt' for these two categories of targeted eligible beneficiaries, aimed at defending them in the financial turbulence and tough shortages brought by the crisis. In this context, it is worth noting that the PA2 of SOP IEC preserved its initial relevance and increased its relevance during the programming cycle's lifetime.

The CS has demonstrated that the logic of the programme intervention maintained its relevance. The contribution analysis has revealed that, for the most part, the established specific objectives have been achieved, particularly at the level of planned activities and outputs and, to some extent, also at the level of immediate outcomes. More limited evidence is available for intermediate, final outcomes and impacts.

As a result of long-term relevance, the PA2 and SOP IEC as a whole did not suffer any programming change. The joint EC and Romanian Government decision lead to the inclusion of the single major ELI-NP project within the PA2 project portfolio, and, following careful managerial monitoring of the funds' absorption by the other priority axes, the only decision made referred to a reshuffle of allocation from a PA4 to PA2, and an internal reshuffling within the policy measures of the PA2. Another decision is linked

[35] As last RIO Country report from later years that were able to 'catch' the impact of 2007-2013 (in fact 2016) investments. E.g. https://rio.jrc.ec.europa.eu/country-analysis/Romania/country-report

with the exclusion of the initial 2.2.2 policy measure on supporting the creation of poles of excellence (justified by the full compliance with complementarities principle), with another policy measure within the PA1 focused on poles of competitiveness.

The relevance of RTD interventions increased during implementation in light of the reshuffle of funds between priority axes (funds were redirected from Priority Axis (PA) 4 including measures for energy efficiency to Priority Axis 2 under which RTD interventions were funded). This action had a double aim, respectively, to introduce a single major project, Extreme Light Infrastructure-Nuclear Physics (ELI-NP), within the project portfolio and speed up the absorption of available funds. Under Priority Axis 4, funds were not fully used due to the lack of mature pipeline projects and weak demand of the eligible applicants.

Although the regional differences in RTD performances in Romania were known, the philosophy underlying the SOP IEC programme's design did not provide a mechanism for pre-allocating ERDF resources to developmental regions.

There was no policy to direct infrastructure investments to RTOs rather than to HEIs. The proof is the absence of any pre-allocation of funds by categories of applicants. RTOs were in greater need of technical/technological modernisation. RTOs had been in a chronic underfunding situation for more than 15 years and were in danger of 'disintegrating' with the professional reorientation of researching staff. It is also true that the RTOs represented 'an inheritance' from the previous regime that had to be saved. The 2007-2013 National Development Plan (NDP) identifies approximately 713 research entities throughout the country, with the highest concentration in Bucharest and traditional technical university centres. The funding was addressed equally to all types of eligible applicants on a competitive basis. The result is based on the ability of the winning organisations to present qualitative applications in order to fully meet the evaluation and selection criteria.

Most of the RTD premises and academic institutional framework is concentrated in the most developed region (București-Ilfov region). 100% state aid intensity for RTOs and HEIs functioned as a 'seat belt' during the turbulence generated by the financial crisis, while a much lower state aid intensity for the beneficiary enterprises and their weak creditworthiness for raising bridge-loans from the commercial banking sector affected their capacity to co-finance. This situation led to the termination of a significant number of financing contracts upon the request of the enterprises.

If ELI-NP is analysed separately in the light of its quite big budget allocation, the distribution of ERDF support appears to be generally balanced across financed beneficiaries from three categories: RTOs, HEIs, and medical sector research organisations. It is assumed these are the ones with a higher potential competitive advantage and aimed at spreading societal benefits.

Efficiency

The ERDF funding played an outstanding role in carrying out RTD activities in Romania. The ERDF available funds for building new RTD infrastructure and the modernisation of the existing ones was a major opportunity, 'a gold mine', for reducing the gap in the technological level of the public RTOs and HEIs. In the first programming period after the country's EU accession, the volume of financial support provided by the ERDF to RTD activities and infrastructures was not sufficiently high to 'move the needle' for the country's research system as a whole. Still, the financed beneficiaries have been able to upgrade their working premises significantly.

This case study shows that it is crucial to have a robust monitoring system and use appropriate result/impact indicators to inform systematic impact evaluation exercise to determine the effectiveness and efficiency of the investments/policy mix. In the absence of these mechanisms, some path dependency can be observed without learning lessons from what was implemented in the past. This is particularly evident when noting that Romania continues to allocate the majority of R&I ERDF funding in infrastructural

projects in the lack of solid evidence about how this has improved the Romanian R&I sector's capacities or performance of the Romanian R&I sector.

The pursued policy mix and the repartition of the budget (both internally and related to the overall NSRF allocations) can be regarded as justified. Regarding categorisation and earmarking (the latter is not obligatory to Romania as an acceding country), more than 80% of Lisbon-earmarked operations were foreseen. This was twenty percentage points more than the threshold for Convergence programmes. However, a big share of that 80% was related to direct subsidies to enterprises.

Sustainability and replicability

The evaluation process found that the outputs achieved under the RTD infrastructure development are sustainable from the technical, institutional, and financial perspective. Technical sustainability is ensured by a high degree of novelty, by technologies implied by the procured equipment, which belonged to the latest generation class of equipment, and by the long warranty period negotiated with the equipment's providers. The detailed technical specifications in tenders' TOR were also prerequisites for ensuring technical sustainability.

In light of ownership rights and the legal regime over the built infrastructure (buildings, other assets), institutional sustainability was clarified even at the FR submission, or at the latest, at the contractual phase. Financial sustainability, in terms of assurance of the recurrent and operational costs, was covered from various sources of financing - either by the public RD organisations from the annual allocated budget, or from extra-budgetary own revenues (RTO, HEI), or by participation in follow-up projects, including ERDF funds of the ongoing Competitiveness Operational Programme (COP) 2014-2020 or national programmes. A firm commitment regarding financial sustainability assumed at the organisation's leadership level (board of administration, university Senate, etc.) was required even at the submission of the project proposals.

In 2015 the Romanian Government allocated to NPRDI II EUR 3,672.8 million from the state budget, disaggregated on the six national policy priorities defined by NSRDI 2007-2013[36]. This represented additional resources aimed at ensuring the sustainability of the newly built infrastructures.

The evaluation also shows that the collaborative R&D measure was not fully successful in ensuring the research projects' financial sustainability and setting up long-term research partnerships between R&D organisations and enterprises. The institutional sustainability of the results obtained in collaborative R&D projects was safeguarded by the partnership scheme. The enterprise beneficiary was the sole owner of the intellectual property rights over the research outputs and solely entitled to go further in the patent registration.

Regarding replicability, the evaluation found that the consolidated administrative capacity of the target RTD infrastructure development led to the proposal of other projects, either submitted under the ongoing COP or to other donors, including FP7 and H2020. Most of the RTOs and HEIs have indeed played the role of a partner rather than the leading applicant's role on behalf of the partnership.

However, it can be emphasised that the implementation of PA2 of SOP IEC represented a source of lessons learnt and a more solid foundation for planning and implementing the subsequent OP in the second programming period. The pioneering implementation teams at the beneficiary level later acted as a resource centre for their organisation. There was also a multiplier effect on the impact of a consolidated institutional memory.

[36] Romanian Government Decision no. 252 of April 15, 2015 for the amendment of the GD no. 475/2007 regarding the approval of the National Plan for research-development and innovation II, for the period 2007-30 June 2014

In terms of replicability, the funding mechanism of collaborative R&D support, which was developed to increase the likelihood of generating project proposals corresponding to the needs of enterprises, could be of interest to developmental regions (better endowed with Regional Innovation Strategies for Smart Specialization) in supporting similar policy instruments under Regional Operational Programmes in the next programming period (2021-2027).

Educational infrastructure investments are an interesting example of the possible synergies which can be developed with the assistance of the different OPs.

Coherence

Regarding coherence with national policies (SME policy, tourism, R&D policy, and energy policy), the SOP IEC approach appeared to be well coordinated.

The priority axes of SOP IEC were designed in full compliance with the lines of action of the Commission's proposal regarding the framework for Competitiveness and Innovation 2007-2013, and responding to the guidelines put forward by the EU Council for cohesion policy for 2007-2013.

The synergies and complementarities of the interventions financed by SOP IEC were foreseen through the mechanisms defined in NSRF and SOP IEC, based on the national development priorities and the main strategic connections for their realisation established through NDP 2007-2013, as well as through the development of some institutional mechanisms that aimed at ensuring a good correlation and coordination of the funds.

However, in the implementation process, there was no systematic verification of the complementarity of the projects, which is mainly caused by the absence of national sectoral strategies to establish the orientations and objectives pursued in the medium and long term, of action and monitoring plans, and of a realistic timetable for implementation, as well as to identify the correspondences between national development priorities and targets set at EU level. As a result, the strategic correlations remained at a static level, and the lack of prioritisation determined the concentration of interventions in certain areas and a low complementarity of the investments made (SOP IEC FIR, 2018).

EU added value

At the level of policy and decision making, it brought:

- A change of the paradigm concerning the need to introduce multiannual public policy financing programmes, rather than annual budgets, to ensure predictability and sustainability;
- Consolidation of strategic planning skills, with an emphasis on developmental vision in the medium and long-term, rather than a focus on short term results;
- Uniformity and homogeneity of managerial skills in the programmes and projects within the institutional system;
- Greater transparency and fairness in governing public funds;
- Governance of ESIF funded programmes built on partnership with stakeholders.

At the level of financed beneficiaries and other stakeholders, it brought:

- A different management style based on projects;
- Changes in raising financing for carrying out the research themes within the annual work plan;
- A better mutual understanding by RTOs and HEIs of the needs of enterprises, and re-orientation of approach to the demand side rather than the supply side;
- A consolidated capacity to meet the continuous higher project's competition requirements and a broad understanding of the EU funded OP goals;
- Changes in organisational, institutional culture and consolidation of the partnership culture and social capital increase within society;
- Higher accountability and responsibility in using public funds, either from the national central or local budgets or from EU funds.

In conclusion, the ‘first EU funded OP generation’ was a challenging pioneering work site where ‘all parties have simultaneously tested, corrected and learnt’, but a secure foundation for the second programming period. ERDF support pioneered the first generation of OPs. It demonstrated that the RTD sector has the development and competitive participation potential to attract financial resources on merit, not through policies and policy instruments to direct funds to the regions.

Annexes

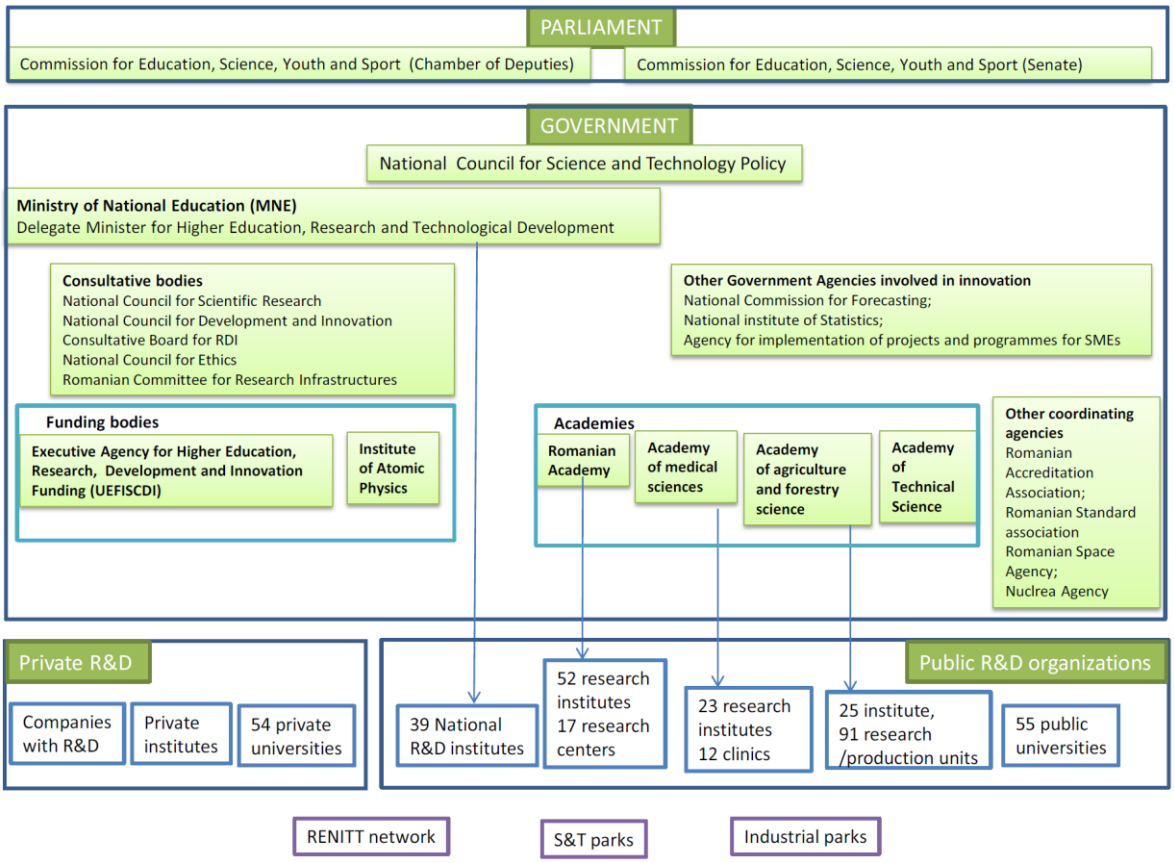
ANNEX I. OVERVIEW OF THE COUNTRY'S NATIONAL SYSTEM OF RESEARCH AND DEVELOPMENT (NSRD)

The key governmental institutions with a major role in the sector's policymaking were:

- **The Commission for Education, Science, Youth and Sport** set up within the Senate of the Romanian Parliament and the homonymous commission of the Chamber of Deputies whose role was to debate and approve draft laws and other legal documents on science, education, sport and youth;
- **The National Council for Science and Technology Policy**, which was the government's high-level policy coordination body that sets the National RDI Strategy priorities and legislative framework, in line with the government programme and sectoral strategies, and in consultation with key stakeholders (local and central public administration bodies, higher education organisations, R&D institutes, economic agents, employers' federations and labour unions, etc.). It was established in 2003 by the Prime Minister's Decision no. 2/6.01.2003 that also defines its structure;
- **The Ministry of Education, Research, Youth and Sport** (MERYS) was the key actor in education and RDI. MERYS collaborated with other line-ministries, which had only a very limited role in RDI activities, arising from the coordination exerted on some national R&D institutes, participation in the National Council for Science and Technology.
- **The National Authority for Scientific Research** (NASR). It was set up under the MERYS structure and was responsible for developing and implementing RDI objectives and policies. The NASR was also part of the European Structural and Investment Funds (ESIFs) management system, being in charge of the implementation of the 2007-2013 SOP IEC as Intermediate Body;
- **The Executive Unit for the Financing of Higher Education, Research, Development and Innovation** (UEFISCDI) set up as a public institution with a legal personality subordinated to the Ministry of Education[37]. Amongst other duties, UEFISCDI was in charge of the coordination of the RDI programmes within the National Plan for Research-Development and Innovation for the period 2015 - 2020 (NPRDI III), under the scientific guidance of the advisory councils of MERYS;
- **Other consultative bodies established under MERYS coordination**.

[37] Based on the Governmental Ordinance no. 62/1999 further approved with modification by the Romanian Parliament through the Law no.150/2000 with subsequent amendments and completions.

Figure 22. Overview of Romania's R&D system governance structure



Source: Erawatch Country reports 2013: Romania

The National System of Research and Development (NSRD) included public and private organizations. The public organizations were comprised of: a) research and development institutes, centres and units organized as public institutions; b) research and development institutes or centres organized under national still state-owned companies or autonomous administrations at a central or local level; c) international research and development centres established under international agreements; d) other public institutions or structures of these with research and development activity. The private organizations were: a) research and development establishments organized as commercial societies; b) commercial societies and their structures having research and development as objects of activity; c) authorized private higher education institutions or their RDI structures.

ANNEX II. OVERVIEW OF EVIDENCE COLLECTED ON EXPECTED EFFECTS OF THE INFRASTRUCTURE FOR RESEARCH INSTRUMENT

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
Outputs	Built/modernized research infrastructure in public HEIs and RTOs and equipped with new scientific equipment	Partially (target defined at PA level) 600 R&D projects financially supported; EUR 523.1 million public expenditure in assisted R&D projects; 100 newly created laboratories; 100 modernized research laboratories	**Desk research:** By contract, all projects financed under the SOP IEC had to include in their own set of indicators a set of mandatory indicators from those defined at the level of the priority axis and to define target levels for them. The realization of the indicators was monitored by IB officers during the project (including the sustainability period), and the achievement of the values of the project indicators was mandatory. **Task 1 data and SOP IEC Final report:** 558 supported R&D projects at the PA level; this measure contributed with 111 projects (18.5%) to the achievement of the PA target; EUR 1,001.89 m public expenditure in assisted RDI projects achieved at PA level; this measure's contribution was 84.5%; **Interviews:** There are no available data at the PI level, but the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. Indirectly it could be assessed that this PI contributed to the achievement of 893 new laboratories compared to the target of 250 at the PA level and to the achievement of 367 modernized laboratories	TO A FULL EXTENT
	ELI-NP infrastructure is built, and research equipment is purchased	Yes Realization of a research infrastructure on an area of 137,075 sq. m; Laser-2 arms of 10 PW; High-intensity gamma beam production system; Experiments with technological transfer in nuclear physics, laser physics, materials engineering and the medical field	**SOP IEC Final report** – Project phase 1 finished 100%	TO A FULL EXTENT
Immediate outcomes	New/modernised research facilities are used for fundamental/ experimental research and in the educational process (licence, master or doctoral degrees)	Partially (target defined at PA level) 250 articles published in scientific publications	**Interviews:** There are no available data at the PI level, but the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. Indirectly it could be assessed that this PI contributed to the achievement of 1,000 published in scientific publications compared to a target of 250 at the PA level Moreover, even no quantitative data are available, all the RTD and HEIs representatives interviewed mentioned that the improved infrastructure had a decisive contribution to the increase in the scientific production, in collaborative projects with national and international research organisation and in the research projects developed as part of the educational process. The consulted stakeholders from HEI confirmed in interviews that infrastructural investments have also contributed to increasing the quality of teaching. The implementation of projects had a great impact on the quality of education, primarily due to the possibility of using modern equipment, laboratories and ICT infrastructure, which directly led to	TO A FULL EXTENT

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
			the improvement in the position of main Romanian universities in international rankings	
	Newly created/maintained jobs in R&D activity	Partially (target defined at PA level) 500 newly created jobs	**Interviews:** There are no available data at the PI level, but the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. Indirectly it could be assessed that this PI contributed to the achievement of 1945 newly created jobs. The major project ELI reported a number of 262 new created jobs	TO A FULL EXTENT
	The science program and the need for specific instrumentation to be used in ELI-NP experiments are jointly defined by researchers from abroad and from Romania	No	**Interviews:** As a result of the Preparatory Phase, the 'ELI White Book' has been compiled, comprising the coordinated efforts of more than 100 scientific authors from 13 countries under the leadership of the ELI initiator Gerard Mourou, and under the guidance of an international Steering Committee. The White Book is a comprehensive description of ELI's technical design concept and scientific case. It is the reference basis for the Technical Design Reports developed by the three sites ELI-Beamlines, ELI-ALPS and ELI-NP in the context of their EU Structural Funds applications	TO A FULL EXTENT
Intermediate outcomes	Increased administrative and technological capacity to deliver high-level R&D services to enterprises	No	**Interviews:** all the consulted stakeholders agreed on at least two benefits they gained in the area or administrative and technological capacity: (i) the first, obviously, is that the modernized/newly created infrastructure opened the way for more applicative research and extended their capacity to respond to enterprises demands; the high technological level of the acquired equipment supplemented with the legal required official certifications represent a competitive advantage which already attracted some enterprises to ask for their services instead of contracting other international providers; (ii) the second refers to the improved experience in managing projects of such complexity under ESFs rules, not only regarding the elaboration of application but also in conducting public procurement processes and monitoring and reporting project progress.	TO A LIMITED EXTENT
	Increased offer of knowledge and technological transfer (publications, patents)	Partially (target defined at PA level) 50 patent applications; 250 articles published in scientific publications	**Interviews:** There are no available data at the PI level, but the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. Indirectly it could be assessed that this PI contributed to the achievement of 258 patent application at the PA level and to a number of 1,000 articles published in scientific publications.	TO A LIMITED EXTENT
	International collaborative projects of high scientific level involving the ELI-NP infrastructure and its researchers' staff are developed	No	**Interview and Desk research:** Between 2014 and 2020, ELI-NP implemented the second phase of the project, which aimed to finalizing the construction works and installation, commissioning and testing of the equipment. On 13 March 2020, the 10PW (ten million of billions of Watts) performance of ELI-NP's High-Power Laser System was officially released, and a demonstrative test was presented. The first experiments at ELI-NP for the study of the interaction of high-power laser pulses with matter started on 18 March 2020. http://www.nupecc.org/npn/npn302.pdf#page=37	TO A FULL EXTENT

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
Final outcomes	Enhanced sustainability of the research capacity in public RTOs and HEIs and the capacity to use and provide specialized scientific and technological services for high technology fields	No	No quantitative evidence has been found. **Interviews:** The interviews conducted with the stakeholders provided some qualitative indications with regard to the improvement of the RTO and HEIs research sustainability and their capacity to provide specialised services for industry in the areas targeted by the PI. Both RTDs and HEIs mentioned that the modernized/new created research infrastructure visibly contributed to the increase in the level of their scientific and educational activities and of the cooperation with other national and international research organisations (increase in the number of masters, doctoral and post-doctoral students, in the number of scientific publications, the number and value of projects financed national or EU-funded programmes). Furthermore, in most of the cases, it created a framework for the diversification of the R&D services portfolio offered to the high-technology oriented enterprises and consequently led to generate additional revenues and economic value.	UNKNOWN
	ELI-NP major project fully integrated into ELI and operated jointly by the ELI European Research Infrastructure Consortium (ELI-ERIC)	No	**Desk research and Interviews**: ELI-NP has entered the international flow of the most important research infrastructures in the field. It has been designated by the Nuclear Physics Collaboration Committee of the European Science Foundation (NuPECC) as a major facility in the Nuclear Physics Long Range Plan. ELI-NP is ready to participate in the establishment of ELI-ERIC and host it. It was established in December 2017 by Research Commissioner Moedas with the Research Ministers from Czech Republic, Hungary Romania as well as to make available ELI-NP facility to the whole European scientific community. At the time, the integration of the three pillars of ELI within ELI-ERIC is still in process.	TO A LIMITED EXTENT
Impact	Enhanced economic competitiveness and productivity of Romanian economy	No	While all the interviewed stakeholders agreed that the ERDF infrastructure investments had an important contribution to the improvement of economic competitiveness, in the absence of any impact and/or contra-factual evaluation of the OP, there is no clear quantitative evidence on impacts, or even on some indications of observed changes and the extent to which they can be assigned to the support provided within this PI.	UNKNOWN
	New technologically advanced industries, education and social development, increased competitiveness	No	**Desk research**: ELI-NP started its operations in 2020 and according to the World Bank study elaborated in 2018 (Romania Laser Valley - development scenarios) '*offers a singular opportunity for knowledge, commercial and spatial spillovers, particularly in Măgurele, where is located, and more generally in Romania*'. There are five arguments mentioned by the WB study to support this statement: (i) ELI-NP location is already an established research hub and as a result of the open-access policy may attract other RTDs and HEIs; (ii) ELI-NP can stimulate economic benefits by hiring Romanian researchers and university students in fundamental and applied research activities; (iii) ELI-NP can lead to commercial and societal applications of research (e.g. medical therapies and health sector); (iv) ELI-NP can lead to a multiplier effect from linkages with knowledge-intensive sectors; (iv) ELI-NP could provide the possibility to create an international pole of excellence related to science and technology. These expected outcomes substantiate that 'Investments carried out in Laser Valley could generate an annual contribution of approximately EUR 500 million to Romania's GDP, approx. EUR 120 million to the state budget and could create approx. 12,000 jobs', and the tax contributions, the amount of taxes, to the state budget could amount to about EUR 110 million per year during the	UNKNOWN

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
			implementation period and about EUR 120 million per year during the operation period. The multiplier effect of this investment is estimated by Price Waterhouse Cooper (PWC) in an independent study conducted for the Ministry of Education and Research in 2016 (available at http://www.laservalley.ro/Home_files/directory/Studiu_de_Impact_ELI-NP_ro.pdf)	

ANNEX III. OVERVIEW OF EVIDENCE COLLECTED ON EXPECTED EFFECTS OF THE COLLABORATIVE R&D PROJECTS

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
Outputs	R&D projects carried out by specialized research entities (HEI/RTO) at the demand of the beneficiary enterprises	Partially (target defined at PA level) 200 projects carried in partnership by R&D institutions and enterprises 600 R&D projects financially supported EUR 523.1 million public expenditure in assisted R&D projects	**Task 1 data and SOP IEC Final report**: 37 projects carried in partnership by R&D institutions and enterprises, accounting for approx. 30% of the budget allocated to collaborative R&D projects 37 projects financially supported from a total of 558 at PA level EUR 13.7 million contributions to the target regarding the level of public expenditure, from EUR 1,001.9 million achieved at PA level	To a very limited extent
Immediate outcomes	The research leads to intended results (i.e. technological advancement and improved knowledge regarding the products/ processes/ services in identified strategic sectors)	Partially (target defined at PA level) 250 articles published in scientific publications	**Desk research:** By contract, all projects financed under the SOP IEC had to include in their own set of indicators a set of mandatory indicators from those defined at the level of the priority axis and to define target levels for them. The realization of the indicators was monitored by IB officers during the project (including the sustainability period), and the achievement of the values of the project indicators was mandatory. **Interviews:** There are no available data at the PI level, but the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. Indirectly it could be assessed that this PI contributed to the achievement of 1,000 articles published compared to the target of 250 at the PA level	To a full extent (All the financed projects achieved their intended results)
	Patents applications	Partially (target defined at PA level) 50 patent applications	**Interviews**: There are no available data at the PI level, but the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. Indirectly it could be assessed that this PI contributed to the achievement of 285 patent applications at the PA level	To a full extent
	Newly created jobs and retention of R&D personnel	Partially (target defined at PA level) 500 newly created jobs	**Interviews**: There are no available data at the PI level, but the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. Indirectly it could be assessed that this PI contributed to the achievement of 1945 new jobs created at the PA level	To a full extent
Intermediate outcomes	Economic benefits are obtained from exploiting commercial results of an R&D project	No	No data available **Desk research:** As part of the funding applications documentation, the beneficiaries were required to present a Business plan that was examined during the evaluation process and had an important contribution to the application's final ranking. **Interviews:** The information collected from the interviewed stakeholders are mixed. There are beneficiaries who preferred to keep the research results for later use, according to their marketing/development strategy. Other beneficiaries have invested	Unknown

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
			their capital for the further development of research results and their preparation for use on an economic scale. There are also beneficiaries who are willing to take the next step toward the commercial use of the research results but who are looking for supplementary sources of financing	
	Increased high-tech intensity of the enterprises, increased cooperation between enterprises and R&D organizations and HEIs, and an increased access of the enterprises to the RDI results	No	No data available **Desk research**: At the national level, independent evaluations found no progress. In 2017, the level of R&I funds invested by businesses was very low: 0.18% of GDP in 2015 (EU28 average in 2013: 1.12%). The highest proportion of these funds was spent on R&I performed by the business sector, and a very small share (0.03% of GDP) was provided to the public sector. The SMEs sector, mainly formed by subsistence enterprises, perform R&D activities to a limited extent: only 38.7% of medium and 27.5 % of small companies were labelled as having an innovative component. In the period 2011-2015, the business sector had a 28% contribution to the total country patent activity (EC-JRC, 2018)	To no extent
Final outcomes	Increased volume of enterprises (private) investments in R&D and innovation activities	Partially (target defined at PA level) EUR 138.9 million private expenditures in assisted RDI projects	**Task1 data and SOP IEC Final report**: EUR 6.7 million contribution to the target regarding the level of private expenditure, from EUR 253.4 million achieved at PA level	To a limited extent
	Enhanced administrative capacity in contracting and managing R&D projects	No	**Interviews:** the consulted stakeholders agreed that the project implementation contributed to improving their experience in managing projects of such complexity under ESFs rules, not only regarding the elaboration of application but also in conducting public procurement processes and monitoring and reporting project progress. Also increased their determination to apply for financing in the framework of subsequent OPs.	To a limited extent
Impact	Enhanced economic competitiveness and productivity of the Romanian economy	No	In the absence of any impact and/or contra-factual evaluation of the OP, there is no clear evidence on impacts or even on some indications of observed changes and the extent to which they can be assigned to the support provided within this PI.	Unknown

ANNEX IV. OVERVIEW OF EVIDENCE COLLECTED ON EXPECTED EFFECTS OF THE INTERNATIONALIZATION OF RESEARCH INSTRUMENT

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
Outputs	R&D projects designed and led by international experts addressing at least one industrial research/ experimental development activity are implemented	Partially (target defined at PA level) 600 financially supported R&D projects 225 SMEs financially assisted in projects 25 large enterprises financially assisted in projects	**Desk research:** By contract, all projects financed under the SOP IEC had to include in their own set of indicators a set of mandatory indicators from those defined at the level of the Priority Axis and to define target levels for them. The realization of the indicators was monitored by monitoring officers during the project (including the sustainability period), and the achievement of the indicators' values was mandatory. There are no available data at the PI level, **Interviews:** the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. **Task 1 data and SOP IEC Final report:** 40 supported R&D Projects from 558 at PA level 4 SMEs financially assisted from 289 at PA level 2 large enterprises financially assisted from 41 at PA level	To a full extent (All the financed projects achieved their intended results)
	International experts and specialised staff in research centres are involved in the R&D projects	Yes 30 specialists from abroad employed	**Monitoring system**: At the PA level, the number of specialists from abroad employed by R&D organisations for the implementation of projects was defined as a supplementary indicator. As indicated in the final implementation report, the actual number of specialists from abroad employed in the supported projects was 71.	TO A FULL EXTENT
Immediate outcomes	The research leads to intended results (i.e. technological advancement and improved knowledge regarding the products/ processes/ services in identified strategic sectors)	Partially (target defined at PA level) 250 articles published in scientific publications	**Interviews:** There are no available data at the PI level, but the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. Indirectly it could be assessed that this PI contributed to the achievement of 1,000 scientific articles published	To a full extent (All the financed projects achieved their intended results, despite the delays registered during the implementation process)
	Patents applications	Partially (target defined at PA level) 50 patent applications	**Interviews**: There are no available data at the PI level, but the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. Indirectly it could be assessed that this PI contributed to the achievement of 285 patent applications at the PA level	To a full extent (All the financed projects achieved their intended results)
	New R&D jobs created/maintained	Partially (target defined at PA level) 500 newly created jobs	**Interviews**: There are no available data at the PI level, but the consulted stakeholders indicated that all the beneficiaries had fulfilled their commitments at least at the contracted level. Indirectly it could be assessed that this PI contributed to the achievement of 1945 new jobs created at the PA level	To a full extent (All the financed projects achieved their intended results)
	Centres of high level scientific and/or	No	**Interviews**: There was no indicator related to the number of created high level scientific and/or technological competence	Expectations met to some extent

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
	technological competence, at European standards, created within a C-D institution, a university or a host enterprise		centres within this measure. However, both information emerging from the assumed objectives of contracted projects and information from consulted stakeholders indicate that such centres had been created within beneficiaries institution and the creation of high-level scientific core teams in the area of expertise covered by the projects.	
Intermediate outcomes	Economic benefits are obtained from exploiting commercial results of R&D projects	No	**Desk research:** As part of the funding applications documentation, the beneficiaries were required to present an impact study/ market study (applicable for the research organisations) or a business plan (enterprises) as part of the full application, which was examined during the evaluation process and had an important contribution to the final ranking of the application. **Interviews:** The information that emerged from the interviewed stakeholders indicate that the results of the projects have a potential for economic application, but so far, they did not materialize due to different reasons such as the long duration of IPR registration and/or of the certification according to quality systems requirements and in other cases due to the need for supplementary sources of financing	Unknown
	Increased high-tech intensity of HEIs/ RTOs and of the enterprises, increased cooperation between enterprises and R&D organizations and HEIs and increased access of the enterprises to the RDI results	No	No data available **Desk research:** At the national level, independent evaluations found no progress. In 2017, the level of R&I funds invested by businesses was very low: 0.18% of GDP in 2015 (EU28 average in 2013: 1.12%). The highest proportion of these funds was spent on R&I performed by the business sector, and a very small share (0.03% of GDP) was provided to the public sector. The SMEs sector, mainly formed by subsistence enterprises, perform R&D activities to a limited extent: only 38.7% of medium and 27.5 % of small companies were labelled as having an innovative component. In the period 2011-2015, the business sector had a 28% contribution to the total country patent activity (EC-JRC, 2018)	To no extent
Final outcomes	Increased volume of enterprises (public and private) investments in R&D and innovation activities	Partially (target defined at PA level) EUR 523.1 million public expenditure in assisted R&D projects EUR 138.9 million private expenditures in assisted RDI projects	**Task 1 data and SOP IEC Final report:** EUR 45.7 (4.6%) million public expenditure in assisted R&D projects from EUR 1,001.1 million at PA level EUR 1.6 million (0.6%) contribution to the target regarding the level of private expenditure, from EUR 253.4 million achieved at PA level	To a limited extent
	Enhanced administrative, research and innovation capacities of the HEIs/ RTOs and enterprises with R&D activity	No	**Interviews:** the consulted stakeholders agreed that the project implementation contributed to the improvement of their experience in managing projects of such complexity under ESFs rules, not only regarding the elaboration of application but also in conducting public procurement processes and monitoring and reporting project	To a limited extent

Effect type	Expected effect	Targets defined by MA	Summary of evidence collected	Level of achievement of threshold
			progress. Also increased their determination to apply for financing in the framework of subsequent OPs.	
Impact	Enhanced economic competitiveness and productivity of the Romanian economy	No	In the absence of any impact and/or contra-factual evaluation of the OP, there is no clear evidence on impacts or even on some indications of observed changes and the extent to which they can be assigned to the support provided within this PI.	Unknown

ANNEX V. PROGRAMME FOR THE STIMULATION OF RESEARCH, DEVELOPMENT AND INNOVATION – 'IMPACT' (GD 918/12 JULY 2006)

Program objectives	• Ensuring the necessary conditions for the implementation of the Sectoral Operational Program for Increasing Economic Competitiveness – the research-development and innovation component, for which the National Authority for Scientific Research has been designated intermediate body; • Consolidation and extension of partnerships in the process of elaborating project proposals for the Sectoral Operational Program for Increasing Economic Competitiveness – research-development and innovation component, in accordance with European Union regulations and Community regional principles and policies
Program duration	2006 – 2010
Source of financing	National Budget
Program management authority	The National Authority for Scientific Research, as designated Intermediate Body for Research
Eligible applicants	**1. Units of public law, with legal personality, included in the research-development system of national interest**: a) national research and development institutes; b) institutes, centres or research stations of the Romanian Academy and of research-development of the branch academies; c) accredited higher education institutions or their structures; **2. Units and institutions of public law**: a) institutes, centres or research-development stations organized as public institutions; b) institutes or research-development centres organized within the national companies, national companies and autonomous administrations or of the central and local public administration; c) international research and development centres established on the basis of international agreements; d) other public institutions or their structures that have in the object of activity the research-development; **3. Units and institutions under private law**: a) research and development units organized as commercial companies; b) commercial companies, as well as their structures, which have in their object of activity the research-development; c) accredited private higher education institutions or their structures; d) non-governmental organizations whose object of activity is also research and development.
Types of financed projects	• **Type A** - projects that will finance specialized consultancy activities for the elaboration of feasibility studies or their components for the preparation of investment project applications for research and development infrastructure and innovation infrastructure • **Type B** - projects through which specialized consultancy will be provided for the realization the necessary documentation for the preparation of applications - business plan, market studies, impact studies, economic analyzes, etc.
Projects Duration	1 to 3 months
Grant value	Type A projects – maximum Ron 100 thousand Type B projects – maximum Ron 40 thousand
Results	950 applications from which 630 projects financed

ANNEX VI. FICHES OF THE SELECTED PROJECTS

1. Project: REMOVED

SOP IEC Policy Instrument	**Collaborative R&D projects in measure '2.1.1. - Joint R&D projects between universities/research institutes and enterprises'**
Title:	***Reducing the environmental impact by optimizing the conversion chain at biogas energy recovery facilities in landfills – 'REMOVED'***
Beneficiary:	SC ECO BIHOR SRL
Partner – Research Organization	Polytechnic University of Bucharest (UPB) – Department of Power Production and Usage
Beneficiary website:	https://www.ecobihor.ro/index.html
Project link:	https://www.ecobihor.ro/proiect_removed.htm
Objectives	• Diversifying the domain of activity of SC ECO BIHOR SRL Oradea by accessing the research and development expertise of the Polytechnic University of Bucharest (UPB); • Establishing, based on experimental research, the composition and index of household waste generation at the local level; • Estimating the dynamics of the evolution of the waste management system as a target at the local and county level; • Development and optimization of a program (software) for estimating the biogas production produced by a controlled landfill of municipal waste; • Identification and realization of a solution for neutralization/stabilization of residues, realization of the experimental model and of the prototype installation; • Development of the production capacity of the company and reduction of the costs related to the pollution emission reduction systems; • Determining the influence of the composition and of the waste generation index at local level, as well as of the characteristics of the storage cell on the quantity and quality of the gas produced in the waste landfill; • Development of human resources by increasing jobs by over 20% and maintaining them at least 3 years after the completion of the project within the company; • Increasing the turnover of SC ECO BIHOR SRL by at least 10% within 3 years from the date of completion of the project.
Results	• The experimental model of the installation for the new generic technology in order to recover and use of thermal energy; the beneficiary has the right for future development and production; • Prototype for tested and certified bioprocessing subassembly with heat recovery; • Software application for the calculation of Biogas production; • Six scientific publications; • 19 new jobs created from which 5 in R&D.
Follow-up activities	• For full-cycle operation, the prototype requires a continuous flow of biogas from organic waste. Incomplete sorting of waste materials causes variations. After project completion, the research continued and found a solution to compensate for the flow of biogas during periods when the one from waste is lower. It is estimated that, in the near future, they will start to put it into practice - prototype reproduction, use and generate revenues; • Established a research department within the enterprise; • 'Operational processes and systems for the treatment and material and energy recovery from waste–PROVED', ERDF financed project under OPC 2014-2020

	aiming to the optimization of electricity consumption in the use of leachate treatment technologies in landfills in order to achieve the same treatment efficiency, with the same partner – Polytechnic University of Bucharest: https://ecobihor.ro/proiect-proved; • The project implementation also prompted the need to improve the legislative framework regarding waste management – especially regarding the selective collection; A joint task force of the sector professional association (Romanian Compost Association) and UPB as partner organisation was actively involved in the provision of inputs for drafting and advocating the adoption of the Law on the management of compostable non-hazardous waste (Law no. 181 has been approved at 19 August 2020) http://legislatie.just.ro/Public/DetaliiDocument/229273
Achievements	• The involvement of ECO BIHOR staff in the implementation of the project resulted in an increase in the level of knowledge, a better ability to describe processes, to develop terms of reference for tender procedures, to integrate and analyse information specific to the field.
Facts	• The company S.C. ECO BIHOR SRL from Oradea was established by KEVIEP Kft Hungary at the beginning of 2004, carrying out its activity, based on the public-private partnership contract concluded between Oradea Local Council and KEVIEP Kft in 2003. According to this partnership, all waste generated at the county level from both the population and public institutions is transported to ECO BIHOR where it is treated, recycled or stored in an environmentally controlled manner; • **An experienced and research-oriented private enterprise.** SC ECO BIHOR SRL operates and manages for a period of 20 years the county ecological waste landfill in ORADEA, the recyclable waste sorting station, the composting station for vegetable waste and the mechano-biological treatment station for household and similar waste; • **An enterprise-capable and willing to work strategically.** The enterprise has a 5-year planning horizon aimed at diversification, an increase of the technological level, clear development directions; research activity is an important part of this strategy; • **A well-known research partner.** The partner (Polytechnic University of Bucharest) mentioned that ECO BIHOR had a good definition of their needs and clear expectations from the research project; the research organisation contributed to fine-tuning the research specification according to their own experience and capabilities; • **A scheme of collaboration with mutual benefits.** ECO BIHOR is the owner of intellectual property rights and a single beneficiary of the research results. It has not been involved in the research based on collaborative activity, but it was in charge with the research contract management; however, it was involved in the provision the research partner with data for the experiments, has participated in testing the model experiments, and this facilitated a reciprocal exchange of knowledge; • **A joint learning exercise enriched both partners.** The lessons taught by this collaboration have helped the entrepreneur stay focused on research activities. The implementation and practical results of the project contributed to the improvement of the University curriculum on solid waste management. They opened new ways for further involvement of the University in common projects with enterprises.

2. Project: RENAULT TECHNOLOGY

SOP IEC Policy Instrument	**Collaborative R&D projects in measure '2.1.1. - Joint R&D projects between universities/research institutes and enterprises'**
Title:	***Solutions to obtain parts with non-stick properties on ice and dirt made of polypropylene and polycarbonate***
Beneficiary:	Renault Technologie Roumanie (RTR)
Beneficiary website:	https://www.gruprenault.ro/tags/renault-technologie-roumanie
Partner – Research Organization	National Institute for Research & Development in Chemistry and Petrochemistry – ICECHIM, Bucharest https://icechim.ro/en/
Project link:	NA
Objectives	• Find and develop innovative materials with special properties and antifouling anti-depositing ice for use in the automotive industry; • The characterization and development of materials with properties of anti-depositing ice; • The characterization and development of materials with properties of antifouling; • Implementing new solutions (coatings, treatments) developed on various parts made by polypropylene and polycarbonate; • Finding solutions for mass production of materials with special anti-icing and anti-fouling properties; • Obtaining car parts or subassemblies that have special anti-icing and anti-fouling properties; • Testing car parts or subassemblies on vehicles in real driving conditions.
Results	• 4 new materials; • 2 patent applications from which one already issued in France; • Scientific articles published: ☐ 'Facile preparation in two steps of highly hydrophobic coatings on polypropylene surface', Applied Surface Science, vol. 347, pg. 359-367, 2015, https://www.sciencedirect.com/science/article/abs/pii/S016943321500923X; ☐ 'Hydrophobic and Transparent Silica Hybrid Sol-Gel Coatings for Polycarbonate Substrate', Bulletin of the Polytechnic Institute of Iasi, Vol. LXI (LXV), Fasc. 1, pg. 81-91, 2015
Follow-up activities	• The beneficiary has implemented other two ERDF financed projects, one within 1.3.1 policy instrument on poles of competitiveness / SOP IEC 2007-2013 and the second one within ongoing COP 2014-2020
Achievements	• The use of these new solutions as coatings on vehicle-specific subassemblies increases the value of the Dacia - Renault brand, the customers having an additional reason to choose the Renault group models based on its new competitive advantage; • Enriched the stock of the patents of the whole group; • The application of these intelligent coatings on Renault vehicle parts is subject to further decisions according to the company's developmental strategy.
Facts	• RTR is the single complete automotive engineering centre in Eastern Europe and the largest Renault engineering centre outside France. RTR is the reference centre for vehicles in the Global Access range worldwide; • **The ERDF played the role of research accelerator**. Financial assistance had the effect of accelerating the implementation of the project not only by ensuring the institutional framework for carrying out the research activity for the benefit of the economic agent but also by creating the opportunity to finance in a relatively short time the research-development activity at a high scientific level;

- **RTR had a clear definition of the research theme, and its expected results,** and the partner research organisation has been chosen following several rounds of discussions with different RTOs and HEIs ;
- **Selection of an experienced partner/sub-contractor.** ICECHIM partner had extensive experience in income-generating based on contractual relations with enterprises and in raising additional competition-based funding for its research plan as long as this institute is not funded from the state budget; however, this project was its first experience in ESFs funded projects;
- **Experienced project management team**. The RTR project management team ensured the management of the financial resources allocated from the budget and by co-financing (expertise in project management, financial-accounting expertise) and monitoring the concordance of the research results performed with the company's needs (expertise in implementing scientific results);
- **Clear allocation of roles between partners**. RTR ensured the management of the contract and used their testing equipment and vehicles parts for the evaluation of the solutions developed by the research partner. The executing partner ICECHIM provided the research services according to the concluded contract with RTR using their specific equipment for the production of polymeric materials at the level of domestic and international market requirements, respectively a wide range of specific laboratory installations, fine synthesis of advanced materials with specific properties of controlled morphology. RTR team was involved in all testing experiments, prototype design and its formal registration, and it was not a passive recipient of the research results ;
- **Ownership of the research results is clarifying institutional sustainability.** Renault company has exclusive intellectual property rights on the newly obtained materials and keeps them at hand for future use;
- **Mutual gain in terms of new knowledge and reputation.** By participating as a partner in the project, ICECHIM has proven its scientific competence and ability to carry out such a demanding project ICECHIM's prestige has increased both in academia and in the private economic environment. The transfer of knowledge and innovative scientific production to the beneficiary has taken place based on a participatory process from both sides. Collaboration between partner organizations has been strengthened.

3. Project: CYBERDIN

SOP IEC Policy Instrument	**Internationalisation of research in measure '2.1.2 Complex research projects fostering the participation of high-level international experts**
Title:	***Cyberinfrastructure for Geodynamic Studies Related to the Vrancea Seismogenic Zone***
Beneficiary:	Romanian Academy - Institute of Geodynamics 'Sabba S. Ștefănescu'
Beneficiary website:	http://www.geodin.ro/
Project link:	http://cyberdyn.geodin.ro/index.php?req=english
Objectives	Construction of a cybernetic infrastructure within the Institute of Geodynamics of the Romanian Academy of Sciences in Bucharest, Romania, in order to study the long-term geodynamic evolution of the active seismogenic area Vrancea
Results	• Project developed in cooperation with a Romanian expert with a worldwide reputation in this area from the National Autonomous University of Mexico; • A High-Performance Computing Cluster (HPCC) together with a Results Visualization Cluster (HPVC) and an interactive 3D results handling system (Geowall); • A workshop with international participation. NEMO (NumErical MOdelling using high-performance computing infrastructures; • Setting up a centre for agricultural and ecological researches organized by departments and specialized labs; • Five newly created jobs, of which 3 research jobs; • Fifteen scientific communications at international events; • Thirty scientific discussion papers; • Three scientific publications in international journals
Follow-up activities	• Participation to FP7, HORIZON 2020; SAFER – projects financed by European Space Agency; • Dissemination of scientific results obtained in the institute in the form of discussion papers at international scientific events or papers published in ISI-rated journals. • Collaborations with the private sector, especially with farmers during tens of regional workshops whose aim to present new technologies, demonstrative tests of new plant varieties and hybrids in accordance with the soil's categories etc. • Establish contacts with the mayors from the rural area and territorial agricultural directorates and held site visits.
Achievements	• Generated a new research area in Romania – Numerical Geodynamics • Examples of scientific works based on the created infrastructure (selection from a comprehensive list): ☐ Conference presentation - Besutiu Lucian, Luminita Zlăgnean - Modelling non-tidal gravity changes within Vrancea active geodynamic zone. NEMO – Numerical Modelling Using High-Performance Computing Infrastructures, Bucharest, Romania, 10-11 June 2013 http://cyberdyn.geodin.ro/conferences/conferences.php?req=program_ro ☐ Conference presentation - Pomeran M., Zlagnean L., and Besutiu L.(2018) Seeking for efficiency in using an HPCC with high-resolution models of oblique subduction, Geophysical Research Abstracts, Vol. 20, EGU2018-6464, 2018 EGU General Assembly, *08 – 13 aprilie 2018*, Viena, Austria, (http://elsedima.ro/admin/media/Book%20of%20abstracts_ELSEDIMA%202018.pdf) ☐ Published article - Manea C.V., Manea M., Pomeran M., Besutiu L., Zlagnean L., 2012 A pararrelized particle tracing code for CFD Simulations in Earth sciences, Acta Universitaria, vol 22 (5),2012, Número de Certificado de Reserva de Derechos 04-2008-100 113 17

	1300-102 ISSN 0188-6266, (http://www.actauniversitaria.ugto.mx/index.php/acta/article/view/358/pdf) ☐ Published article - Besutiu L., Manea C.V., Pomeran M., 2017. Vrancea seismic zone as an unstable triple junction: new evidence from observations and numerical modelling. EarthDoc, DOI: 10.3997/2214-4609.201702541, http://earthdoc.eage.org/publication/search?pubsearchkey=besutiu
Facts	• The 'Sabba S. Ștefănescu' Institute of Geodynamics is an R&D organisation that operates autonomously under the umbrella of the Romanian Science Academy; • ERDF finance was the unique possibility to develop the required computer cluster; • This is a pioneered infrastructure in Romania since no such facility is available for geodynamics study in the country. Also, this infrastructure provided a technological boost needed at the Institute of Geodynamics of the Romania Academy of Sciences, placing this institution in the worldwide top research centres; • The project implementation was complementary to other previous national research funding programs such as MENER, AMTRANS or, especially the Excellence Research Program, CE-EX which contributed to the development of the infrastructure and to the procurement of some research equipment;

4. Project: RECOLAND

SOP IEC Policy Instrument	**Internationalisation of research in measure '2.1.2 Complex research projects fostering the participation of high-level international experts'**
Title:	***Multi-criteria Decision System for Remediation of Sites Contaminated with Toxic and Persistent Pollutants in Large Industrial Areas – 'RECOLAND'***
Beneficiary:	Polytechnic University of Bucharest – Faculty of Power Engineering
Beneficiary website:	http://energ.pub.ro/
Project link:	NA
Objectives	Development of a multi-criteria decision-making system (computer system) to allow: • Risk assessment on population health and its use as a decision-making criterion in establishing the suitability of soil in historically or accidentally polluted areas, • Identifying the optimal solution to remedy soils contaminated with toxic and persistent pollutants; • Decontamination cost analysis.
Results	• A multi-criteria decision-making system; • Two pilot installation for electro-remediation of contaminated soils; • Research reports; • 10 new jobs created in R&D; • One patent application; • One software application registered under the national registry of computer programs; • Thirty scientific publications; • One research group created within the faculty in the area of remediation of contaminated soils.
Follow-up activities	• Further research projects funded from the national budget within NPRDI II; • Bi-lateral projects with Turkey and China • Attempts for start-up setting up and further searching for additional alternative financial resources.
Achievements	• **Increased capacity to foster cooperation with other HEIs and with enterprises.** The RECOLAND project has increased the R&D capacity of the institution and also fostered the cooperation between the university and the enterprises around which there have been significant historically contaminated areas, whose destination is still uncertain; • **A decision-making planning tool aimed at environment restoration in contaminated, dismantled, polluting industrial areas.** A decision-making tool for planning soil suitability was developed considering the economic side and the environmental and quality of life component. This tool was applied in a project addressed to 4000sq. m contaminated site in Copșa Mică, an industrial area where carbon black, sulfuric acid and non-ferrous metals including lead and cadmium, were processed until 2008. Copșa Mică has been considered the most polluted area in Europe until the Chernobyl nuclear accident.
Facts	• **International collaboration was experienced before the preparation of the project application.** The international researcher developed the project application based on her experience in several previous projects managed within INTERREGIO framework in Italy; • **A pioneering project aimed at supporting sector national strategy implementation**; • **The continuous support in the project completion of a strong HEI was the major enhancing factor.** The Polytechnic University secured the cash flow from its budget due to delays in the processing of reimbursement claims; the attempt for a start-up creation based on the project results' technological transfer highlighted the difficulties an entrepreneur has to face in obtaining the needed funding.

5. Project: ANGIONET

SOP IEC Policy instrument	**Infrastructure investments for research, measure '2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'**
Title:	***Development of public R&D infrastructure and creation of new infrastructures***
Beneficiary:	The Academy of Medical Sciences (AMS) from Romania
Beneficiary website:	http://www.adsm.ro/
Project link:	https://angionet.ro/#
Objectives	• Development of public R&D infrastructure in the medical field; • Increasing the research capacity development of 17 medical units (research centres) in Romania in the field of angiography by endowing it with state-of-the-art angiography systems; • Creation of a national research and development network by establishing a National Registry of Interventional Treatment of ACS - (acute coronary syndromes); • Specific register for patients with cervical-cranial arterial stenosis; • Conducting clinical research by involving 100 patients on average / research centre; • Involvement of at least 30 highly qualified specialists in achieving scientific objectives; • Involvement of 10 young specialists by creating a training centre in the field of angiography.
Results	• 17 centres equipped with modern angiographic systems distributed in medical research centres all around the country: Bucharest (2), Constanta, Suceava, Iasi, Timisoara (2), Buzau, Cluj (2), Brasov, Satu Mare, Galati, Fundeni, Craiova, Ploiesti, Tirgu Mures; • 17 newly created jobs.
Follow-up activities	• **Phased implementation.** The second phase of the project developed within COP 2014-2020 (ERDF funded) using the infrastructure created in the first phase within SOP IEC; • **Strengthened capacity to raise funding for research.** A comprehensive package of follow up applications submitted in national and international funded projects competitions are proof of this capacity, as follows: ☐ Personalized solutions for improving healthspan based on the epigenomic profile of cardiac cells, competition NO Grants - Collaborative Research Projects; ☐ CEI Extraordinary Call for Proposals 2020 E-Health services for older patients with cardiovascular disease and multi-morbidities with high risk in contact with coronavirus Covid-19, E-Angio-19; ☐ CEI Extraordinary Call for Proposals 2020 Artificial Intelligence Algorithms for Discriminating Between COVID-19 and Influenza Pneumonitis Using Chest X-Rays (AI-COVID-Xr); ☐ H2020-SC1-DTH-2018-2020, topic SC1-BHC-06-2020, action RIA, proposal no. 101017507, GRACE - An innovative, AI based digital personal healthcare assistant; ☐ H2020-SC1-2020-Single-Stage-RTD, topic SC1-BHC-06-2020, action RIA, proposal no. 210689483, HealthMeUp - CDSS An innovative, AI-based decision support tool for healthcare professional; ☐ H2020-ICT-2020-2, action RIA, proposal no. 210690863, VIRTUOSO - Secure AI-driven Data Portability and Service Orchestration in Heterogeneous Fog Environments;

	☐ LIFE Programme - Climate Changes -Monitoring and warning system for climate change impact on health - LIFE Adaptation to Climate.
Achievements	• **Creation of an integrated research platform.**Creation of a research platform that brings together all the centres and themes of the project, the platform that includes registers and imaging database, with telemedicine possibilities and a digital library; • Seven patients registers, four more than the initial estimation; • **Built pioneering integrated research and practitioners teams.** Creation of a pioneering HEART TEAM, a group of qualified healthcare professionals who collaborate to agree on the best treatment plan for each patient; • Qualitative leap of the medical act in the health sector; • Knowledge transfer from to central to regional and local research teams; • Increased national and international recognition of the AMS Romania.
Facts	• The AMS is a national public institution with academic prestige in the field of medical and pharmaceutical research with a history of over 80 years and whose mission is to develop medical sciences (clinical, basic, preventive medicine) and pharmaceutical sciences to improve public health, to participate together with the Ministry of Health in the elaboration of the National Strategy in the medical and pharmaceutical field • **Strategic importance and coordinated approach.** The submission of the funding application at the end of 2014 was the result of discussions between the representatives of the Ministry of Health and the Ministry of National Education, through the National Authority for Scientific Research; The project had strategic importance and responded to the need in the field of public health in Romania: the incidence of deaths due to cardiovascular diseases and digestive / liver tumours; • **Phased implementation was envisaged and agreed upon as a result of its high complexity.** The project started in 2015 at the end of programming implementation as per the n+2 rule. Therefore, it was necessary to consider a two-phase implementation timeframe. Considering the complexity of the works implied by the infrastructure's construction was impossible to be required a physical and financial completion in 11 months timeframe. It was also taken into account that the project included a major acquisition of equipment, respectively 17 angiographs (which also required additional works to arrange the premises where to be installed in 17 different locations). The issuance of the legal authorizations also required time to be processed and approved. Last but not least, the research activity planned to be carried out would have been implied the acquisition of supplies necessary to carry out the research; • **Most important challenge was linked with the public procurement process**. In order to address this challenge, the financed beneficiary used external TA services as support for conducting the public procurement procedures and division in smaller lots, but in full compliance with the legislation in force In overcoming the risks associated with public procurement, the successful completion of the delivery was secured by the quality of the medical equipment winning suppliers (e.g. Philips and Siemens); • **Savings reinvested in additional equipment.** The savings resulting from a very competitive public procurement process have been used (with prior approval of the MA as per the policy instrument's regulatory framework) to procure supplementary equipment that included simulators for training medical staff.

6. Project: CAMPUS

SOP IEC Policy Instrument	**Infrastructure investments for research, measure '2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'**
Title:	***Centre for Advanced Research on New Materials, Products and Innovative Processes –'CAMPUS'***
Beneficiary:	Polytechnic University of Bucharest (UPB)
Beneficiary website:	https://upb.ro/cercetare/centrul-campus
Project link:	http://campus.pub.ro/
Objectives	Creation of an Advanced Research Center for Innovative Materials, Products and Processes to promote an intelligent control environment, integration and coordination of multi and interdisciplinary research teams within Polytechnic University of Bucharest
Results	• CAMPUS Centre building: basement + ground floor + 7 floors that houses laboratories, lecture halls, conference rooms, offices and relaxation areas, with an area of over 8,600 square meters; • 41 new research laboratories; • 56 pieces of research equipment procured; • A last generation computing cluster which includes 56 servers which are worth over EUR 500 thousand; • Nuclear magnetic resonance equipment, worth over EUR 800 thousand.
Follow-up activities	• CAMPUS not only ensured a high technical-scientific environment for research and education of a large number of master's and doctoral students (around 1,000 students until 2020) but also attracted and reintegrated internationally renowned specialists to create and develop high-performance research teams focused on interdisciplinary topics at the frontiers of knowledge – contributed to the reduction of 'brain-drain' phenomenon; • It contributed to the improvement of the quality and efficiency of the R&D activity carried out in the university through the convergence of the efforts and expertise of different groups and research centres from faculties, the avoidance of parallel and small - scale research, • Ongoing effort to get formal RENAR accreditation for the measurements laboratories. • Provision of consistent research services offer for testing and certification of innovative materials and products for industrial producers, to facilitate the implementation of European standards; • The research teams accessed many projects financed from the budget but also research contracts with important private companies (COMOTI; NXP, Infineon, etc.); a full list of projects here: http://campus.pub.ro/website/projects ; • Project example: Technologies for automatic annotation of audio data and for implementation of automatic speech recognition interfaces (TADARAV) https://tadarav.speed.pub.ro/en/ ; • Project example: Development of technology-based security applications complex experiments used in the study of cosmic radiation – 'DEXTER', partnership with National Institute for Physics and Nuclear Engineering Horia Hulubei, Institute of Geodynamics, National Institute for Research and Development from Constanța, Institute of Space Science, University of Petroșani http://proiecte.nipne.ro/pccdi/12-projects.html • Project example: Developing Novel UAV Education Set and Training Curriculum In order to Catch State of The Art Technology, Contract ERASMUS+ nr. 2018-1-TR01-KA203-059632; • Project example: Research Collaboration and Mobility for Beyond 5G Future Wireless Networks (RECOMBINE) – H2020 https://cordis.europa.eu/project/id/872857 ; • An essential step forward is upgrading the Centre into the Research Institute of the Polytechnic University of Bucharest 'CAMPUS' as stipulated by the UPB

	CHARTER starting with 2020.
Achievements	• The Centre for Advanced Research on New Materials, Products and Innovative Processes (CAMPUS) is the UPB's advanced research & development centre for multi - and interdisciplinary technologies; • Apart from research, CAMPUS is also an educational centre for undergraduate and postgraduate studies and e-learning.
Facts	• Complementary projects implemented by Polytechnic University of Bucharest (selection): ☐ Career Development in Education through Human Resources Training (CIFRU) - SOP HRD; ☐ National partnership for the implementation of faculty projects for the transition from school to active life (PACT) – SOP HRD ☐ Promotion of Entrepreneurial Culture: Adaptability, Dynamism, Initiative in the Electronic Industry SOP HRD ☐ Competitive training of PhD students in priority areas of the knowledge-based society - SOP HRD ☐ PhD students in support of innovation and competitiveness – SOP HRD; • The construction that hosts the Centre is uniquely designed, both from the infrastructure point of view and functionality. It holds a state of the art 7 stories green and intelligent building with unconventional power sources, energy recovery, reuse of resources, and intelligent management systems; • The building itself is a working lab. It integrates 42 research labs, spread over more than 8,000 square meters, equipped at European standards. The labs are connected in a complete interdisciplinary technological flow, starting with the study of materials (chemical engineering), going to electrical engineering and electronics (e.g., circuits, antennas), power and mechanics (e.g., alternative energy sources, environmental protection), and then telecommunications, information technologies (e.g. multimedia processing) and computer science (e.g. artificial intelligence); • Before CAMPUS HUB implemented several other projects within SOP HRD, projects addressed to the development of human resources – promoting the entrepreneurial culture, competitive development of PhD candidates in priority areas of knowledge; • Used external consultancy for the development of the feasibility study. The most difficult part of project implementation was to obtain the approval of Terms of References for the construction services from the national authorities in charge of the control and supervision of the public procurement processes.

7. Project: CARDIOPRO

SOP IEC Policy Instrument	**Infrastructure investments for research, measure '2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'**
Title:	***Expansion and modernization of research infrastructure in order to increase competitiveness in the field of cardiovascular disease, diabetes and obesity***
Beneficiary:	The 'Nicolae Simionescu' Institute of Cellular Biology and Pathology
Beneficiary website:	http://www.icbp.ro
Project link:	http://www.icbp.ro/static/en/en-networking_grants-grants-international/cardiopro.html
Objectives	• Increasing the quality and competitiveness of research by purchasing new equipment in order to introduce modern, competitive technologies at the European level; • Promoting cutting-edge technologies in research aimed at preventing and treating cardiovascular disease and diabetes; • Widening integration of IBPC-NS in the European Research Area by strengthening the existing, national and international collaboration relations; • Integral capitalization and expansion of human potential, attracting young researchers, creating new jobs, reducing 'brain-drain'; • Updating the institute's existing development strategy and elaboration of a short, medium and long-term action plan; professionalization of research management and consolidation of the role of science in society.
Results	• Twenty R&D modernized laboratories; • Fourteen newly created R&D laboratories; • 261 pieces of R&D equipment purchased from which 17 worth over EUR 100 thousand each; • 2,758 sq. m with special arrangements for R&D; • 5,035 sq. m consolidated building area; • 94 ISI scientific papers published, with a cumulative impact factor of 226.3; • 641 Citations in ISI-listed specialized journals (in 2012); • 22 Scientific papers in journals without ISI quotation.
Follow-up activities	• Three projects won through competition 2010-2012 - FP7; • 18 Projects won through national competitions; • Examples of follow-up projects: ☐ Project Title: Doctoral and post-doctoral programs of excellence for the training of highly qualified human resources for research in the field of Life, Environment and Earth Sciences SOP HRD. Period: 2014-2015; ☐ Project Title: Improving institutional competitiveness in the field of type 1 diabetes by developing an innovative concept of mesenchymal stromal cell immunotherapy – DIABETER, Period: 2016 – 2020 http://www.icbp.ro/static/en/en-networking_grants-grants-international/diabeter.html ☐ Project Title: Targeted therapies for aortic valve disease in diabetes – THERAVALDIS. OPC, Period: 2016 – 2020 http://theravaldis.icbp.ro/ ☐ Project Title: Advanced ex vivo analyses and multi-frequency ultrasound technology for improved evaluation and diagnosis of coronary plaque (ACRONYM: XploreCAD), Cofunded – ERA-CVD – ExploreCAD, Period: 2018 – 2021 http://www.icbp.ro/static/en/en-networking_grants-grants-international/xplorecad.html ☐ Project Title: Exploring new pathways in age-related heart diseases (EXPERT). ERA- CVD, period: 2017 – 2020 (international collaboration) http://www.icbp.ro/static/en/en-networking_grants-grants-international/expert.html ☐ Project Title: Supportive therapy for diabetes by increasing the stress

	endurance and regenerative capacity of β-cells – BETAUPREGI. Period: 2020 - 2023
Achievements	• **Setting up newly special research units.** A special department was created in the new modern field of research, the Department of Proteomics • **Higher employment attractiveness for fresh graduates, PhD graduates.** The number of young researchers from the institute, contacts, collaborations and exchanges of ideas with the Romanian specialists in Diaspora has increased; • **Collaboration with medical institutions has intensified. The link between basic research and clinical research has been strengthened. Now,** most of the projects are won in collaboration with doctors from university clinics within the Municipal Hospital of Elias Hospital, Fundeni Hospital, etc. • **Gained experience in working with outsourced consulting.** Because the team of researchers from IBPC had limited experience in managing construction works, they hired a project manager.
Facts	• **A flagship biomedical science institution with a long history.** This institute and its infrastructure are unique without analogue on the national level**.** The 'Nicolae Simionescu' Institute of Cell Biology and Pathology (IBPC-NS) is a fundamental research centre of the Romanian Academy, founded in 1979. The institute has 41 years of experience in the cellular and molecular study of the cardiovascular system under normal and pathological conditions, especially major diseases that seriously affect modern society: atherosclerosis, diabetes, obesity and their complications. The Institute is a Member Institution of the UNESCO-Network of Cellular and Molecular Biology (1990) and was selected Centre of Excellence of the European Community (2000); • **Access to upfront investments in technical assistance.** IBPC accessed financing provided by the Romanian Government to prepare the package of projects that were to participate in the competitions organized on SOP IEC. Thus, the feasibility study related to the investment was elaborated, as well as a first draft of the Financing Request; • **Major challenges**. The public procurement process proved to be difficult mostly due to the non - unitary interpretation of the legislation by different institutions from the management system of the ESFs. ; • **The ERDF funding crucial and outstanding for building new research infrastructure and modernization of the equipment.** • **Societal benefits brought by the project outcomes consist of:** ☐ Knowledge-based therapies. New emerging therapies for treating chronic diseases taking into account that only a solid foundation for future research leads to new therapies. '*There is no therapy without knowledge'*; ☐ High attractiveness for young and promising PhD graduates, researchers to take employment opportunities; ☐ The experience and the results accomplished has led to follow up projects; ☐ Collaboration of researchers with medical clinics from all over the country; ☐ Goodwill at the international level and contribution to the worldwide heritage of knowledge.

8. Project: CEUREMAVSU

SOP IEC Policy Instrument	**Infrastructure investments for research, measure '2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'**
Title:	***Euro-Regional Centre for the Study of Advanced Materials, Surfaces and Interfaces –'CEUREMAVSU'***
Beneficiary:	The National Institute of Materials Physics – Romania (INCDFM)
Beneficiary website:	https://infim.ro/en/home/
Project link:	http://www.ceuremavsu.infim.ro/
Objectives	• Creation of the Euro-Regional Centre for the Study of Advanced Materials, Surfaces and Interfaces; • Improving the quality and competitiveness of research in INCDFM-Bucharest by modernizing and renewing the equipment for the preparation and characterization of nanostructures and advanced functional materials; • Increasing the level of technology transfer of the results obtained in INCDFM to the industrial partners, consolidating the activities for making prototypes, products, materials, diversifying the offer of services, testing, certifications, measurements; • Integral capitalization of the human potential involved in research in INCDFM: attracting young researchers, specialization doctoral students and postdoctoral researchers, organizing courses; • Integration of INCDFM in the European Research Area (ERA) by strengthening the existing collaboration relations with European partners in the public and private fields, establishing new links, joint research projects, active participation in the FP 7.
Results	• Two new R&D laboratories; • Five modernized laboratories; • 28 pieces of R&D equipment acquired, from which 23 worth over EUR 100 thousand each; • 24 new jobs for highly qualified specialists; • 70 maintained jobs; • 10 international projects in which the CEUREMAVSU was involved and its R&D infrastructure was used during the sustainability period.
Follow-up activities	• Participation in FP7, H2020, EURATOM, CERN-RO, ELI-IFA and other international projects • A detailed list of projects could be found at https://infim.ro/project-category/proiecte-internationale/.
Achievements	• **Significant increase of the scientific results outreach activities with an impact on visibility and recognition.** The level of journals published by researchers at the institute has almost tripled, with obvious consequences for the visibility of research at the institute, citations of these papers; • **Collaboration with new partners from abroad.** An unexpected positive result was the proposal of the Elettra Sincrotrone Trieste, Italy, to host one of the INCDFM infrastructures to benefit from synchrotron radiation, which considerably raises the quality of the results obtained; • **Significant research staff increase as a result of attractiveness in terms of premises and working environment.** The turnover of the institute has practically doubled. They have been employed since the completion of the project so far approx. 70 young researchers and research assistants; • The project implementation led to an increase of the organization's attractiveness for foreign researchers, e.g. bio-sensors specialists from Portugal joined the INCDFM specialists to implement a project financed by ERDF within OPC 2014-2020 https://projects.infim.ro/AMD-FARMA-MED-RO/.
Facts/	• **INCDFM is a national research and development institute**. With approx. 200 employees in research and development, is the third-largest institute on

Evidence/Impact	the Măgurele platform and specialized in research in the field of condensed matter, materials science and applications in these fields; • INCDFM used the facility created by the nationally funded programme 'IMPACT' for the development of the feasibility study requested as part of the application within SOP IEC; • **Newly built infrastructure has paved the connecting road with the big and powerful industries operating in Romania.** Before having this infrastructure, 'it *did not even count for the big industry'.* Besides the newly built infrastructure, the results in fundamental and excellence research seem to have been helped INCDFM in opening collaboration with large companies. The commercial secret is still a barrier in the extension of the collaboration, especially with those large companies with their research department or whose research activity is strategically led by the mother companies. Despite the '*big gap'* between the public, academic research and confidential industrial research, some bridges of collaboration have started to be built; • **Profound changes in the organizational culture:** The upgraded level of technology also had an impact on the corporate culture by reducing the layers of the structure, changes in the management style with the magnitude of a real shift from an authoritarian, hierarchical style to a consultative decision-making process, and creating a participatory and motivating work environment; • **INCDFM became a learning organization**. Before 2.2.1call, they were used to promote many and disperse small projects originated by several researching teams. Due to its challenging dimension and ambitious objectives, this project was the first integrated at the entire institute's level. Its ownership was internally assumed by the whole researching team. Before taking the ERDF funding opportunity under the SOP IEC, they were not used to work nor with private consulting companies to provide technical assistance, neither with the banking sector for attracting alternative financial resources. On the contrary, the middle financial management was scared at searching for credits or other financing types. In conclusion, after following a continuous learning process during the preparation and implementation of this project, lessons learned have been spread throughout the organization, and continuous learning became a real organizational value and the main driver for change promotion. • **Retention of the young fresh graduates in their home country and attempts to reverse the migratory flow of the highly qualified specialists** can be listed amongst the benefits and qualitative impact of the ERDF financial support in renewing the researching infrastructure. The candidates for researching employment opportunities find the home proper working environment and higher predictability regarding development and promotion perspectives in their researching career. Due to its dimension and other social factors influencing retention of the Romanian specialists abroad, these experiences acquired, and achievements did not manage to reverse the migration flow from a 'brain drain' to ' a brain gain'. However, unquestionable, they are certain and sustainable successes.

9. Project: CRYO-HY

SOP IEC Policy Instrument	**Infrastructure investments for research, measure '2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'**
Title:	***Development of ICSI's CD infrastructure by creating a low-temperature laboratory for energy applications of cryogenic fluids – 'CRYO-HY'***
Beneficiary:	The National Research And Development Institute For Cryogenic And Isotopic Technologies (ICSI)
Beneficiary website:	https://www.icsi.ro/?lang=en
Project link:	https://www.icsi.ro/cryohy/
Objectives	• Increasing the research capacity of ICSI by developing the R&D infrastructure and attracting young and highly qualified specialists; • Strengthening the knowledge offer made by universities and R&D institutes; • Stimulating the technological transfer based on the cooperation between R&D ICSI institutions and enterprises and stimulating their demand for innovation; • Supporting the setting up and development of enterprises based on high technologies developed by ICSI in the field of cryogenic fluids; • Developing a pole of excellence at ICSI level in research and applications for cryogenic fluids.
Results	• Four new laboratories with a total built surface of 905 sq. m; • Twelve new R&D pieces of equipment, each with a value of more than EUR 100 thousand; • Eighteen new jobs created till the end of project completion; • Thirteen jobs maintained after the sustainability period is over; • Seven international projects in which the infrastructure was involved during the sustainability period.
Follow-up activities	• For the research environment, the capitalization of the results is achieved primarily through: (i) scientific outreach activities (background/discussion papers and published articles); (ii) submission of patents' dossiers for the protection of intellectual property rights; (iii) projects carried out in partnership. Their visibility is ensured, in principle, by dissemination in conferences and media; • Cooperation between the institute and Babeş Bolyai University of Cluj-Napoca, so that, based on the established collaboration agreement, part of the CRYO-HY installation systems were used to obtain liquid helium, which was delivered to this university for research purposes; • Participation in several FP7 projects and projects financed from the national budget: ☐ BS_15B Upgrading the TGRS gamma spectrometry diagnostic system from JET for the high-power experimental DD and DT campaigns; ☐ Romania's participation in EUROfusion WPJET4-LRM, WPJET4-GSU and complementary research; ☐ Preliminary design of main water detritiation system (Main-WDS) ☐ Romania's participation in EUROfusion WP-SA and complementary research; ☐ Hydrogen & Fuel Cell • Implementation of a follow-up project within ERDF funded COP 2014-2020, PA1, PI 1.1.4 - Attracting staff with advanced skills from abroad to strengthen R&D capacity
Achievements	• **Increased research capacity.** Its researchers' scientific capacity to address new issues related to the energy applications of cryogenic fluids has been improved. This capability is pivotal to increase the participation of ICSI Rm. Vâlcea in the RDI sector at national, European and international level; • **Transition to the next level at a different scale and dimension.** The new research services and knowledge acquired by the group of researchers

	created the necessary premises for the subsequent involvement of ICSI in national thematic research programs, but also in projects and partnerships at the European and international level in the field of energy applications and cryogenic temperatures; • **Gain visibility and reputation within the research community**. Articles, publications, quotations following the transfer of knowledge obtained in the project and the collaboration with the polytechnic university environment: ☐ Upgrade of the tangential gamma-ray spectrometer beam-line for JET DT experiments, Fusion Engineering and Design, Volume 123, November 2017, Pages 749-753, https://doi.org/10.1016/j.fusengdes.2017.05.064 ☐ Definition of the radiation fields for the JET gamma-ray spectrometer diagnostics, Fusion Engineering and Design Volume 88, Issues 6–8, October 2013, Pages 1366-1370, https://doi.org/10.1016/j.fusengdes.2013.01.083 ☐ Implementation and testing of the JET gamma-ray cameras neutron filters pneumatic system, Fusion Engineering and Design Volume 86, Issues 6–8, October 2011, Pages 1196-1199, https://doi.org/10.1016/j.fusengdes.2011.01.125 ☐ Tandem collimators for the JET tangential gamma-ray spectrometer, Fusion Engineering and Design Volume 86, Issues 6–8, October 2011, Pages 1359-1364, https://doi.org/10.1016/j.fusengdes.2010.12.073 ☐ CeBr3-based detector for gamma-ray spectrometer upgrade at JET, FUSION ENGINEERING AND DESIGN Volume: 123 Pages: 986-989 DOI: 10.1016/j.fusengdes.2017.02.103 Published: NOV 2017
Facts	• **Ensured complementarity within its own projects' portfolio.** ICSI also implemented another two ERDF financed projects under SOP IEC, one within PI 2.1.2 (ROM HyIso) and the second within 2.2.1 (ROM-EST); both types of projects have led to the expansion of the institute's research team, and the increase of the visibility of the research carried out. If in the case of project 2.1.2 the result indicators aimed, in addition to jobs creation, to obtain patent applications, scientific publications and presentations at conferences, in the case of project 2.2.1, it was proposed to participate in 7 international projects in the next 5 years at the end of the project, the publications being a result generated by the development of these projects • **New strategic approaches** based on the R&D strategy of ICSI Rm. Vâlcea, whose vision is to support scientific and technological innovation in priority areas for society, is strongly oriented towards transferring technology/products/services. In this respect, ICSI took restructuring measures in 2018-2019, leading to establishing a new department within the organizational chart and a new business line whose aim is to investigate market needs and build bridges with the economic sector. ICSI Business – mission is the economic valorisation of research results (e.g. knowledge, products, technologies, methods, R&D services) through activities, including Tech transfer, matching the business environment demand. • **HRD policy aimed to attract fresh HEI graduates and young promising researchers in a smaller urban community lacking cultural and educational infrastructure.** The HRD strategy of the institute is based on four pillars: (i) Recruitment and selection, (ii) Stimulation of mobility, (iii) Sustainable employment and (iv) Specialization and career development opportunities following staff expectations and ICSI competences need. As a result, ICSI has managed to build a capable and dedicated team at the scientific, technical and administrative level. However, the institute's location did not offer a wide cultural, educational infrastructure comparable with that of the Capital city or other cities with long academic and research tradition.

10. Project: LabELMAG

SOP IEC Policy Instrument	**Infrastructure investments for research, measure '2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'**
Title:	***Laboratory for the electromagnetic study of innovative materials – 'LabELMAG'***
Beneficiary:	'Gheorghe Asachi' Technical University of Iași, Faculty of Electronics, Telecommunications and Information Technology
Beneficiary website:	https://etti.tuiasi.ro/
Project link:	http://labelmag.tuiasi.ro/
Objectives	• Increasing the R&D capacity of the university, stimulating cooperation between university and enterprises; • Increasing the access of enterprises to University R&D by creating a modernized research laboratory at European standards in the field of electromagnetic study of innovative materials at microwave frequencies; • Upgrading the level of the Microwave Laboratory's material endowment within the Faculty of Electronics, Telecommunications and Information Technology from Iași.
Results	• **Increase of the research capacity**. The acquisition of research equipment and state-of-the-art software licenses has allowed the intensification of research activity in the field of electromagnetic study of innovative materials, in line with European and global trends; • **Increase of the private direct expenditures in research and development projects**. The development of the research infrastructure has allowed the attraction of private finance from the industrial sector either as co-financing in joint research projects and/or as income from the delivery of the consulting research services, measurements and product analysis. The most consistent collaboration with the private sector was made with the local office of Continental Automotive ltd. Company; • **Increasing international visibility**. The existence of the new research infrastructure has led to an increase in the possibility of involvement in joint projects with international partners; • **A modern facility for the training and education of young researchers** in a very dynamic field and with many top practical applications in contemporary telecommunications industries.
Follow-up activities	• Implemented ESFs financed further projects addressed to students and aimed to increase entrepreneurial skills; • A new executive master programme curriculum in the automotive field in English language, developed in partnership with Continental Automotive ; • Integration of TU Iasi in a series of consortia that have submitted projects under Horizon 2020. Since September 2020, TU Iasi coordinates the project 'BrainTwin - Development of a World-Level Neuro-engineering Research Centre by European Twinning', funded by the European Commission within Horizon 2020, the call for projects WIDESPREAD-05-2020: Twinning. The consortium includes, in addition to TU Iasi as coordinator, the following institutions: Project Group for Automation in Medicine and Biotechnology from Fraunhofer IPA (Germany); The Institute of Neurosciences of Castilla y Leon from the University of Salamanca (Spain); Steinbeis 2i (Germany); Centre for Social Innovation (Austria); • Further development of the laboratory by creating a Support Centre for elaborating and implementing research and development projects with international funding in the field of new and emerging technologies – ERDF project financed within Competitiveness Operational Program (COP) 2014-2020.
Achievements	• The equipment acquired for the research laboratory facilitated the measurements of the electromagnetic field at a high level of accuracy, a first not only for the University but also for the entire Nord-Est Region, which met the needs of external beneficiaries, such as partners from industry or

	researchers from other institutions; • Laboratories with modern equipment have increased the interest shown for research activities, being a real attraction for young people interested in a career in research (doctoral and postdoctoral); • Inclusion of the LabELMAG infrastructure in the program for structural research contracts within the capitalisation program of research results (RVP 1.0) developed by the World Bank in partnership with RDA Nord-Est.
Facts	• **Fully internalized project management.** The project team developed the application without external aid. It was their first exercise in writing application, and the Applicants Guidelines elaborated by the MA was good support; • **Collaboration within the same organization for conducting procurement**. The acquisitions were carried out with the support of the University's procurement department. Important support was also given by the designated representatives of national public acquisitions authorities; • **Two dimensions** – one related to the promotion of excellence in research, unicity al national level and the other to promote the research at the junior level – master and doctoral studies; • **The newly introduced payment request mechanism proved better than the disbursement claim mechanism aimed at safeguarding beneficiary cash-flow.** The project was developed in the last part of the programming period, and they benefited from the availability of the payment request mechanism for paying the suppliers, thus reducing the financial risks and the pressure on own financial resources; • **State Aid rules influenced beneficiary institutions' capacity to engage in commercial practices through the newly built or modernized infrastructure financed.** The project does not generate revenues as the sustainability period of 5 years from the closure yet just expired; the state aid rules has impeded infrastructure recipient organization to earn revenues based on the commercialization of the scientific production and services; it was a requirement that in the sustainability period the industry will have free access to equipment and research services using the results of the projects; however, the existing uncertainties related to this subject is waiting to be clarified with the support of Nord-Est RDA; • **Sound financial sustainability.** The university supports recurrent operating costs of the equipment.

11. Project: METEXPERT

SOP IEC Policy Instrument	**Infrastructure investments for research, measure '2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'**
Title:	***Development of laboratory for characterization and mechano-metallurgical expertise of metallic materials – 'METEXPERT'***
Beneficiary:	Polytechnic University of Bucharest – Centre for Eco-Metallurgical Research and Expertise (ECOMET)
Beneficiary website:	http://www.ecomet.pub.ro/home/
Project link:	http://ecomet.pub.ro/wp-content/uploads/2015/06/Pliant-METEXPERT.pdf
Objectives	• Modernization and extension of the existing mechano-metallurgical expertise laboratory within the Eco-Metallurgical Research and Expertise Centre, by endowing it with state-of-the-art modern equipment; • Increasing the quality of advanced research at the Polytechnic University of Bucharest and increasing its capacity to form successful partnerships in domestic or international scientific and technical collaboration programs; • Attracting researchers from abroad to integrate and open up the national research infrastructure to the European space; • Transfer to the economic and social environment, the research results in the field of characterization and expertise of metallic materials and alloys, composite materials to become competitive through economic growth; • Improving the training of master's, doctoral and postdoctoral students in the field of materials engineering at the level of European standards; • Increasing the number of jobs by hiring 3 young researchers.
Results	• 8 newly created laboratories; • Three pieces of R&D equipment, each with a value of more than EUR 100 thousand; • Twenty-two pieces of R&D equipment acquired, from which three with a value of more than EUR 100 thousand each; • 160.8 sq. m of modernized surface in 4 rooms; • Three newly created R&D jobs.
Follow-up activities	• The development of the infrastructure following the implementation of this project allowed the beneficiary to form a working team that developed international collaborations in the European Framework Programme (FP7) and Horizon 2020; • A full list of the projects could be consulted here: http://www.ecomet.pub.ro/research/projects/
Achievements	• The acquired equipment contributed to the carrying out excellence research. They attracted qualified staff, facilitated the obtaining of results and increased the number of publications, increased the level of collaboration with economic agents in the country, supported the increase of the weight of the applied research. The centre provides state-of-the-art materials expertise, requested by a wide range of industrial fields (Railway transportation, Heat producing installations, automotive, steel manufacturers)
Facts	• The Centre for Research and Eco-Metallurgical Expertise (ECOMET UPB) was founded in 2001 and performed its activity within the Polytechnic University of Bucharest. The activities are concentrated on multidisciplinary researches in the field of advanced materials (metallic, nanomaterials and special alloys) and environmental engineering; • The whole project was conceived and elaborated by the team of the centre, without any other support. The Applicants guidelines provided by the MA was sufficient toolkit and the experience of the team members, gained in writing winning bids and carrying out previous (national) funding, was decisive; • This project completed the existing research infrastructure, gained through the national projects 'INFRAS' and 'CAPACITATI' financed within NPRDI II; • The project's duration was very short, 7 months; there was no space for participation in other forms of support. The equipment purchasing contracts also stipulated that the supplier perform a part of users' training. The training was delivered both in Romania and abroad, at the supplier's headquarters; • The arrangement of the spaces was made at the expense of UPB; • After the end of the five years sustainability period, the activities carried out for the economic operators started to generate income.

12. Project: NRCFS

SOP IEC Policy Instrument	**Infrastructure investments for research, measure '2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'**
Title:	***Establishment of the National Research Centre for Food Safety (NRCFS)***
Beneficiary:	The Polytechnic University of Bucharest (UPB)
Beneficiary website:	https://upb.ro/
Project link:	http://www.foodsafety.upb.ro/index.php/en/
Objectives	• Improving the quality and efficiency of the research department of the Polytechnic University of Bucharest in the field of food safety and security; • Increasing the professional performance team of R&D field in UPB; • Improving collaboration with industry and providing highly skilled personnel; • Making the Romanian food industry more competitive in the European Common Market, and not only.
Results	• Eight newly created R&D laboratories; • 18 pieces of R&D equipment with a value of more than EUR 100 thousand each; • 670 sq. m of upgraded/constructed surface; • Nine permanent new jobs created and more than 10 doctoral and postdoctoral candidates; • Three international projects in which the infrastructure has been used; • 20 scientific publications; • Five patent applications.
Follow-up activities	• RENAR accreditation of the newly built and equipped laboratories as per legislation in force, to give both legal and economic value of the measurements; • Scientific exchanges with similar technical universities from the Republic of Moldova aimed at supporting them to comply with the regulatory framework for competition-based financing provided within the Association Agreement of the RM with the EU and cross-border OPs; • Project submission to SOP-HRD focused on getting doctoral scholarships
Achievements	• Increased cooperation with research organizations from Europe; • Increased scientific support for the real economy by providing research services in different areas of activity, from food producers to major steel producers; • Improved quality of the educational process by providing an adequate mix of knowledge and skills claimed by the real labour market (theoretical updated notions but also premises for achieving practical work experience); • Increased level of scientific production based on research themes proposed by the business environment and of participation in international projects; • Gains in terms of scientific performance recognized at the international level based on 'cash factor'; Facilitated positive changes in the university's organisational culture.
Facts	• **The advantage and pride of being part of an HEI with old tradition and goodwill.** UPB is one of the oldest universities in Romania (it celebrates 202 years since its setting up); • **ERDF financing played an outstanding role. It wa**s a major opportunity *'a gold mine'* for reducing the existing (at *that time) ga*p of the technological level o*f the universi*ty's laboratories; **Internal i*nstitutional* support for project implementation.** The administrative departments of the University gave full support for the procurement process as well as for the financial management of the project; • **Synergy with other EU financed programmes**. The new infrastructure also facilitated complementarity funded under SOP HRD the development of doctoral programmes; • **Tech transfer is still a challenge and a concerning issue.** Even though the University recently created a department for the technological transfer of research results, it becomes obvious that this area needs more support. • **Sound financial sustainability.** Follow up financial contribution of the beneficiary ensures sustainability. The University secured the cash flow of the project and, after project closure, provided continued support for the maintenance of the equipment and necessary supplies;

13. Project: PRECIS

SOP IEC Policy Instrument	**Infrastructure investments for research, measure '2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'**
Title:	***Research Infrastructure for the Development of Intelligent Innovative Products, Processes and Services***
Beneficiary:	Polytechnic University of Bucharest, Faculty of Automatic Control and Computers
Beneficiary website:	http://acs.pub.ro/
Project link:	http://precis.acs.pub.ro/centrul-de-cercetare/
Objectives	• Expanding the current infrastructure and research activities of the Polytechnic University of Bucharest, Faculty of Automatics and Computers, to foster technology transfer and development of innovative new generation products, processes and services customized mainly for industry and health; • Addressing new priority research directions at international and national level, with an impact on increasing the competitiveness of the Romanian economy and the acquisition of equipment that facilitates these researches' realisation.
Results	• Construction of the building for research centre (with an area of 8,745 sq. m) • 28 research laboratories equipped with state of the art R&D equipment; • 291 pieces of equipment acquired from which three worth over EUR 100 th; • 35 new research jobs created and 10 auxiliary jobs till the end of project closure • 140 existing jobs maintained • Increased exchange of information and collaboration between research teams and industrial units in the country and abroad in order to efficiently capitalize on research activity (scientific transfer in production) and increase the competitiveness of industrial partners; • The use of newly built research infrastructure in 11 follow up projects with international partners; • Created a partnership network around the PRECIS centre that includes members from 20 prestigious universities and research centres around the world; • Strengthened cooperation with 15 universities and research centres in Romania • PRECIS played the role of catalyst in setting up innovative research, development and innovation cluster comprising 15 entities whose aim is to achieve sustainable partnerships between the university and industry; • Intensifiedactivity of publishing research results with impact on UPB worldwide reputation and career development and promotion of the academic teaching staff based on increased 'cash factor'.
Follow-up activities	• Implementation of another project NETIO - Ecosystem of research, innovation and product development and ICT services for a society connected to the Internet of Things funded by ERDF under the ongoing COP 2014-2020. http://netio.ro/ • Other projects whose financing was gain based on competition basis are exemplified below: ☐ Horizon 2020 - SSICLOPS - Scalable and Secure Infrastructures for Cloud Operations; ☐ Horizon 2020 -RAGE - Realizing an Applied Gaming Eco-system; ☐ Horizon 2020, ID. 643636- Sound of Vision - Natural sense of vision through acoustics and haptics; ☐ Eurostars, E! 9831 HAI-OPS - Hospital Acquired Infection and Outbreak Prevention System; ☐ COST Action CA15127 RECODIS - Resilient communication services

	protecting end-user applications from disaster-based failures; ☐ Horizon 2020, H2020-ICT-2014-2 SUPERFLUIDITY - Superfluidity: a super-fluid, cloud-native, converged edge system; ☐ ERASMUS + DECAMP - Open Distributed European Virtual Campus on ICT Security; ☐ Excellence in Smart Data and Services for Supporting Water Management - DATA4WATER, project number: 690900, H2020, Competition: H2020-TWINNING-2015 Spreading excellence and widening participation
Achievements	• The newly built infrastructure was used to set up a specialized Research Centre under the roof of Polytechnic University of Bucharest • Participation in Innovation Labs - a pre-acceleration programme that advances tech creativity and entrepreneurial drive among young professionals and students https://2015.innovationlabs.ro/2015.innovationlabs.ro/index.html.
Facts	• **The tradition and prior achieved experience in EU funded projects implementation in education was a good foundation for successful implementation**. With a tradition of over 50 years, the Faculty of Automatics and Computers at UPB achieves excellence in education and research in two fields: 'Computers and Information Technology' and 'Systems Engineering'. Starting from the existing institutional capacity and the reputation gained over time, the strategy of the Faculty of Automatics and Computers focuses on providing a distinct learning, training and research environment, maintaining the leading position in the country and increasing international prestige, strengthening collaboration with other academic communities in the country and abroad; • **Internal rooted initiative to take the ERDF financial opportunity.** A team of professors from the Faculty of Automatics and Computers wrote the application by themselves, based on their previous experience in national and international (FP7) projects and a well-defined idea of improvements needed in Faculty's activity; the development of the feasibility study was supported from the UPB budget; • **Major challenges and concerns started before the project kick-off.** These were mostly linked with the long duration of the evaluation process since the submission of the proposal and risks that may arise from conducting public procurement for a hard investment. The application's evaluation lasts more than expected, and the timeframe for implementation was shorter than envisaged. Despite time pressure and other potential risks in the procurement process, the project management team succeeded to mitigate them and conclude the infrastructure project within the allowed timeframe; • **A new scientific platform for ambitious R&D themes.** The newly created laboratories allow the approach of more actual and production-oriented research and innovation themes; the follow-up NETIO project opened a new way to improved cooperation with the enterprises in the area of knowledge transfer; • **High attractiveness and research staff retention.** The centre also proved to offer an attractive environment for the young researchers and therefore contributed to higher participation in master programmes and a higher retention rate in research activities; personnel fluctuation still exists due to the public research organizations' sub-financing.

14. Project: ELI-NP

SOP IEC Policy Instrument	**Infrastructure investments for research, measure '2.2.1 - Development of the existing R&D infrastructure and the creation of new infrastructures (laboratories, research centres)'**
Title:	***Extreme Light Infrastructure – Nuclear Physics (ELI-NP)***
Beneficiary:	Horia Hulubei National Institute of Physics and Nuclear Engineering (IFIN–HH)
Beneficiary website:	https://www.nipne.ro/research/departments/
Project link:	https://www.eli-np.ro/
Objectives	ELI-NP contributes to a higher degree to the fulfilment of the two main European Strategy Forum on Research Infrastructures (ESFRI) objectives: • Scientific and technological excellence is embodied into the ELI-NP project to the utmost, with both laser and gamma beam systems that will constitute world benchmarks; • ELI-NP is part of the pan-European ELI project and will offer more than 25,000 hours/year of open, free-of-charge access for research organisations solely based on excellence. Access granted for for-profit research will be granted in return for the payment of fees reflecting full-cost + fair margin, in compliance with the Community Framework for State Aids for Research and Development. Revenues from for-profit research will remain marginal (about 6% of operational costs); ELI-NP also contributes to four from the six objectives established within the National Plan for Research Development and Innovation for the period 2007-2013 and to the objectives of SOP IEC: • Increase the number of researchers and their professional performances – 167 new research jobs expected to be created at the end of Phase 1 and 262 at the end of Phase 2; • Develop the research capacities and opening the RDI systems to the international scientific environment and the national socio-economic environment – a new research infrastructure consisting of 33,653 sq. m of buildings, 2x10 PW laser system and a gamma beam system developing up to 720 MeV of electron energy, up to 20 MeV of gamma energy, eight experimental rooms; • Obtain outstanding scientific and technological results comparable to the ones obtained at the European level, reflected by the increase in international visibility and recognition of Romanian research – expected to offer more than 25,000 hours of access, to perform an expected annual average of 71 experiments. The ELI-NP facility is expected to receive every year 426 external researchers (i.e. researchers who are not employed at ELI-NP). The results of collaborations between ELI-NP researchers and external researchers are expected to be 145 articles in impact-factor publications/year, 79 other articles and publication (conference proceedings, etc.)/year, 4 patents/year (not including patents derived from research led at ELI-NP to be applied for by companies), and 12 technologies developed (design, prototype, etc.)/year, after the end of Phase two. • Increase R&D competitiveness by stimulating partnerships in the main S&T domains, concretized in innovative technologies, products, and services to solve complex problems and create implementation mechanisms. The ELI-NP facility planned to attract in 2020 EUR 7.9 million of nationally competitive grants, EUR 1.06 million of international competitive grants, EUR 8.08 million of institutional funds, EUR 8.8 million of international funds (ELI-ERIC contribution). Also, collaborations with undertakings and other research organisations are estimated at EUR 64 thousand in contractual research fees and EUR 19 thousand in license fees. In 2022, however, collaborations with undertakings and other research organisations will reach EUR 614k thousands, and license fees EUR 160 thousand. The proportions will be kept roughly constant until the end of the reference period (2031); • Generate spin-off companies to attract high-tech companies and further investments, becoming the core of an advanced technologies cluster (Magurele

	Hot Spot for Innovation).
Results	• Civil constructions consisting of administrative building and research offices, canteen, guest house, access roads, storage spaces and facilities at standards comparable to those of the top centres in the world and fulfilling all the conditions of the authorization according to legal norms; • Geothermal system, the largest in the world at present and which provides over 5 MW to ensure the environmental conditions (temperature, humidity) required in civil and special buildings; • Special constructions for high power laser systems, gamma beam, experimental cameras, laboratories and workshops met after the tests all the necessary parameters for the installation and operation of the scientific equipment (e.g. construction of the anti-vibration platform, over 120 thousand tons weight, 3700 sq. m area, its controlled movement being below 1 μm.); • 262 new jobs created
Follow-up activities	• IFIN-HH and ELI-NP have greatly increased their attractiveness for top researchers in the country and abroad; for example at ELI-NP were employed about 10% of applicants and after the area of origin 1/3 are from Romania, 1/3 Romanians returned from abroad and 1/3 foreigners; • Phase 2 funded from the ongoing COP 2014-2020
Achievements	• Romania has entered the international flow of the most important research infrastructures in the field, the ELI-NP Centre being inspiring for the society and the young generation of researchers
Facts	• Identified by the ESFRI as one of the top priority projects of research infrastructure for Europe, ELI has been brought to legal, organisational, financial and scientific maturity thanks to a 36-month Preparatory Phase launched in November 2007, which involved nearly 40 research and academic institutions from 13 EU Member States; • As a result of the Preparatory Phase, the 'ELI White Book' has been compiled, comprising the coordinated efforts of more than 100 scientific authors from 13 countries under the leadership of the ELI initiator Gerard Mourou, and under the guidance of an international Steering Committee. The White Book is a comprehensive description of ELI's technical design concept and scientific case as of the end of 2010. It is the reference basis for the Technical Design Reports developed by the three sites ELI-Beamlines, ELI-ALPS and ELI-NP in the context of their EU Structural Funds applications. • On 3 December 2009, the EU Competitiveness Council adopted the Declaration of the Czech Republic, Romania and Hungary on the implementation of the ELI project as an infrastructure distributed in the three countries using structural funds allocated to those countries; • Romania was selected to host this project mainly due to the expertise in nuclear physics at the IFIN-HH institute, the institution that implemented ELI-NP; • The challenges and risks have been correctly identified since the development phase of the project application. It was decided in accordance with DG Regio to implement the project in two financial phases, of which Phase I within SOP CCE 2007-2013 (one project, one application, two financial phases); • Excellent collaboration and coordination with all project stakeholders, especially with the relevant scientific community (lasers and nuclear physics), national (including MA and IB) and local authorities and the European Commission. Also worth mentioning is the support provided by the International Scientific Advisory Committee of ELI-NP, which was real support in prioritizing the implementation of the scientific case; • ELI-NP users can be split into three different categories: ☐ Open access users (Research organisations) apply for access to the ELI-ERIC Program Advisory Committee (PAC); ☐ Fast track access users (Research organisations) constitute a category of users who feature an urgent reason to be granted access to the facility in an emergency; ☐ Contractual research users - Undertakings. Contractual research constitutes the only way for undertakings to access the facility. According to an estimate performed by the ELI-NP project team for the ELI-NP Cost-

Benefit Analysis, fees for undertakings are expected to cover up to 6% of operational costs, while 5.2% of the access time (which is estimated to be for all users 25,700 hours/year) is expected to be granted to them. The fees will cover only costs related to the operation of the infrastructure. These data are compatible with the requirements of the Community Framework for State Aid for Research and Development, point 3.2.1

- The ELI Delivery Consortium International Association (ELI-DC) was founded in April 2013 as an international non-profit association under Belgian law (AISBL). It aims to promote the sustainable development of ELI as a pan-European research infrastructure, support the coordinated implementation of the ELI research facilities, and preserve the consistency and complementarity of their scientific missions. It will also organise the establishment of an international consortium that will be in charge of the future operation of ELI, preferably in the form of a European Research Infrastructure Consortium (ERIC). ELI-DC Members are: The Institute of Physics of the Academy of Sciences of the Czech Republic (Fyzikální ústav AV CR, v.v.i.), Czech Republic, ELI Host Member; The ELI-HU Non-Profit Ltd., Hungary, ELI Host Member; The Horia Hulubei National Institute of Research and Development for Physics and Nuclear Engineering, Romania, ELI Host Member; Elettra - Sincrotrone Trieste S.C.p.A., Italy; DESY - Deutsches Elektronen Synchrotron, Germany; STFC Science & Technology Facilities Council, United Kingdom; Centre National de la Recherche Scientifique (CNRS), France;
- In the last years, the domain competition increased, like France, Italy, and the United States of America relaunched their national programs regarding the development of high power lasers facilities for research.

ANNEX VII.INTERVIEWS LIST

Stakeholder category	Organisation	Role in the organisation	Name
Stakeholder national RTD policy	The Executive Unit for the Financing of Higher Education, Research, Development and Innovation (UEFISCDI)	CEO	Adrian Curaj
Managing Authority – Intermediate Body	SOP IEC Intermediate Body – National Authority for Scientific Research	General Director	Dana Gheorghe
Managing Authority – Intermediate Body	SOP IEC Intermediate Body – National Authority for Scientific Research	Counsellor	Mihaela Cimpuieru
Managing Authority	SOP IEC Management Authority	Head of the Monitoring and Evaluation Department	Mihaela Manolescu
Managing Authority – Intermediate Body	SOP IEC Intermediate Body – National Authority for Scientific Research	Counsellor	Daniela Gheorghian
Managing Authority	SOP IEC Management Authority	First Managing Director	Cătălina Meliță
Managing Authority	SOP IEC Management Authority	Head of the Programming Unit	Dorina Muntean
Stakeholder national RTD policy	SOP IEC – Monitoring Committee	NGO Representative	Sorin Ioniță
Beneficiary – Policy instrument infrastructure investments	Polytechnic University of Bucharest	Vice-Rector, Professor	Adina Magda Florea
Beneficiary – Policy instrument infrastructure investments	Polytechnic University of Bucharest	Professor	Ecaterina Andronescu
Beneficiary – Policy instrument infrastructure investments	Polytechnic University of Bucharest, Faculty of Electronics, Telecommunications and Information Technology	Professor, President of the Advanced Research Center for Materials, Products and Innovative Processes 'CAMPUS'	Corneliu Burileanu
Beneficiary – Policy instrument internalisation of the research	Institute of Geodynamics 'Sabba S.Stefănescu' of the Romanian Academy Bucharest	Head of Solid Earth Laboratory	Lucian Beșuțiu
Beneficiary – Policy instrument infrastructure investments	Polytechnic University of Bucharest	Director of Center for Eco-Metallurgical Research and Expertise (ECOMET)	Cristian Predescu
Beneficiary – Policy instrument infrastructure investments	Academy of Medical Sciences Bucharest	Project Manager	Cristina Plești oianu
Beneficiary – Policy instrument infrastructure investments	Academy of Medical Sciences Bucharest	Project Director	Radu Deac
Beneficiary – Policy instrument science-industry collaborative R&D	San Systems Industry SRL Pitești	Project Director	Alin Mihăilescu
Beneficiary – Policy instrument internalisation of the research	Polytechnic University of Bucharest	Project Director	Diana Mariana Cocârță

Stakeholder category	Organisation	Role in the organisation	Name
Beneficiary – Policy instrument science-industry collaborative R&D	Tangent Electro Trade SRL Sângeorgiu de Pădure, Romania	Project Director	Gheorghe Dinu Socotar
Beneficiary – Policy instrument internalisation of the research	Clinical Institute Fundeni	Project Manager	Mădălina Grigoroiu
Beneficiary – Policy instrument science-industry collaborative R&D	Renault Technologie Roumanie SR	Project Manager Performance RTX&International	Rusu Marius Ciprian
Beneficiary – Policy instrument infrastructure investments	Polytechnic University of Bucharest	Professor	Marius Enăchescu
Beneficiary – Policy instrument infrastructure investments	Institute of Cellular Biology and Pathology 'N. Simionescu' Bucharest	Project Director, Director of the Institute of Cellular Biology and Pathology 'N. Simionescu' Bucharest	Maya Simionescu
Beneficiary – Policy instrument infrastructure investments	Technical University 'Gh. Asachi' Iasi	Project Director	Nicolae Lucanu
Beneficiary – Policy instrument internalisation of the research	University of Agricultural Sciences and Veterinary Medicine Iasi	Project Manager	Lucian Raus
Beneficiary (partner research organisation) – Policy instrument science-industry collaborative R&D	National Institute for Research & Development in Chemistry and Petrochemistry Bucharest	Project Responsible	Cristian Petcu
Beneficiary – Policy instrument infrastructure investments, Major Project ELI-NP	INFIN Horia Hulubei Măgurele	Quality Control and Oversight Director	Andrei Ionel
Beneficiary – Policy instrument infrastructure investments	National Research And Development Institute For Cryogenic And Isotopic Technologies Râmnicu Vâlcea	ICSI Energy Department Coordinator	Elena Carcadea
Beneficiary (partner research organisation) – Policy instrument science-industry collaborative R&D	SC Ecobihor SRL Oradea, Romania	General Manager	Zoltan Attila Pasztai
Beneficiary (partner research organisation) – Policy instrument science-industry collaborative R&D	SC Telebit Prod SRL Iași, Romania	Project Director	Dan Dorin Cepăreanu
Beneficiary (partner research organisation) – Policy instrument science-industry collaborative R&D	Polytechnic University of Bucharest	Project Responsible	Tiberiu Apostol
Beneficiary – Policy instrument infrastructure investments	INCD FM	Project Director	Cristian Teodorescu

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