Octombrie 2019

Proiect: „Cresterea capacității sistemului CDI de a răspunde provocărilor globale. Consolidarea capacității anticipatorii de

elaborare a politicilor publice bazate pe dovezi”

Cod MySMIS 127557, SIPOCA 592

Denumire pachet de lucru *(Pachetul de lucru 5 - Elaborarea SNSI 2021-2027 și a instrumentelor de implementare)*

Denumire livrabil: Analysis of the factors that obstruct the diffusion of innovation, including digitization

Final

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București, 2019

"Increasing the capacity of the RDI system to respond to global challenges. Strengthening anticipatory capacity to develop evidence-based public policies" - POCA 127557

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Acknowledgements

I thank for the specific inputs, editorial contribution and comments received from Unitatea Executiva pentru Finantarea Invatamantului Superior, a Cercetarii, Dezvoltarii si Inovarii (UEFISCDI) team: Cosnita Daniel, Dragomir Bianca , Dumitrache Nicoleta, Gheorghiu Radu, Haj Cezar, Jitaru Gabriela, Medeea Petrovan, Mitroi Marius, Rusu Diana, Sebanica Cristina, Velter Victor.

I gratefully acknowledge the solid, objective and thorough feedback received from Adrian Curaj, who carefully read the report and provided insight and expertise that greatly assisted the analysis, although he may not agree with all of the interpretations/conclusions of this study.

Comments on this report from the Committee for the Coordination of Smart Specialisation (CCSI), particularly the Ministry of Research and Innovation, the Regional Development Agency (ADR) North – East, ADR Muntenia, ADR West, Ministry of European Funds are gratefully acknowledged.

This report does express the view of the author and not necessarily reflects the view of the Ministry of Education and UEFISCDI.

EXECUTIVE SUMMARY

The report tries to shed light on the barriers of the innovation in Romania, highlighting the systemic challenges which have been chronically affecting the national innovation ecosystem. The report highlights the regional disparities, but focuses on those cross-cutting, significant problems, present in all regions and NACE fields. The legislation, regulation are at national level and do not have regional specificity. The problems are common in all regions, but specific attention should be given to the biomedical, energy and ICT field where the relevant legislation for these sectors may require a distinct analysis.

The problems identified are severe, systemic challenges affecting the innovation ecosystem and some, the whole society. They have become characteristics of the system since they have been persisting for many years.

The analysis can not go beyond the general, systemic obstacles, since any detailed, sound analysis, assessing the impact on specific smart specialisation domains can not be performed due to the of lack of compliance to the strategic actions, including funding and lack of stable, predictable legal framework.

Three main deficiencies, severely limiting the capacity to innovate were identified. Two are related to the broader innovation ecosystem: (1) the unpredictability of the legal framework and (2) skills shortage due to demographic disruption and lack of availability of skills relevant to the market.

- The **lack of human resources/relevant skills/demographic problems**. Romanian diaspora is the fifth largest in the world and has the highest growth rate in recent years. Around 3.6 million, 17% of Romanians live in OECD countries. To the high level of emigration adds the natural demographic decline (number of deaths/number of birth).

  The recent economic growth has not be transferred in the increased quality of life. There has been and it is going to be a significant brain drain driven by the search for better lives, better education, health and welfare systems, better careers. Around 760,000 highly educated Romanians live in OECD countries. In 2015/2016 Romania had the highest emigration rate of highly educated, rate which increases more rapidly than the number of national tertiary graduates. (OECD, 2019). The education system fails to equip the bulk of the students with the relevant skills.

  The persistent loss of the high level professionals, in whom the country invested, while failing to provide a flexible, coherent education to the bulk of young population, may be on long term the most damaging systemic challenge of the entire society. This is reflected also in the lowest ranking/ scores on the pillars Skills / Human Capital dimension&Health in Global Competitiveness Index (GCI) 2018 and European Innovation Scoreboard (2019). Romania is ranked particularly low in the ranking of 140 economies in the dimensions Skillset of graduates (131), Ease of finding skilled employees (133), Internal Labour mobility (135).

- The **volatility of the legal framework**, the **unpredictability**, both from the market and taxation point of view, has been generating significant time efforts for companies to understand and comply to changing legal requirements.

- The **third main hindrance** is the lack of compliance to the RDI policy strategic directions/targets, the mismatch between promise regarding the R&D budget complemented by the dissipation of RDI funds across a fragmented R&I system, lacking funding schemes rigorously based on the results of regular evaluation.

- The R&I system is **chronically underfunded**. Romania, allocated in 2017 the lowest GERD per capita in EU28 (48 EUR per capita, compared to 619 EUR the EU28 average).
- There is a National Strategy for RDI (SNCDI) 2014-2020, based on multi-annual planning. The RDI investement target is 2% by 2020 (1% public+1% private). All national governments committed in strategic documents to the GERD targets. The evidence shows that this is decoupled from political will. In 2019, the public intensity for RDI was around 0.15% (vs 1% target of public investement in R&D by 2020).
- The lack of science awareness increases the vulnerability of the national R&D budget.
- The Ministry holding responsibilities for Research and Innovation, in various institutional formula, has had over 27 ministers since 1989, and four ministers in 2018. The Research Development and Innovation (RDI) system remains vulnerable to political interference, ad-hoc changes and pressure exercised by the stakeholders, to align the RDI priorities to specific group interest and to avoid funding based on rigorous performance institutional evaluations.

There is limited evidence base STI policy-making and governance

- The **main RDI policy instruments** in the 2014-2020 policy cycle are: (1) the National Plan for RDI 2015-2020 (PN3). (2) The Competitiveness Operational Program (Programul Operational Competitivitate POC), Priority Axis 1. RDI supporting economic competitiveness with a total budget € 952.57 million. (3) The Operational Programme Regional Development (Programul Operational Regional POR) 2014-2020, PA1, 'Technology transfer', (€206.5 million). These three programmes partially (PN3) or totally (POC, AP1 and POR, AP1) target the investement in smart specialisation domains. To these instruments, various other programmes provide support for R&D activities. Among the most important as funds allocated are Nucleu Programme (allocating funds for INCD, the Research Plan of the Romanian Academy (RA) allocating funds through a distinct budget line to the R&D Institutes of the RA, the sectoral plans etc. The NUCLEU and the Romania Academy funding lines have similar budget volumes as PN3.
- There **is no official information** on the impact of National Plan II for RDI (PN2), which was not evaluated ex post, neither of the POS-CCE programme. A mid-term evaluation of **National Strategy for RDI 2007–2013 (SNCDI 2007–2013)** was published in 2012, but there is no ex post evaluation.
- The **Mid Term Evaluation, assessing the impact of the National Strategy for RDI 2013-2020** on the smart specialisation domains was conducted within the project "*Development of the Administrative Capacity of the Ministry of Research and Innovation for the implementation of actions set out in the National Strategy for Research, Technological Development and Innovation 2014-2020 (code SIPOCA 27[1]).* The evaluation included four PN3 programmes (582 projects) finalised by March 2019, explicitly targeting the smart specialisation domains and the aggregated data regarding 46 POC, AP1 projects, finalised by March 2019. This is not a mid term evaluation of the National Strategy for RDI (RDI), of its impact on the smart specialisation domains, neither of the PN3 but merely the evaluation of few PN3 programmes. PN3 allocates only approximately of a third of the public national R&D budget.

  The budget allocated for PN3 has not followed the increasing expenditure trend to reach the 1% target by 2020. Output, outcome SNCDI indicators are correlated with input indicators to which budget allocation does not comply.

[1] http://sipoca27.ro

- PN3 was started in 2016, one year later after its approval. Both POC and PN3 had delays and discontinuities in funding. The call under POR, AP 1 was launched with delay. The low level and the lack of continuity of the competitive, project based, funding, make very difficult the possibility to improve the RDI performance and attain a sizeable impact at macroeconomic level.
- The *Mid Term evaluation of SNCDI 2014-2020* assesses that broadly, there is an appropriate mix of funding instruments. All instruments show a positive, however low, impact.
- The main problems highlighted by the RDI performers were related to the low funding, high competition, lack of continuity of the competitive funding. Significant delays in the launch of many instruments, discontinuities in funding further hamper the efficiency of the funding. The low and unpredictable funding does not allow the RDI performers to establish an institutional R&D strategy, affects their capacity to develop/maintain the existing infrastructure, but also to attract and retain the human resource.
- Other obstacles relate to heavy and complex bureaucracy involved by the RDI programmes financed by structural funds.
- The evaluation of the proposals was assessed in some programmes as too long, further delayed by the long period between results of the evaluation and implementation.

Individual evaluation of PN3. POC. POR. NUCLEU

- **PN3.** Annual reports are produced by the Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI) for the PN3 subprogrammes under its management. The reports provide comprehensive data regarding the number of applications, the projects' implementation, and other important elements of descriptive statistics. There is one stop shop platform providing easy access to information regarding calls. The presentation in a structured, searchable format of the PN3 information recommands the UEFISCDI platform as a good practice.

  Four PN3 programmes / (582) projects were included in the Mid Term evaluation. Comprehensive input/output data, structured per project/programme were provided by UEFSICDI to the evaluators. Ministry of Research and Innovation (Ministerul Cercetarii si Inovarii – MCI) is in charge of the evaluation of the whole PN3.
- **POC, AP1** Two independent evaluations of the impact of POC, AP1 on smart specialisation domains were planned to date (in 2017, and the second semester 2019). No further information is available.

  Aggregated data regarding 46 POC projects finalised by March 2019, were provided to the evaluators and included in the Mid Term Evaluation of SNCDI 2013-2020.
- **POR, AP1** was launched with delay. The first evaluation of the programme was scheduled for the third semester 2019. No further information is available.
- **NUCLEU** programme alocates around the same share of the national R&D budget as the PN3. The information related to Nucleu Programme in a comprehensive format is missing. No information regarding the evaluation of this long term funding scheme is available.
- **Romanian Academy** is the beneficiary of a distinct R&D funding line from the state budget, similar in volume as NUCLEU programme (and PN3). The RA provides Annual Activity Reports. No additional information regarding recent external evaluation is available.

Competitive funding based on regular evaluation of the research performance

- The R&D funds are dissipated across a fragmented R&I system which lacks funding schemes rigorously based on the results of regular evaluation of the performance of the R&D institutions.
- The RDI system is highly polarised, with a limited number of actors (institutions/individuals) concentrating the scientific output.
- Universities went through a classification exercise in 2011. The classification was meant to be tied with specific funding lines available to the best performers. The results were heavily contested and starting 2012-2013 the funding is independent of the evaluation and ranking.
- The 2011 regulatory framework stipulates that all public research organisation (PRO) in order to be entitled to R&D public funds must be evaluated and ranked by their research performance. All the evaluated institutes were ranked in the A category.
- All National Research and Development Institutes (INCD) and universities should produce annual self-evaluation reports. The reports, if available (and often are not, or not for the latest years), are mainly a list of achievements (partially also due to the lack of dedicated staff and scientific repositories).
- During the period 1995-2017, the fragmentation has increased: the number of public R&D entities has increased, while the number of researchers has decreased (based on INS data).
- The low R&D investements were directed towards national RDI institutes, merely supporting their survival. The R&D investments, targeting societal challenges/ strategic priorities and mainly channelled through the National Plan for RDI, may have been neglected in this context.
- The national research is disconnected from the international research trends. There is a low national participation in Horizon 2020 programmes, but also there is a low interest in accessing such funds.
- The public research is disconnected from economic needs, reflected in the low level of public-private collaboration.
- Recent investments increased the quality of research infrastructures, but often these lack long term strategic approach/did not respond to national strategic priorities.

RDI in business sector. Collaboration. Economic/Market structural factors

- BERD intensity in Romania is low, showing a revival starting 2014 (increasing from 0.16% of GDP in 2014 to 0.29% in 2017). However, the increase of the private investement in RDI (from simple to double) is not reflected in a similar increase of the human resources in RDI in the private sector.
- There are several fiscal incentives for RDI. Yet, companies take limited advantage due to unclear and ambiguous methodology.
- There is low level of collaboration public-private. Both sectors function in silos, responding to distinct pressures.
- There is limited flow of knowledge, knowledge transfer support. There is lack of innovation managers/ transfer brokers.
- There has been limited support to clusters.
- The total turnover from all size classes in new products new to the market is very low and dominated by large companies.

- The Romanian SMEs show very low innovation activity, with low, to null performance in all the components (product/process. marketing/organizational, innovating in house) (EIS, 2019).
- The number of SMEs is one of the lowest position in EU (EC, 2018).
- Out of **824,817** companies active in industry, construction and services (except insurance), **382,800** were companies with **0 employees**, 330,205 with 1 to 4 employees, 55,205 with 5 to 9 employees, and 56,207 with more than 10 employees (EUROSTAT, 2019).
- SMEs have low capacity to develop RDI departments. Multinational companies (MNC), given the IPR provisions, tend to transfer the RDI results to the headquarters.
- Romania's economy remains dominated by service providers and labor-intensive industries that require a lower level of knowledge. The R&D investments are concentrated in high, medium technology.
- The Romanian companies are mainly producers, with no significant roles in the other value chain segments.
- The efforts to involve businesses in the policy making process were limited in the past and even when done, the expected level of participation was not reached.
- Recent efforts undertaken by regional and national authorities to engage the business sector in the identification of the smart specialisation priorities may create a momentum for the business to be active in the RDI policy design.

Financing

- The venture capital (VC) market is at incipient stage, with few visible venture capital providers on the market. Very few business Angels are active on the market. This is reflected in the low ranking (101 of 140) of the Financial system pillar in GCI 2018.
- SMEs' access to financing is limited due to both supply- and demand-side constraints.
- Competition inhibits the development of newly arising companies, which may not have the force to compete with well established enterprises, in the context of the workforce crisis and fluctuating legislation.

Policy. Governance

- Various Strategies were designed and implemented during 2014-2020 policy cycle. They were not designed/nor implemented in a coordinated and integrated manner.
- The governance of the RDI has been hindered by a fragmentation amongst Ministries and Agencies. There is no evidence that the coordination mechanisms were functional/operational. In August 2019, the Committee for the Coordination of Smart Specialisation was established and became operational.
- This policy fragmentation also brings an additional layer of complexity which the beneficiaries face in accessing information.
- The Romanian RDI policy may be seen more „supply" oriented rather than visionary and „mission" oriented. Currently the R&D policy target mainly the supply side of the system represented to a very high extent by publicly owned Research Institutes.
- There are no specific policies targeting start-ups (as defined by the EC: '*younger than 10 years, innovative, intention to grow*')

- There is no specific policy targeting High Growth Innovative companies (scaling up etc.)

Administration. Regulation. IPR

- The lack of predictability of the legal framework, the unstable legislation, taxation, regulation and competition are cross-cutting factors that strongly affect the business environment.
- Overly cautious or burdensome regulations affect the innovation.
- Romania had a number of regulations on Intellectual Property (IP) with several contradictions on invention ownership, use and its transfer. These act as disincentives for individual researchers/innovators, institutions and private investors.
- The high patenting costs, the long 'time to patent' periods discourage the SMEs, while the multinationals prefer to transfer the intellectual property to the headquarters.

Education

- Education in Romania is chronically underfunded.
- Dropout rates are high. One in five students fail to make the transition to upper secondary education. A significant share of 18 years population will not reach the baccalaureate level.[2]
- International surveys point to severe deficiencies in basic skills among Romanian teenagers. Romanian education system currently enables only a minority of its students to excel. And the high achievers, most often go abroad and do not return.
- Romania faces important challenges regarding the decreasing number of students in tertiary education: from 2006 to 2016 the total number of students dropped by 17 %. Tertiary educational attainment (age 30-34) in 2017 was 26.3 % compared to 40.6% in EU28.
- The supply of skills is NOT correlated with the needs of the economy.
- The labour market relevance of vocational education and training (VET) is still a challenge. There is limited availability of vocational and life long training.

Human Resources

- Romania continues to face substantial challenges, both for increasing the number of researchers and for reducing the serious brain-drain phenomenon. Those who have chosen to remain face significant obstacles in a system lacking predictability.
- In Romania, the share of Human resources in science and technology (HRST) in 2018 was 27.9%, the lowest in EU (EUROSTAT).
- In the context of significant reduction of the number of students and the low RDI investement, the reluctance of the private sector to engage in RDI activities, the discussion may shift from attractiveness of academic/research career to limited opportunities to enter the system.

Culture for innovation

- There is a reduced demand for new and innovative products and services, due to the lack of market maturity.

[2] https://uefiscdi.gov.ro/Publicatii-1

- The national **innovation culture** can be assessed as weak. The working environment in the public sector remains rigid, lacking openness for new ideas and incentives to support them.

Regional disparities

- Romania's prosperity is not equally shared, with a large population (around 40%) disconnected from the drivers of growth. The lack of local opportunities has not generated the needed labor force mobility.
- As far October 2019, the development regions, in line with the relevant laws, **are not administrative-territorial units and do not have legal personality** (Law 315/2004[3], Romanian Constitution). The NUTS2 regions exist primarily for the purpose of coordinating development projects.
- There are significant disparities between the 8 NUTS2 regions. The level of polarization at the territorial level has not significantly diminished in the last 20 years.

DIGITISATION

Romania is part of catching up cluster, ranking the second lowest in EU28 in the Digital Economies and Society Index (DESI).[4] Romania performs best in the Connectivity dimension (ranking on the 22nd position), due to the wide availability of fast and ultrafast fixed broadband networks. More than one fifth of Romanians have never used the internet. Only 9 % of Romanian enterprises are using social media (compared to 21 % EU average), 7% use the cloud services (compared to 18% inEU28). Romania's rank in Digital public services decreased each year one position since 2016, dropping to the lowest position in 2018.

- The country has very good IT specialists, **but they are too few**. The country ranking in terms of graduates (17th) decreases to 27th in the number of employees. Many of the best go abroad.
- An important share of its student population does not reach basic levels of competence and leave school before graduating from upper secondary education.
- The number of ICT places in public universities is limited and there is a lack of ICT graduates.
- There is need of the government to build trust in digital services.
- The national administration IT system is fragmented, with a low level of interoperability.
- The public sector, where is a significant need of IT specialists in order to ensure implementation and functioning of digital services can not compete with the wages in the IT private sector.
- The medical system is still not covered by a centralised electronic system. The doctors remain under a significant administrative burden and do not benefit by centralised registries for epidemiological studies.

[3] LEGE nr. 315 din 28 iunie 2004

[4] The Digital Economy and Society Index (DESI) is a composite index developed by the European Commission (DG CNECT) to assess the development of EU countries towards a digital economy and society, aggregating a set of relevant indicators structured around 5 dimensions: Connectivity, Human Capital, Use of Internet, Integration of Digital Technology and Digital Public Services.

1 INTRODUCTION

The report "*Analysis of the factors that obstruct the diffusion of innovation, including digitization*" addresses one the seven fullfilment criteria[5] under the specific thematic enabling condition '*Good governance of national or regional smart specialisation strategy*", as laid down by Common Provisions Regulation on the European Regional Development Fund, the European Social Fund Plus, the Cohesion Fund, and the European Maritime and Fisheries Fund[6,7]. The Common Provisions Regulation stipulates under each specific objective, prerequisite conditions for its effective and efficient implementation (*'enabling conditions'*).

In this specific context, the report was produced during *August-September 2019*, in the frame of the project *"Increasing the capacity of the RDI system to respond to global challenges. Strengthening anticipatory capacity to develop evidence-based public policies" – POCA, code 127557*, by the author, under expert contract with UEFISCDI. The report (in progress at that time) was presented in the first meeting (16.09.2019) of the National Committee for Coordination of the Smart Specialisation (Consiliul National pentru Coordonarea Specializare Inteligenta) and circulated for feedback. The current version addresses the comments and integrates the feedback received. A final version was submitted to the European Commission in October 2019.

The report tries to shed light on the barriers of the innovation process in Romania, contextualised in the national innovation ecosystem. The report must be read bearing in mind the purpose which it does address, the resources allocated to it, and the time constraints in which the analysis was conducted. Considering the short working time, the author invested significant efforts and benefited from information accumulated in other personal studies performed for European Commission.

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[5] Smart specialisation strategy(ies) shall be supported by: (1) *Up-to-date analysis of bottlenecks for innovation diffusion, including digitalisation*; (2) Existence of competent regional / national institution or body, responsible for the management of the smart specialisation strategy; (3) Monitoring and evaluation tools to measure performance towards the objectives of the strategy; (4) Effective functioning of entrepreneurial discovery process; (5) Actions necessary to improve national or regional research and innovation systems; (6) Actions to manage industrial transition; (7) Measures for international collaboration

[6] https://data.consilium.europa.eu/doc/document/ST-6147-2019-ADD-1/en/pdf

[7] https://ec.europa.eu/commission/sites/beta-political/files/budget-may2018-common-provisions_en.pdf

2 METHODOLOGY

The assessment is based on a thorough analysis of most recent data and studies publicly available (EUROSTAT, WorldBank, EC, OECD, National Institute for Statistics, Ministry of National Education, Ministry of Research and Innovation, National Registry of Commerce, UEFISCDI data&publications, academic papers etc.). All the data, indicators considered in the analysis, are the latest available, as provided by EUROSTAT and the National Institute of Statistics (INS) (as for September 2019). The report focuses on the current policy cycle (2014 to date), but occasionally highlights trends over longer periods of time to emphasize specific aspects.

Alongside analysis of secondary data, a parallel study summarises **179** in-depth open-ended interviews with Romanian innovation actors, out of which 159 were with representatives of the private environment and 20 with representatives of regional universities, institutes and public research organisations, clusters, professional associations, hubs and business incubators.[8] The interviews were performed in 2017 and 2018, by regional 'observers', within the Project "*Development of the Administrative Capacity of the Ministry of Research and Innovation for the implementation of actions set out in the National Strategy for Research, Technological Development and Innovation 2014-2020 (code SIPOCA 27[9])"* with the purpose of investigating the potential of some areas to become smart specialization priorities at regional level. The coverage of typology of RDI performers and NACE sectors relevant for smart specialisation is ensured by the adequate sampling of the actors interviewed. The interviews were conducted in all the eight development regions (Bucharest - Ilfov (B), South-East (SE), South-Muntenia (SM), South-West (SW), West (W), Center (C), North-West (NW) and North-East (NE). The questions were opened and were focused mainly on issues related to problems faced by companies in the research-development-innovation process, the perception on the dynamics of innovation in the smart specialization areas identified.

The analysis developed in these two distinct manners draw the same conclusions, as detailed by the author, in the body of this report.

Besides descriptive statistics, the reports draws on previous work of the author in Research Innovation Observatory Country Reports: Romania (RIO 2016[10], 2017[11], 2019) and the information provided by the Major Companies Romania Reports (2016, 2017, 2018)[12, 13, 14]

The analysis integrates the relevant elements of innovation models and focuses on those aspects that pose challenges and for which there is publicly available evidence.

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[8] conducted by Cristina Serbanica &Petrovan Medeea – Katerina

[9] http://sipoca27.ro

[10] Chioncel, M.F. Del Rio, J.C. 2018, RIO Country Report 2017: Romania, available at https://rio.jrc.ec.europa.eu/en/country-analysis/Romania/country-report

[11] Chioncel, Zifciakova J 2017, RIO Country Report 2016: Romania, available at: https://rio.jrc.ec.europa.eu/en/country-analysis/Romania/country-report

[12] MAJOR COMPANIES IN ROMANIA, 2016 Edition. Edited by Doingbusiness.ro Edited by Doingbusiness.ro, available at https://doingbusiness.ro/media/downloads/MCR2016.pdf

[13] MAJOR COMPANIES IN ROMANIA, 2017 Edition. Edited by Doingbusiness.ro, available at https://doingbusiness.ro/media/downloads/MCR2017.pdf

[14] MAJOR COMPANIES IN ROMANIA, 2018 Edition. Edited by Doingbusiness.ro, available at: https://doingbusiness.ro/media/downloads/MCR2018.pdf

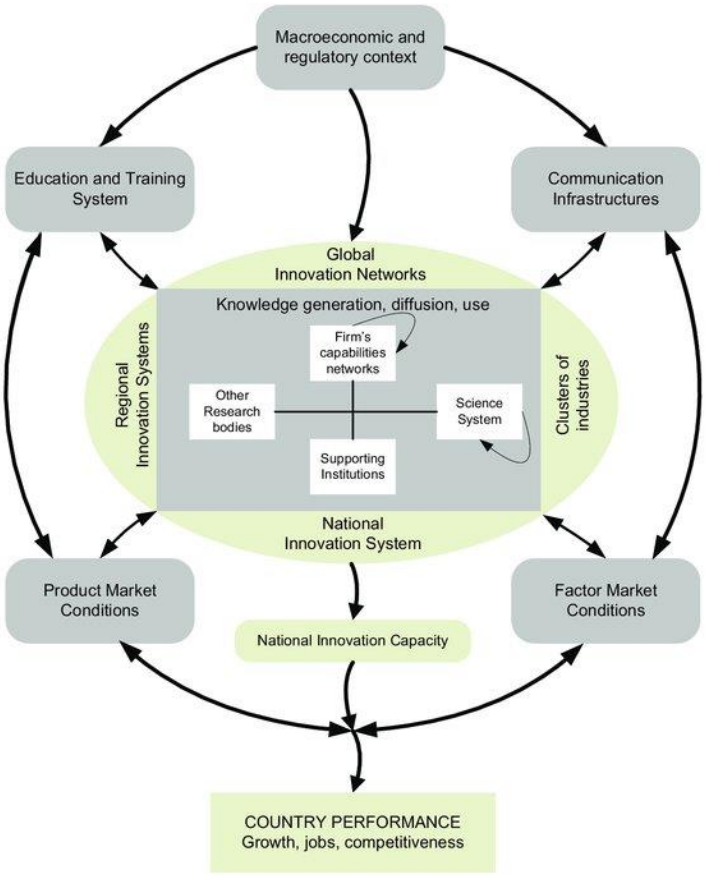

Figure 1. OECD National Innovation system

It combines the *OECD national innovation system* (Figure 1) but extends the analysis to include elements from *Isenberg´s model of entrepreneurship ecosystem*, which defines tens of specific elements that are grouped for convenience into six ecosystem domains: Conducive culture, Enabling policies, Availability of appropriate Finance and quality Human capital, Venture-friendly markets for products, and a range of institutional and infrastructural Supports.

The analytical approach integrates all the elements of the *Quadruple Helix innovation model*[15]. If the Triple Helix innovation model[16] refers to a set of interactions between academia, industry and governments, to foster economic and social development and acknowledges explicitly the importance of higher education for innovation, the Quadruple Helix embeds the Triple Helix by adding as a fourth helix the 'media-based and culture-based public' and 'civil society'. Quadruple Helix encourages the perspective of the *knowledge society*, and of *knowledge democracy* for knowledge production and innovation. The Quintuple Helix innovation model[17] is even broader by

[15] Carayannis, Elias G.. Campbell, David F.J. (2009). "'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem". International Journal of Technology Management. 46 (3/4): 201. doi:10.1504/IJTM.2009.023374. ISSN 0267-5730.

[16] Etzkowitz, Henry. Leydesdorff, Loet (1995-01-01). "The Triple Helix -- University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development". Rochester, NY.

[17] Carayannis, Elias G.. Campbell, David F.J. (2010). "Triple Helix, Quadruple Helix and Quintuple Helix and How Do Knowledge, Innovation and the Environment Relate To Each Other?:

additionally adding the helix of the 'natural environments of society', as drivers for knowledge production and innovation, thus defining opportunities for the knowledge society and knowledge economy.

The analysis covers all the domains of the innovation ecosystem: *resource mobilization, knowledge demand, knowledge production, knowledge circulation*. Although the analysis does not follow this domain structure, it does integrates all the domains. It takes into account also the lessons learned from the mid term evaluation of the impact of the National Strategy for RDI 2014-2020.

While some sectors are riskier than others, some common risks, regardless of the turnover, the size and the NACE field they operate, affect the whole business environment. The report highlights the regional disparities, identifies specificities but focuses on those cross cutting, significant problems, present in all regions and NACE fields. The legislation, regulation are at national level and do not have regional specificity. The problems are common in all regions, but specific attention should be given to the biomedical, energy and ICT field where the relevant legislation for these sectors may require a distinct analysis. While the analysis is centered on 'obstacles' obstructing the diffusion of innovation, there are good practices and these should be noticed. Boxes identify such good practices.

The analysis starts with *National Context Chapter*, which provides a description and analysis of the national innovation ecosystem, aiming to identify underlying elements that may hinder the innovation. These may be related to the economy sectoral structure, business organisation, entrepreneurial ecosystem, policy framework. The following chapter focuses on RDI system and introduces elements of knowledge production and resource mobilisation. *Chapter 4* centers on barriers for innovation, identifying cross-cutting problems. *Chapter 5* analysis the country performance in digitization and the barriers hindering better performance. *Chapter 6* concludes the analysis, in some key messages and formulates some suggestions at a broader level.

A Proposed Framework for a Trans-disciplinary Analysis of Sustainable Development and Social Ecology". *International Journal of Social Ecology and Sustainable Development*. **1** (1): 41–69. doi:10.4018/jsesd.2010010105. ISSN 1947-8402.

3 NATIONAL CONTEXT

This section provides the description and analysis of the national innovation ecosystem, aiming to identify underlying elements that may hinder the innovation. These may be related to the sectoral structure, type of business organisation, policy framework.

3.1 Structure of the economy (sectoral/industrial specialisation)

The country's economy is developing, as proven by the latest positive macroeconomic indicators, which underline diversity, complexity, decline of the unemployment rate. Romania, is an upper middle-income economy, with many chances to climb the hierarchy in 2020/ 2021. [18,19] The GDP growth was 4.1% (2018) and it is estimated to reach 5.5% in 2019[20]. The contribution to the GDP growth was generated by services (2%), taxation (1%), industry (1%) and agriculture (1%). Construction had a negative impact (-0.3%). In 2018, the inflation registered the highest level in the last years (5.9%). Real GDP per capita in Romania has steadily increased since 2010, reaching €8,700 per capita in 2018. Despite the rapid growth, it remains the second lowest in the EU (Eurostat, 2019). However, there is fear that this is not a long term sustainable growth, but more likely a volatile growth that is susceptible to be seriously affected by hidden imbalances or by 'black swans'. [21] Competitiveness Index in Romania averaged 13.90 Points from 2007 until 2018, reaching an all time high of 63.46 Points in 2018.[22]

Sectoral structure of the economy. Services have the highest contribution to GDP (57.1% in 2018), with positive forecast. The agriculture recorded a significant decline from 22% (value added of GDP) in 1990 to 4.2% (2018). The industry contributed to 23.6% of GDP in 2018[23]. The wholesale and retail trade repair of automotive industry and motorcycles has the highest share in the turnover, followed by manufacturing, but the two sectors shift position when assessing the value added and the share of persons employed by sector. ICT industry in on the third position, followed by transportation and storage. State-owned enterprises have a key role in critical infrastructure sectors such as energy and rail transport. However, the private companies are more performance-driven than the state-owned ones.

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[18] According to the latest thresholds determined in July 2018 by the World Bank, low-income economies (a politically correct name for "the third world") are defined as those with a GNI per capita, calculated using the World Bank Atlas method, of USD 995 or less in 2018, lower middle-income economies – between USD 996 and USD 3,895, upper middle-income economies – between USD 3,896 and USD 12,055, and high-income economies – USD 12,056 or more.

[19] http://business-review.eu/business/upper-middle-income-romania-fails-to-being-officially-recognized-as-a-developed-country-this-year-203564

[20] Comisia Nationala de Prognoza, Mai 2019

[21] Nassim Taleb coined the term 'black swan as a highly improbable event with the principal characteristics: it is unpredictable, it carries a massive impact and,

[22] https://tradingeconomics.com/romania/competitiveness-index

[23] http://www.cnp.ro/user/repository/prognoze/prognoza_2019_2022_varianta_de_primavara_2019.pdf

The Romanian state proved until recently to be an extremely 'complacent shareholder', having little interest in the economic performance of the companies which it owned (EC, (2018), European Semester Country Report).[24] Romania is a net exporter of unprocessed products. Within the structure of agricultural production, crop production is prevalent, with a 70.3% share in the total production in 2018, as compared to 28.3% for animal production and 1.4% for agricultural services. (INS, 2019 – Romania in Figures)[25] It has 3.7 million agricultural holdings, 14.6 million ha agricultural land, of which 9.4 million ha are utilized arable land (INS, 2019). Overall the country agriculture has the capacity to feed almost the double of its population, but it is underdeveloped and sluggish. The main problems are the lack of mechanization, inadequate farming structure, underdeveloped infrastructures, lack of managers, low productivity, lack of storage capacity, lack of digital transformation and the position in the value added network (VAN) ((NCH, 2016[26], Popescu A, 2013 (a) [27], (b)[28]).

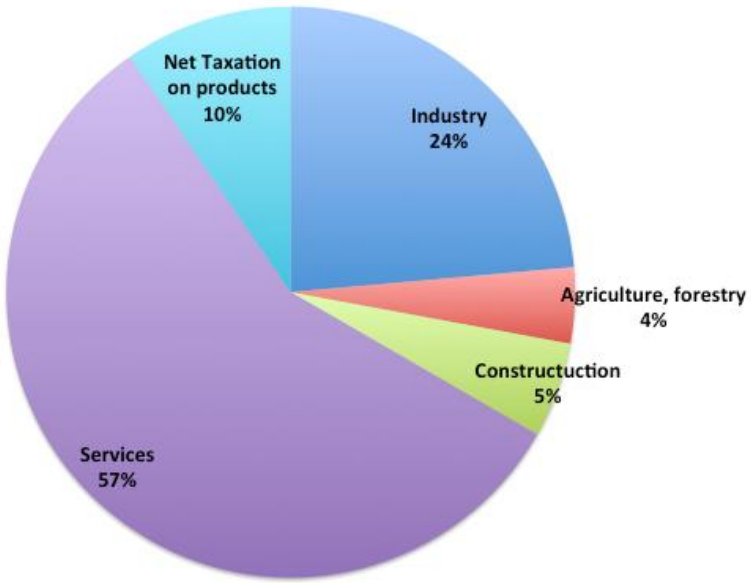


Figure 2. Structure of the GDP (based on: Proiecţia principalilor indicatori macroeconomici 2019 – 2022, Comisia Nationala de Strategie si Prognoza)

[24] EC, 2018 European Semester Country Report: Romania. Available at: https://ec.europa.eu/info/publications/2018-european-semester-country-reports_en
[25] INS, 2019 – Romania in figures, available at: http://www.insse.ro/cms/sites/default/files/field/publicatii/romania_in_figures_2019.pdf
[26] NCH, (2016) Discovering Romania as Business Hub, *A New Era of Internationalization through Enhanced Partnerships*
[27] Popescu Agatha, (2013a), Considerations on the Rural Population as a Resource of Labor Force in Romania, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.13(3):229-236
[28] Popescu Agatha, (2013b), Considerations on the main features of the agricultural population in the European Union, Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, Vol.13(4):213-220

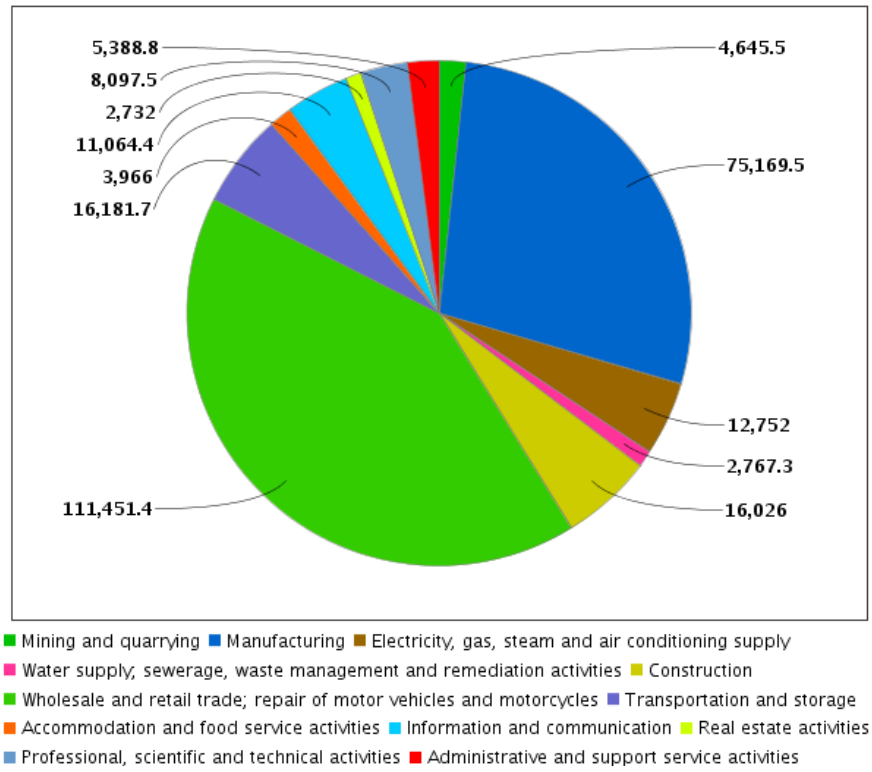


Figure 3. Turnover by NACE rev.2 – 2016, latest available data (source: EUROSTAT)

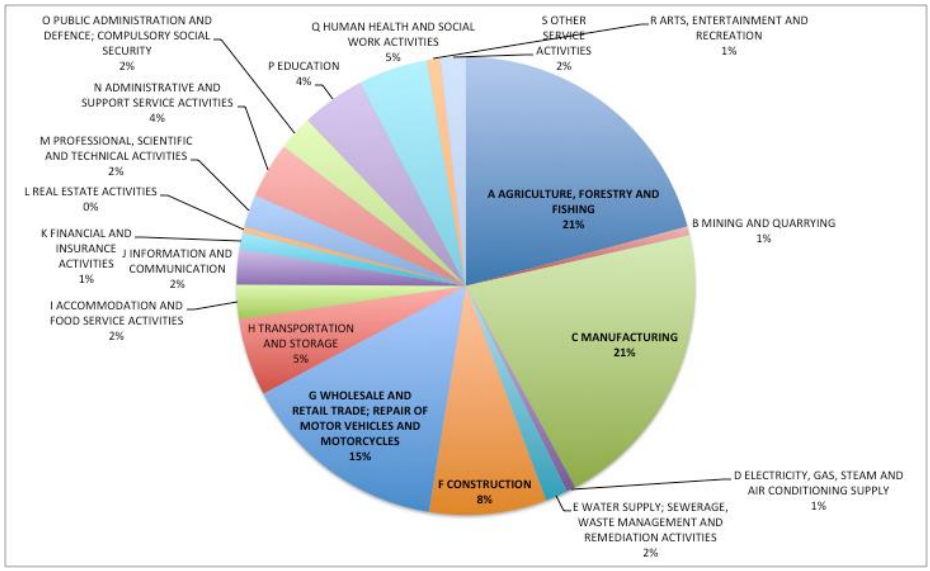


Figure 4. Employment distribution by NACE[29] -2016 (source: INS)

[29] http://www.insse.ro/cms/sites/default/files/field/publicatii/balanta_fortei_de_munca_la_1_ianuarie_2018.pdf

The share of employment in "Agriculture, forestry and fishing" (Figure 4) with a value of 20.8% (INSSE, 2018).[30] was the largest among the EU member states (MS) in 2018, regardless its significant and continuous decrease.

Around 1.6 million working-age adults are labeled as "self-employed in agriculture". A significant share of this population, according to some experts, represents unemployed workforce, hidden in the official statistics under this label.

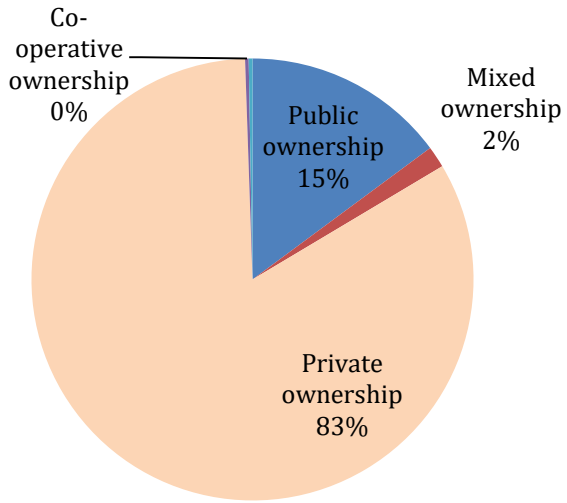


Figure 5 Employment distribution by ownership (Data Source: INS)

In 2018, the share of persons employed in the private sector (83.0%) was 5.6 times higher than those of persons employed in the public sector (14.9%). The men held the majority share in the mixed (63.6%) and private (57.3%) sectors. Instead, women were prevalent in public sector (61.1%).

Innovation

Since 2008, the country innovation performance has had a negative trend. According to the European Innovation Scoreboard (EIS, 2019), Romania is in the group of Modest Innovators with an innovation performance level below the half of the EU28 average. Turnover from innovation as % of total turnover is among the lowest in EU for industry total and the lowest for services showing a descendent trend since 2006 when achieved the maximum value in all components. The Employment in high- and medium-high technology manufacturing sectors and knowledge-intensive service sectors as share % of total employment is 22% (2018), the lowest in EU, increasing from 19.8% in 2010.

High Growth Enterprises/High Growth Innovative Enterprises. Romania in 2017 (according to the July 2019 Eurostat data) has one of the lowest number of fast growing enterprises in EU and the lowest proportions of HGIEs (2.3%). The highest shares of HGEs are in wholesale and retail trade, repair of motor vehicles and motorcycles, followed by manufacturing, construction and information and technology.

Over 20 Romanian companies entered the Deloitte's 2018 Technology competition that recognizes the most dynamic technology companies in Central Europe. Most of them are in IT, software solutions for automation. Two of the **Trencadis** and **Mondly** have

[30] INSSE, 2018, available at: http://www.insse.ro/cms/sites/default/files/field/publicatii/balanta_fortei_de_munca_la_1_ianuarie_2018.pdf

made it to Deloitte's 2018 Technology Fast 50 Central Europe, in the main category, Technology Fast 50 ranking, respectively in the Rising Stars category. (Deloitte[31]).

3.2 Quality of life

Romania has the second lowest life expectancy in EU (total and female), and the lowest for men. Also it has one of the lowest age for healthy life. Romanian women can expect to spend less than one third of their remaining years free of disability. Romania spends less than a third of the EU average on health care, the lowest level in EU28. Low funding and the inefficient use of resources limit the effectiveness of the healthcare system affected also by a significant shortage of doctors and nurses (EC, 2018 Country Report).

Infant mortality represents a particular challenge: at 7.6 deaths per 1 000 live births, it was the highest in the EU and over twice the average of 3.6 in 2015. Heart diseases and stroke are the biggest contributors to mortality, being two and a half times higher than the EU average and the second highest in the EU.

Deaths from some types of cancers have increased sharply and infectious diseases are a significant challenge: RO has the highest rate of tuberculosis in the EU. Undiagnosed viral hepatitis also poses a significant problem with sub-optimal testing and surveillance.

The mortality that could have been avoided through appropriate health care interventions is the highest in the EU for women and the third highest for men. Wide inequalities exist in the prevalence of these chronic diseases by education level. (OECD, 2017 – The Country Health Profile)[32].

In 2015, the consumption expenditure per household was the lowest in EU28 (latest available EUROSTAT data, August 2019). In 2018, 32.5% of the population was at risk of poverty and social exclusion. The recent economic performance has not been translated in population's well-being. Neither, the economic growth was supported with measures to increase competitiveness and sustainable growth, which includes quality of life, access to good education and health care.

Net monthly earnings. Romania's average net monthly earnings reached (665 EUR) RON 3,142 in June 2019, rising by 15.5 percent compared to May 2018 (National Institute of Statistics, INSS). The highest wage increases were concentrated in the public sector. Real wages increased by 11.2% between June 2018 and June 2019, due to high inflation rate. Since the beginning of 2019, the government has increased the minimum gross wage from RON 1,900 to RON 2,080 and introduced a separate minimum wage for workers in construction of RON 3,000. However, Romania still has the second lowest average wage among the EU member states.[33]

[31] https://www2.deloitte.com/ro/en/pages/about-deloitte/articles/two-romanian-companies-in-deloitte-2018-ranking-fast-50-in-central-europe.html

[32] OECD, 2017 (The Country Health Profile, Romania), available at: https://www.oecd-ilibrary.org/docserver/9789264283534-en.pdf?expires=1569503879&id=id&accname=guest&checksum=A8BCC14894DDDB7B533D439CDCF570D8

[33] http://business-review.eu/business/romanias-average-wage-hits-eur-665-in-june-on-higher-earnings-in-the-public-sector-203797

3.3 Demography

There is a negative natural increase (INSSE, 2019 Romania in Figures) considering only the number of deaths and births. The emigration has been also particularly high (OECD, 2019). The demographic and economic effects of this evolution has already started to be felt in the workforce crisis and the decrease of the pupils/students population. According to Population Division World Population Prospects 2019[34], the demographic trends calculated in various scenarios envisaged a decrease of the population to just above *15 millions by 2050 in the case of zero migration and constant mortality/ constant fertility*. This will entail changes in the various sub-populations (school population, population of childbearing age, working age population).

3.4 Regional disparities

The country is formally divided into 8 'development regions' (eight NUTS2 level) and four macro-regions (NUTS1), however with purely administrative responsibilities.

There are significant disparities between the 8 NUTS2 regions in terms of wealth, RDI facilities, education support and performance. The level of polarization at the territorial level has not significantly diminished in the last 21 years.

The city of Bucharest is the main pole of economic power, concentrating a significant share of the economic activity (in terms of GVA, employees, total assets, etc.).

Two regions (compared to three in 2016), North-East and South-West Oltenia have in 2017 GDP per capita below 50% of the EU average. South Muntenia managed to climb over this threshold in 2017. [35] (34/2019, Eurostat, NewsRelease).

The GDP (PPS per inhabitant)[36] in Bucharest–Ilfov region (43,200 pps/inhabitant), followed by the West (20,000) and Center, is almost four times (3.7) higher than the GDP/inhabitant in the Region North East (11,600). The share of early leavers from education is the highest in Macroregion 2 (NUTS1). There are significant disparities also regarding unemployment, South-West (9.9%), South (8.9%) and South East showing the highest rates. The share of people at risk of poverty or social exclusion in N-E (44.7%), S-E(40.3%), and S-W Oltenia (42.2%) is significantly higher than in Bucharest (21.4%), N-W (22.3). (EUROSTAT, 2019).

In terms of turnover from innovation as % of total turnover, South Region Muntenia dominates the ranking, with a value significantly higher compared to the other regions. the most industrialized region of the country. Major companies, such as Dacia - Renault (Pitesti - Arges), Pitesti Nuclear Fuel Factory (FCN Pitesti), OMV Petrom, Petrobrazi refinery and Petrotel - Lukoil Ploiești, are in this region. According to the analysis of the Regional Development Plan (RDP) 2014-2020, a special feature of the region's economy is that almost all branches of industry are represented in the region.

[34] https://population.un.org/wpp/Download/Standard/Population/

[35] https://ec.europa.eu/eurostat/documents/2995521/8700651/1-28022018-BP-EN/15f5fd90-ce8b-4927-9a3b-07dc255dc42a
https://ec.europa.eu/eurostat/documents/2995521/9618249/1-26022019-AP-EN.pdf/f765d183-c3d2-4e2f-9256-cc6665909c80

[36] Gross domestic product (GDP) is a measure for the economic activity. It is defined as the value of all goods and services produced less the value of any goods or services used in their creation. The volume index of GDP per capita in Purchasing Power Standards (PPS) is expressed in relation to the European Union (EU28) average set to equal 100

	Turnover from innovation as % of total turnover by economic sector (%)					
Region	**2006**	**2008**	**2010**	**2012**	**2014**	**2016**
North West	19.1	15.3	21.7	4.33	2.19	1.57
Center	13.4	17.5	12.6	5.02	5.99	6.64
North East	20.3	9	8.1	2.84	2.42	1.81
South-East	31.5	11.2	12.2	2.86	3.9	1.5
South-MUNTENIA	25.6	23.8	24	5.75	21.7	20.56
South-East Oltenia	21.1	9.4	14.9	0.90	0.66	0.25
West	10.1	8.9	9.4	3.37	4.92	1.24
BUCURESTI – ILFOV	16.4	15.3	12.7	3.37	5.62	3.16

Table 1 Turnover from innovation as % of total turnover by economic sector (%) in NUTS 2 Regions (INS, 2019)

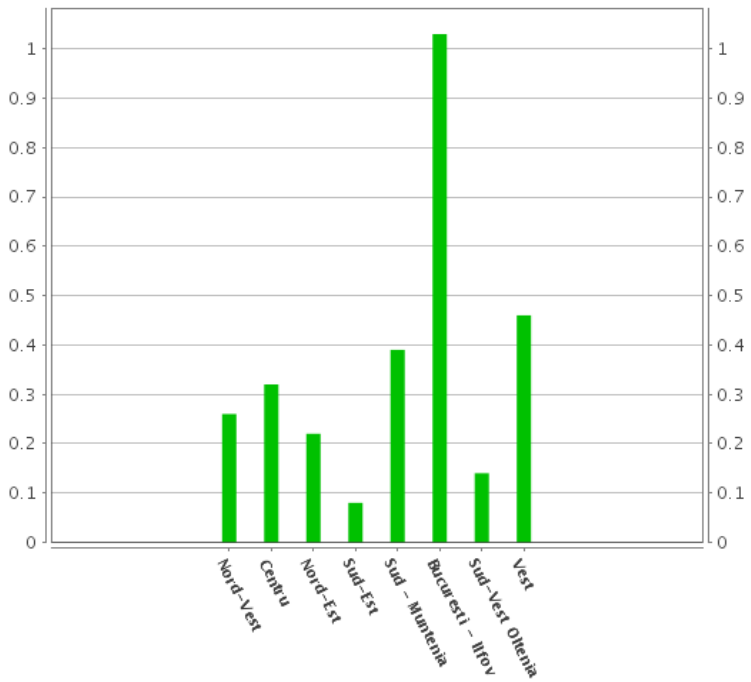


Figure 6 2016 intramural R&D Expenditure (GERD) by NUTS 2 regions (% GDP). (Source: Eurostat)

Further information regarding the regional disparities is provided under relevant subsection.

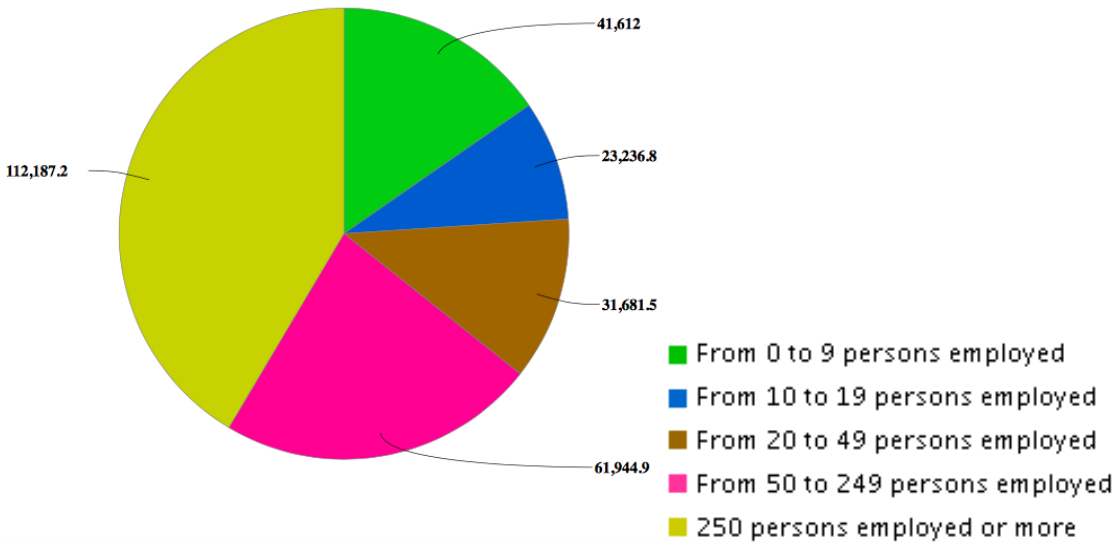
3.5 Firm organisation

Capacity to innovate, ability to engage, absorb and disseminate knowledge depends also on the size of the business.. Therefore, this section will analyse the share of SME, large companies, multinationals, start-ups, business demography, aiming to map the characteristics that may have an impact on the capacity to innovate.

Large companies/multinationals. A significant share of the Romanian industry consists of branch plants of foreign firms, particularly for the production of automotive components, heavy machinery and equipment for the extraction of oil and gas. The economy is dominated by multinationals, active in Automobile and automotive components, Banking and finance, ICT, Manufacturing, Retail chains, Consumer products, hotels.

Foreign Direct Investments (FDI). The number of companies with foreign capital participation reached **224,682** by the end of July 2019, with a social capital of 48.595.786 mil Euro (based on National Registry of Commerce, 2019).[37] The major sectors for FDI by social capital are: (1) the wholesale and retail trade repair of automotive industry and motorcycles (48%). Mining and extraction (32%), banking and finance (10.7%). The Netherlands, Spain, Germany, Cyprus, Austria and Italy are among the main investors in RO (August 2019, National Registry of Commerce). "*Firms with domestic majority capital, although dominant in number, have a declining economic strength relative to firms with foreign majority capital. "* Excerpt From: BNR. "Notebooks, No. 42. "iBooks.

Small Medium Enterprises (SME) The SMEs in Romania provide 67.5 % of total employment, slightly more than the EU average and for half of the value added (49.9%) of GDP. The number of SMEs - 29 per 1,000 inhabitants (of 15 years or above compared to 57 in the EU-28) is one of the lowest position in EU (EC, 2018: Annual report on European SMEs 2017/2018. EC, 2018). Out of **824,817** companies active in industry, construction and services (except insurance), **382,800** were companies with **0 employees**, **330,205 with 1 to 4 employees**, 55,205 with 5 to 9 employees, and 56, 207 with more than 10 employees. In terms of NACE, the highest share was in (1) wholesale and retail trade, repair of motorcycle (274,560), followed by manufacturing (71,441) and ICT (37,000). (EUROSTAT, 2019)



[37] http://www.onrc.ro/index.php/ro/statistici?id=254

Figure 7 Turnover of the non-financial business economy by size class of employment, 2017 (Source: Eurostat)

Three types of atypical typologies are encountered in the Romanian economy: (i) companies that report a number of employees equal to zero. (ii) companies that report a turnover equal to zero and (iii) companies that have negative equity (almost half of companies, in December 2014). *BNR. "Notebooks, No. 42. "iBooks. "Labor taxation, more difficult entry and exit of the market and less friendly behavior of tax authorities"*

Box 1. Romanian Unicorns

UiPath, First Romanian Unicorn

UiPath, the global leading provider of Robotic Process Automation (RPA) and AI software worldwide, the winner of the Most Disruptive Innovation Award of the 2017 Central European Deloitte Technology Fast 50 ranking, is the **first unicorn of the Romanian economy.** DeskOver was founded in 2005 aiming to offer solutions for automatization of repetitive administrative business tasks. In 2015, DeskOver becomes UiPath, after Earlybird Digital East Fund organized a consortium for the first seed funding round. At that time, the company consisted of 10 people operating from an apartment in Bucharest. Over the next years, $400M investment by partners as Accel, CapitalG, Kleiner Perkins, Sequoia[38] supported the entrepreneurial team in building a global business, extended currently to more than 2,000 staff across 31 offices in 14 countries. The company is the fastest **growing enterprise software company** ever, growing at more than 10x per annum from 2015-18, currently reaching more than 2000 customers worldwide. The company raised more than $1B from top-tier venture capital firm and has annual revenues higher than $100m. UiPath raised a €500m in 2019, valuing the business at more than €6bn.[39]

Emag, the Romanian largest online retailer, founded in 2001, a pioneer on the online RO market, becomes at the end of 2018, a candidate as Romanian unicorn.[40] The company has been constantly investing in technology-based services and has over 4000 staff working in Romania, Bulgaria, Hungary and Poland.

3.6 Business environment

Romania stands on position 52, in the ease of doing business ranking of 189 economies. It has a higher position than HU, HR, BG but lower than PL, SK, CZ, for example (Doing Business, 2019).[41] It has a stable position (52) compared to 2017, in the Global Competitivness Index 4.0 2018,[42] ranking 140 economies. The lowest scores are in 'efficiency of legal framework in challenging regulations' dimension. Most of dimensions have deteriorated since 2015. Bucharest demonstrates the potential for dealing efficiently with high demand for business services, while Oradea outperforms in registering property and Timisoara in contract enforcement (Doing Business 2018, Regional Reports).

Topics	DB 2018 Rank	DB 2016 Rank	DB 2015 Rank

[38] https://www.uipath.com/company/investors
[39] https://www.investeurope.eu/about-private-equity/private-equity-in-action/case-studies/uipath/
[40] http://business-review.eu/business/emag-becomes-the-second-romanian-unicorn-iulian-stanciu-ceo-when-i-started-i-told-my-colleagues-i-wanted-a-billion-dollar-business-192566
[41] http://www.doingbusiness.org/
[42] Global Competitivness Index 4.0 2018, available at: http://www3.weforum.org/docs/GCR2018/05FullReport/TheGlobalCompetitivenessReport2018.pdf

Starting a business	111	45	37
Dealing with construction permits	146	105	101
Getting electricity	154	133	132
Registering property	44	64	63
Getting credit	22	7	6
Protecting minority investors	64	57	54
Paying taxes	49	55	53
Trading across borders	1	1	1
Enforcing contracts	17	34	33
Resolving insolvency	52	46	46

Table 2. DB Ranking (Source: WB Doing Business Ranking 2015, 2016 and 2018)

Business demography

The net business population growth shows an increase from 0.89% in 2014 to 2.29% in 2017, fluctuating during this period. The rates of births and deaths of Romanian companies indicate a rather high dynamism and instability. Both the number of firms' births and firms deaths increased during this period (EUROSTAT, 2019). The highest increase is in the number of enterprises with 1 to 4 employees (from 251,810 to 301,573).

More than one quarter (26.1%) of young population expected to start a business between 2012 and 2016. This could be explained partly by the high youth unemployment rate and the increase of entrepreneurship mind set and support for starting a business (16.6%).[43]

The Start-Up Nation programme[44] has offered generous support to entrepreneurs. However, the descriptive statistics, in the absence of programme impact evaluation, may indicate just an opportunistic attitude of the applicants. Author's analysis of the National Registry of Trade (ONR - Oficiul National de Comert) data shows that in the last two years, the volume of new firm creation increases significantly during the time window of the calls for Start-up Nation programme. To be noticed that '**start-up'** in the definition of the programme does not draw on all three criteria commonly used in EC definition of start-up: *younger than 10 years, highly innovative technologies or business models, aim to grow* (European Start-up Monitor[45]).

According to an analysis published in July 2019 by the Sierra Quadrant, the number of de-registrations of companies and PFAs[46] reached 62,530 in the first 5 months of this year, 75% more than previous year.

The 2019 report prepared by the National Council of the SME (Consiliul National al Intreprinderilor Mici si Mijlocii din Romania - CNIPMMR), during November 2018-February 2019, analysing the typology of the beneficiaries of the Start-up Nation 2017 (that uses as definition of start-up: 'company created in 2017') shows that 68.9% of start-ups created in the frame of the programme, have activity in production, followed by creative industries (25.2%), IT (3.2% and Services (2.6%). A large share (81.6%)

[43] https://www.oecd-ilibrary.org/docserver/9789264283602-en.pdf?expires=1563486764&id=id&accname=guest&checksum=C99BEC7713C81466A0408E97B93ABCE3
[44] https://start-upnation.ro
[45] https://europeanstartupmonitor.com
[46] Authorised Physical Person = Persoana Fizica Autorizata = taxpayers who obtain income from self-employment

are not VAT payers (indicating the low turnover). 55.8% of the founders have a degree, and 48.5% have a background in economics and only 19% a technical background. Only 15.8% had a previous entrepreneurial experience and a large majority had priory an experience in a distinct field than in the one they have received funding (CNIPMMR, 2019)[47]. Most of these start-ups by definition, and as CNIPMMR study shows, do not have the innovative component.

The Startup Investment & Innovation in Emerging Europe report 2018 identifies around 3,700 tech startups (or startup projects), and 200-300 new startups or startup projects newly arising each year. The vast majority develops SaaS technologies. "*To a large extent, this is due to the lack of venture capital with entrepreneurs looking for business models and types of applications which can be monetized very quickly*, which is often the case with SaaS solutions." Romania also has some good startups (complying to the EC definition) in cyber security, robotics, payments, artificial intelligence, and agritech (East-West Digital News, (2018)). In the StartupBlink ranking,[48] Romania ranks 38 globally among 202 countries, based on the strength of its startup ecosystem. The cities with the most vibrant startup ecosystems are Bucharest, Cluj-Napoca and Iași.

Romanian start-ups face a low survival rate beyond the five-year period. Factors that influence this state are often the lack of space for doing business, the lack of B2B support services (legal advice, accounting), the lack of access to the necessary financing for business development, lengthy and complex administrative procedures, unpredictability of the legal framework, blurred responsibility of the public authorities, red tape, lack of adequate corporate governance, lack of solid business models, managerial expertise. (EU Start-up Monitor, 2015)[49].

There are no studies related to national scale ups. Since the beginning of 2019, in Romania, only 3 companies have registered investments over 1 million euros: FintechOS, TypingDNA and, Elrond.[50] Following UiPath's success, reaching the unicorn status in 2018, other start-ups grew rapidly, or show the potential to scale up. **UiPath**, is the world leader provider of Robotic Process Automation (RPA) and AI software worldwide, is also the **first unicorn of the Romanian economy.** The company grew from around $1 million to over $100 million in revenue in less than 21 months. Most of the scale-ups, showing impressive growth over a short period of time operates in Robotic Process Automation (RPA), AI softwares, cybersecurity, mobile applications, online applications.(M Chioncel, RIO 2019)

Romanian Entrepreneurial Ecosystem Index

The „Romanian Entrepreneurial Ecosystem Index" (REEI)[51] was created by UEFISCDI. It was based on the methodology provided by Endeavor Insight[52], a non-profit organization dedicated to high-impact entrepreneurship. The index is a cumulated measure of the achievements of 5 key-measures: 'inspiration', 'consultancy', 'work experience as an employee', 'mentorship' and 'investment'. In order to better understand the entrepreneurial environment the REEI was

[47] http://cnipmmr.ro/wp-content/uploads/2019/05/CATALOG-INTERIOR.pdf
[48] https://www.startupblink.com/startups/industry/mobile
[49] European Startup Monitor 2015 https://europeanstartupmonitor.com/fileadmin/presse/download/ESM_Presentation_Brussels.pdf
[50] https://eytechblog.eyromania.ro/ey-tech-blog/astzi-startup-maine-scaleup/
[51] http://ree.uefiscdi.ro/entrepreneurship-in-romania/romanian-entrepreneurial-ecosystem-index/
[52] https://endeavor.org/impact/insight/

divided into two components: the input component, consisting of inspiration, consultancy and work experience and the output or impact component, which consists of mentorship and investment. The value of the Romanian Entrepreneurial Ecosystem Index is 4.5 on a scale from 0 to 10, and has its maximum at 8. It suggests that the Romanian Entrepreneurial Ecosystem is very weakly developed. The networks established among entrepreneurs are not strong enough to lead to a self-sustaining environment

Source: M Mitroi - UEFISCDI

The report of the Policy Support Facility (PSF) panel of experts under the PSF Specific Support for Romania[53], which has been carried out from July 2016 to December 2017 outlines that a key factor to scaling up Romania's growing technology start-up scene consists in developing a robust ecosystem that nurtures Romanian innovation and entrepreneurship. The analysis of the European experts reveals the need for smarter legislative and financial instruments and incentives to nurture Romania's innovators and entrepreneurs. In the report, the country's innovation and entrepreneurial ecosystem is described as having a lot of potential, but being still at the "early stage" of development. It highlights the need to improve the country's "dynamics of change" towards a more innovative digital economy. The report mentions that the biggest barriers hindering development are a "lack of trust, predictability and transparency", as well as access to finance for innovative enterprises and the limited capacity of higher education institutions to play a more active role in the entrepreneurial ecosystem. The recommendations provided highlight that Romania should have an entrepreneurship ecosystem that empowers entrepreneurs and provides stability. More predictability – the legal, political and business framework – backed up by better market conditions and access to financial and non-financial support schemes are a corollary of this, giving venture capitalists, business angels and innovative entrepreneurs the impetus to start and scale up their businesses.[54]

4 RDI SYSTEM

4.1 RDI governance

The Ministry for Research and Innovation (Ministerul Cercetarii si Inovarii - MCI), was established in January 2017, through the split of the Ministry of National Education and Research in two distinct ministries with their specific responsibilities ((a) Ministry of National Education and (b) Ministry of Research and Innovation) and through the restructuring of the National Authority for Scientific Research and Innovation (Autoritatea Nationala pentru Cercetare Stiintifica si Inovare - ANCSI), previously responsible for RDI policy. The Ministry, by law, is responsible for the design, implementation, coordination, monitoring and evaluation of the research and innovation policies and of the national RDI system.

[53] https://rio.jrc.ec.europa.eu/en/policy-support-facility/specific-support-romania

[54] The report is the result of the request of the Romanian government for Specific Support to Romania under the Horizon 2020 Policy Support Facility (PSF). The assessment exercise included two fact-finding visits to Romania and consultations with over 50 stakeholders. The panel included experts from Finland, France, Poland and Portugal.The Horizon 2020 Policy Support Facility provides expertise and operational support to Member States in designing, implementing and evaluating national research and innovation policies, including country Peer Reviews and Specific Support to policy reforms, as well as thematic Mutual Learning Exercises to improve policy-making practice through exchanges among several countries.

According to its mission, MCI has among the most important roles, the following (as presented on the official Ministry Homepage):[55]

- 'to establish and maintain strategic objectives implemented by the National Plan for RDI and other tools for implementation of the National Strategy in line with the priorities of the Government's economic and social policies.
- develop the National Plan for RDI on multi-annual periods, based on the assessment of resources required, assess the programs contained in it, make their annual breakdown and inform on their implementation.
- forecast, plan and implement, as appropriate, the budget for R&D and innovation, included in the state budget, and financial resources needed to carry out policies in its field of competence.
- ensure the allocation, of funds for financing the PN3, and other tools to implement the strategy they manage. approve and **finance core programs** (Programul Nucleu), develop sectoral R & D plan and approves its own research and development sectoral plans of other authorities.
- stimulate and support dialogue between the scientific community and other civil society structures.
- seek to harmonize their policies with those of education, industry, trade, environment, health, employment and other areas.
- develop policies on technology transfer and support the implementation of the results of inventions / innovations in partnership with business.
- monitors and evaluates research units, development and innovation in accoADRnce with the law.
- ensure institutional development of institutes and research units subordinate, coordination and under authority.

In the 2014-2020 policy cycle, MCI has been also responsible for the overall implementation of the two main funding instruments of the National RDI Strategy: the National Plan for RDI 2015-2020 (PN3) and the Competitiveness Operational Programme (Programul Operational Competitivitate - POC), Priority Axis 1, for which acts as intermediary body.

The Government of Romania, approves every year, in the State Budget Law, the budget allocated to R&D activities in its specific chapter and through a distinct line the budget allocated to the Romanian Academy. Generally, this initial planning is followed by a budget rectification, which often has revised the R&D budget (positively or negatively). MCI, in line with its legal roles, decides on the way funds are allocated to different budgetary chapters.

The responsibility for the PN3 administration is split between MCI, and three funding bodies: the Executive Agency for Funding Higher Education, Research, Development and Innovation (Unitatea Executiva a Finantarii Invatamantului Superior, UEFISCDI), the Romanian Space Agency (ROSA) and the Institute for Atomic Physics (IFA). UEFISCDI administrates the largest share of PN3 competitive funding.

Various Councils[56] and Consultative Bodies, the Romanian Academy and its branches provide policy support and case by case policy advice. In January 2017, the four RDI advisory councils just starting their activity after a lengthy and open selection process were suspended by the new government, reorganized and reactivated in april 2017. The academic community, the association Ad-Astra, the European University

[55] full list of responsabilities is available on the official website http://www.research.gov.ro/ro/articol/980/despre-ancs-prezentare

[56] http://www.research.gov.ro/ro/categorie/967/despre-ancs-organizare-organe-consultative-4-consiliul-pentru-inovare

Association (EUA) reacted with concern to the controversy related to the dismissal of the councils and of the foreign evaluators.[57, 58] The Romanian Academy has its own chapter in the national state budget, designs its own research agenda and distributes its budget among 70 research institutes and research centres, performing 'fundamental research' according to its status, as established by law.

UEFISCDI is a public institution, subordinated to the Ministry of National Education, which provides evidence base studies for the allocation of national state funds for universities and the coordination, from an administrative point of view, of specific programs and subprograms of the National Plan for Research, Development, Innovation (Sub-programme 1.1 Human Resources (fully), Sub-programme 1.2 (partially). Sub-programme 1.3 R&D Infrastructures partly. Sub-programme 1.4 Support partly). As a research funding agency, it organizes competitions and subsequently monitors the implementation of projects accepted for funding. The Agency manages around 22% of the public funds allocated to the RDI activity. Through specific projects has provided support to the Ministry in charge in developing strategic documents (such as the National Strategy for RDI, National Plan for RDI). MCI is the main authority, deciding the final form of all strategic documents and the relevant implementation instruments.

Each NUTS 2 region has a Regional Development Agency (ADR - Agentie de Dezvoltare Regional)[59] which elaborates a Regional Development Plan and ensures the technical management of funding. The agencies are diverse in organisation, number of staff, culture, expertise. Six of the eight ADRs elaborated between 2005 – 2008, the Strategies for Regional Innovation 2008 - 2013, financed through the Framework Program 6 of the European Commission. All seven 'less developed regions' finalised in 2017 the design of the Smart Specialisation Strategies, responding to the EC request to all EU MS to fulfill the ex-ante conditionality on the RDI area, which specifies the existence of smart specialisation strategies at national/regional level (as further detailed in section RDI Policy).

The National Committee for Coordination of the Smart Specialisation was founded in August 2019, through Ministry Order. The Committee includes members from MCI (8 members), UEFISCDI (2 members), Ministry of Regional Development and Public Administration and ADRs (19 members), Ministry of Economy (2 members), Ministry of Business Environment and Entrepreneurship (1) and Ministry of European Funds (2 members). In line with this Order, the Ministry of Research and Innovation, through the Directorate of the RDI Policies and Programmes ensures the institutional governance for the management of the National Strategy for Smart Specialisation. It has already been approved that the Committee will be extended to include members from the Ministry of National Education, Ministry of Agriculture, Ministry of Communications and Information Society (Ministerul Comunicațiilor și Societății Informaționale (MCSI), Ministry of Energy.

Outstanding issues

"*A genuine regionalisation process still remains uncertain in Romania. The topic has been intermittently on the top of the public agenda, but controversies regarding the appropriate depth and breadth of regionalization have determined the delay of any firm decision."* (M Chioncel RIO 2017, R Gheorghiu, EW 2015). As far October 2019,

[57] http://civitas.dogaru.net/nu-reorganizarii-organismele-consultative-ale-ministerului-cercetarii-si-inovarii/

[58] http://www.eua.be/activities-services/news/newsitem/2017/05/30/eua-statement-on-the-recent-developments-in-romania-regarding-the-research-policy-framework

[59] The role of each Regional Development Agency is to contribute to sustainable and equitable development by removing disparities and imbalances among areas within the region. Established by Law 151/1998, the Regional Development Agencies currently operate under Law 315/2004 on regional development in Romania.

the development regions, in line with the relevant laws, **are not administrative-territorial units and do not have legal personality** (Law 315/2004[60], Romanian Constitution). Both types of regions exist primarily for the purpose of coordinating development projects.

4.2 The RDI performers

According to INS data, in 2017 there were 713 units with R&D activity: 276 public RDI (out of which 86 HEIs) and 437 belong to the private sector (414 business sector and 23 private non-profit). Among the public organisations, 70 centres belong to the Romanian Academy (as counted from the site of the Romanian Academy[61]). The total number of R&D units dropped to 571 by the end of 2018.

Sectors of performance	Year 2017 Number	Year 2018 Number
Total of wich:	713	571
Public sector	**276**	**256**
- government sector	190	171
- higher education sector	86	85
Private sector	**437**	**315**
- business sector	414	298
- private non-profit sector	23	17

Table 3 Number of units with R&D activity (source: INS).

The National Network for Innovation and Technological Transfer (ReNITT) comprises 50 specific organizations: technology transfer centers, technology information centers, technology and business incubators, 4 science and technology parks.[62]

At the end of 2018, there were 44733 employees with R&D activity. More than half of the R&D employees are concentrated in Bucharest-Ilfov Region. The analysis of the researchers by scientific field shows the dominance of reserchers in S&T sciences (47%), followed by natural sciences (22%) and medical sciences.

Further analysis is provided in Chapter 5.7.

Employees from research-development activity by occupation	Year 2018 Number of persons
Total	**44733**
Researchers	27471
Technicians and assimilated	6670
Other categories of employees	10592

Table 4. Employees from research-development activity by occupation (source: INS)

NUTS 2 Region	Year 2018	
	Number of persons	% of total
TOTAL	**44733**	**100,0**

[60] LEGE nr. 315 din 28 iunie 2004
[61] https://acad.ro/academia2002/acadrom/pag_lista4_fnd.htm
[62] http://www.research.gov.ro/ro/articol/4481/sistemul-national-de-cercetare

NORTH - WEST	3484	7,8
CENTER	4140	9,3
NORTH - EAST	3821	8,5
SOUTH - EAST	2479	5,5
SOUTH - MUNTENIA	2631	5,9
BUCHAREST - ILFOV	**23095**	**51,6**
SOUTH - WEST OLTENIA	1464	3,3
WEST	3619	8,1

Table 5 Employees from research-development activity by NUTS2 region (source: INS)

Researchers by scientific field	**Year 2018**	
	Number of persons	**%**
Researchers - total	**27471**	**100,0**
Researchers - in scientific natural and exact sciences	5953	21,7
Researchers - in scientific engineering and technological sciences	12817	46,7
Researchers - in scientific medical sciences	4014	14,6
Researchers - in scientific agricultural sciences	1502	5,5
Researchers - in scientific social sciences	1687	6,1
Researchers - in scientific humanities	1498	5,5

Table 6 Researchers by scientific field (source:INS)

The analysis of turnover of innovative enterprises by size-class (INS - 2019 data), shows that in 2016, 57% is generated by large companies, 24% by medium and 19% by small companies (author's calculation).

4.3 R&D funding

Romania, allocated in 2017 the lowest GERD per capita in EU28 (48 EUR per capita, compared to 619 EUR the EU28 average). In 2019, the public intensity for RDI was around 0.15% (vs 1% target of public investement in R&D by 2020).

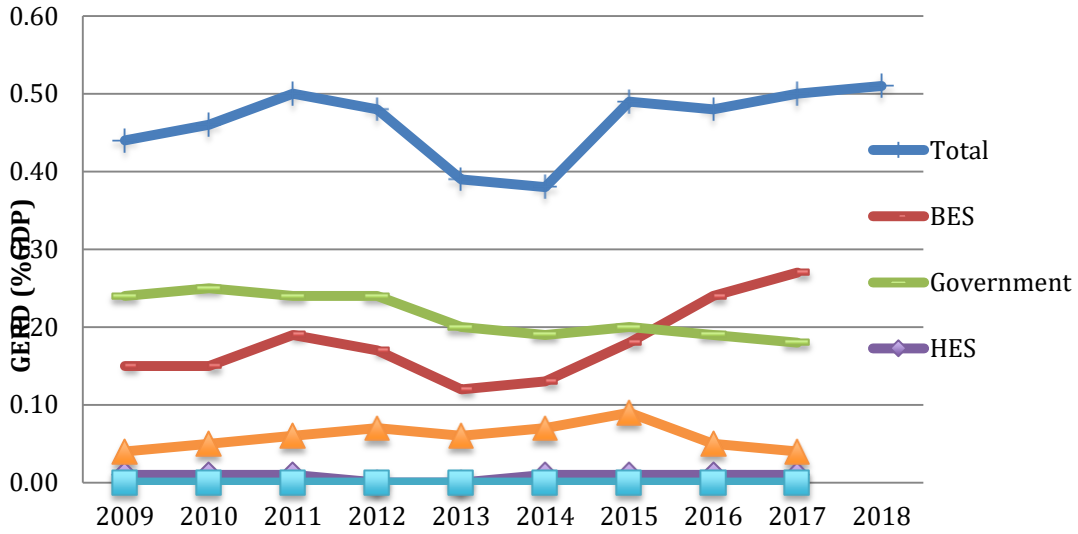


Figure 8. Time evolution of GERD: total and by source of funding (source: EUROSTAT)

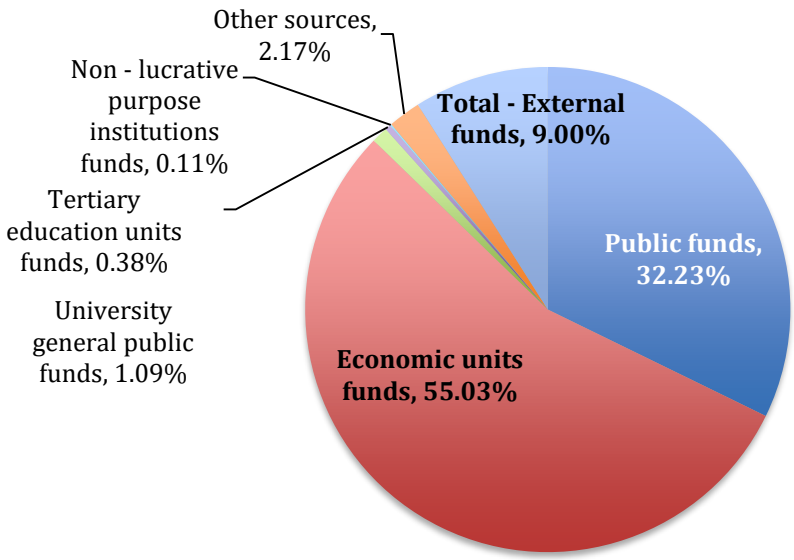


Figure 9. Total R&D expenditures by source of funding in 2018 (Source: INS)

It should be noticed that the budget line in the Annual State Budget dedicated to RDI is labelled 'R&D budget" (and not RDI budget).Therefore, while the activities and the implementation instruments target the broader innovation ecosystem herein the budget will be reffered to as the R&D budget, in line with the national legislation.

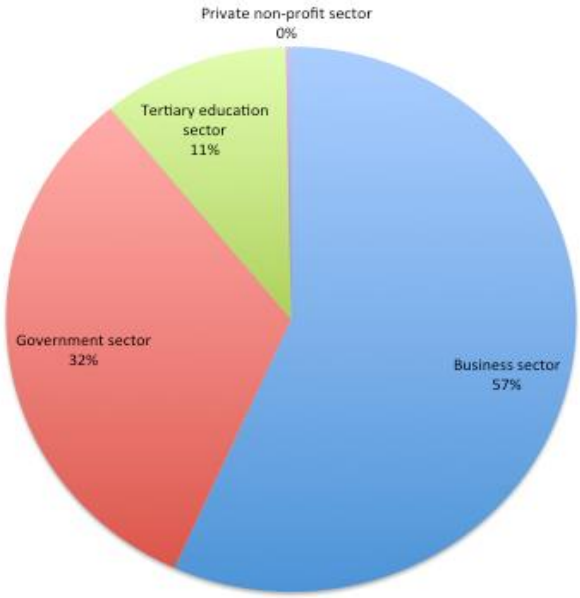


Figure 10 2017 GERD by sectors of performance (Source: Eurostat)

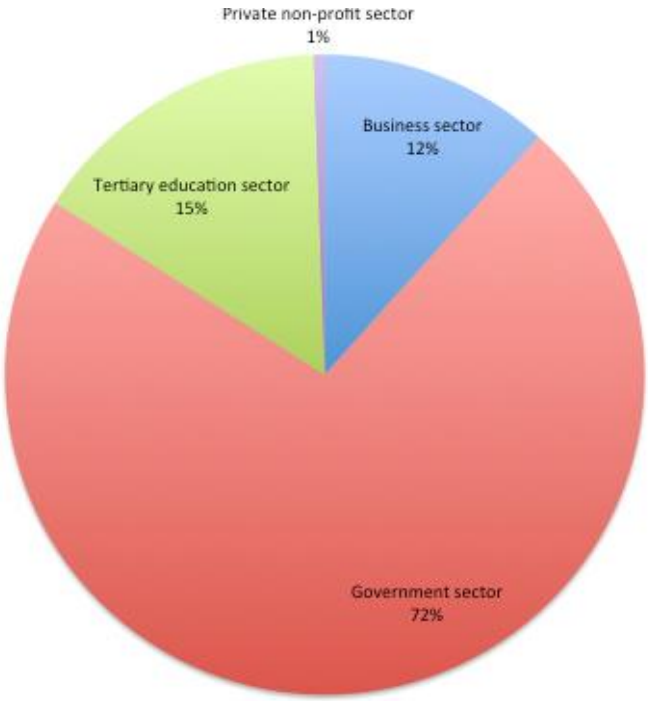


Figure 11. Public R&D funds by sector of performance (Source: Eurostat)

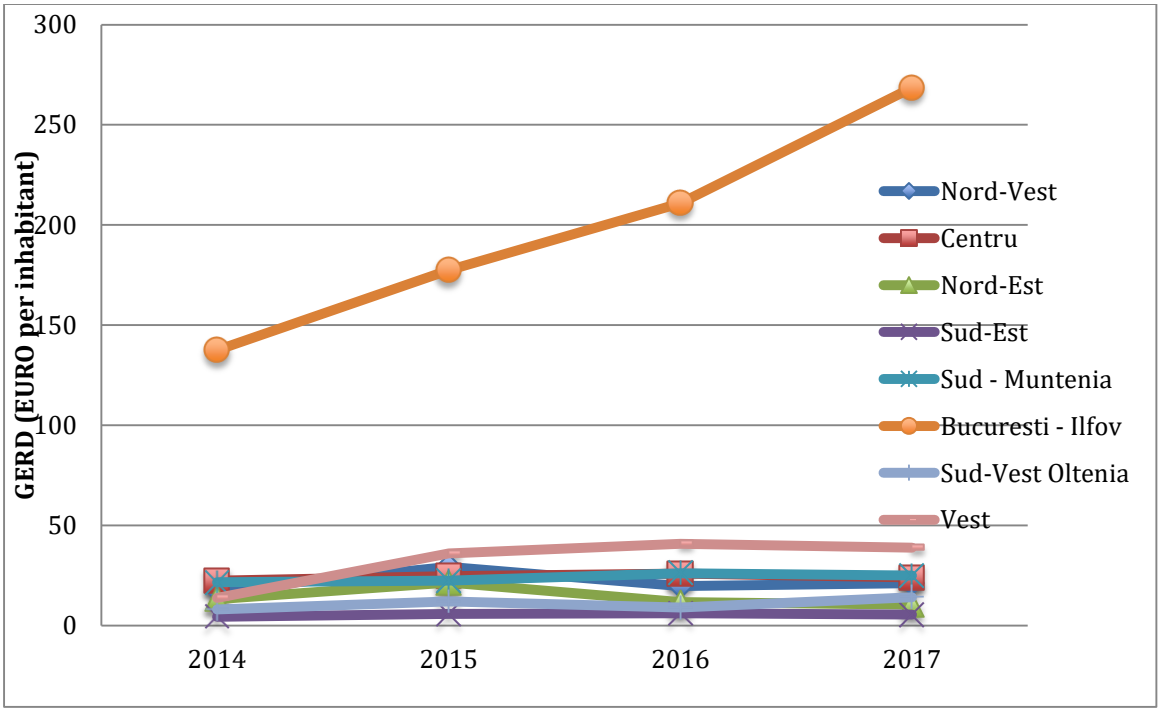


Figure 12. Time evolution of GERD (per capita) in NUTS2 regions (source: EUROSTAT)

Multi-annual planning. Although, in theory, the allocation of funds is based on multi-annual strategic planning, as presented in the National Strategy for RDI and Smart Specialisation, the annual allocations/RDI annual budget executions do not comply to the targets assumed in the Strategy.

Competitive vs. institutional The Public Research Organisations (PROs) and institutes of the Romanian Academy have access to block funding instruments. The Romanian Academy (RA), self claimed as performing 'fundamental research'[63], has its own chapter in the national budget. Several ministries manage their separate sectorial R&D plans. These include funds for research in agriculture, studies on economic issues, medical research, market forecasts etc.

According to author's calculation, based on MCI data, in 2018, the share of public funds allocated through PN3 represented less than 40% (compared to 35% allocated to Programul Nucleu). If to this, we add the public budget allocated directly, through a separate budget line, to the Romanian Academy, a significant share of the public R&D budget is allocated to public research organisations, through mechanisms which arguably may be rather block funding (than competitive funding). Most of the POC-AP1 and PN3 programmes are open for both HEIs and public research organisation.

RDI Total (CDI Total)	Budget approved 2018 (thousands RON)	Budget approved 2018 (thousands EUR)	Proposed budget 2020 (thousands RON)	Proposed budget 2020 (thousands RON)	Proposed budget 2022 (thousands RON)
TOTAL	1637754	356033			
55. Other Transfer	1288851	280185	1138950	1419320	1509986
Funding RDI programmes	**641345**	139423	657293	734214	836282
PN3	611345[64]	132901	644292	712407	813286
Sectoral Plans	27000	5870	10000	18000	20000

[63] https://acad.ro/acteNormative/pag_acteNormative.htm
[64] out of which 419.818 (executed budget, administrated by UEFISCDI site)

Grants	3000	652	3000	3807	3000
Development programmes	**547006**	118914	5634000	574606	563200
Nucleu Programme	448806	97567	328053	461406	450000
RI of national interest	95000	20652	10000	110000	110000
Contribution to international organizations	75500	16413	39600	75500	75500
Investement of economic agents with public capital	25000	5435	25000	25000	25000
58. Projects with funding from external funds					
Programmes funded by ERDF	258101		115370	0	0
ELI-NP	257929		115232	0	0

Table 7. The 2018 budget of the Ministry of Research and Innovation [65] (Souce: MCI)

4.4 RDI Performance

Indicators on scientific publications among the top 10% most cited publications, research excellence composite indicator and the ERC success rate show that Romania underperforms in most areas in research. Romania has one of the lowest Adjusted Research Excellence scores[66] (in 2016, 16.8 compared to 16.6 BG, and 16.7 in LT) in the Joint Research Centre ranking (Vertesy, D, 2018).

The publication output increased since 2005 (the number of ISI publications increased from 3003 to 9821 in 2018, while the number of SCOPUS publications over the same period increased from 4743 to 15997), partially as a pressure of the academic and institutional evaluations but also to the access of the HEI to competitive funding. When correlating the number of publications with number of full-time equivalent researcher or euro invested in R&D, the performance significantly improves (author's calculation/ publication per euro invested). This signals that the low scientific output is generated to a large extent by the scarcity of funds and human resources in R&D. The last available report regarding scientific output produced by Thomson in 2015 indicates that the highest share of publication was produced by universities. Physics and Mathematics are the two fields with the highest relative output share and normalized citation impact, while Space Science ranks highest in normalized citation impact but had only modest contribution in comparison to the total global output share (Thomson Reuters&UEFISCD (2015)[67]. Romania's normalised citation impact, while remaining below world average citation impact between 2005 and 2013, has managed to climb above that threshold in 2014.

As observed in the *Annex "Number of Publications and Open Access (OA)'*, the share of the open access of Romanian ISI papers increased from 9.85% (2005) to 29.60% (2018), reaching a value above the share of all OA ISI papers (24.74%) and much

[65] Thomson Reuters, Unitatea Executiva pentru Finantarea Invatamantului Superior, a Cercetarii, Dezvoltarii si Inovarii, 2015 - Bibliometric Analysis of Romania's Research Output, 2005-2014 availble at https://uefiscdi.gov.ro/scientometrie-baze-de-date

[66] The Research Excellence index is a composite of four components: share of top 10% most highly cited publications per total publications (data source: CWTS); PCT patent applications per population (OECD, World Bank); Participation in Marie Skłodowska-Curie Actions (DG-EAC); ERC grants per public R&D (DG-RTD, Eurostat, OECD).

[67] Thomson Reuters&UEFISCD (2015) Bibliometric Analysis of Romania's Research Output, 2005-2014

more rapidly than it (over the same period increasing from 9.53% to 24.74%) (*based on Analysis of WoS & Scopus databases - by Victor Velter, UEFISCDI*).

The patent activity is also modest. In EIS 2019, RO has the lowest position in terms of patent application (scoring 5.95 compared to 212 of Sweden).[68] The total number of patent applications[69] to the European patent office (EPO) was 99 in 2017, showing a light ascending trend over the last years.

The overall Romanian patenting activity is fragmented across a number of smaller entities. Some 37% of all 'Romanian' inventions are owned by 'academic & government' entities, closely followed by individuals (35%) and, at some distance, by business (28%) (Thomson Reuters 2015). The patent first filings at the USPTO and EPO show also an increase in the recent years. Approximately 37% of the patent applications are owned by Academic & Government entities, 28% by the commercial sector, while individual inventors own a sizeable share of the activity. The top high scoring inventions according to Thomson Reuters Patent Strength IndexTM scoring system belongs to the private sector: BITDEFENDER IPR (2014), followed by DIGITALOPTICS CORP EURO LTD. (Thomson Reuters Romanian Research Output: IP Analysis prepared for UEFISCDI (2015)[70])

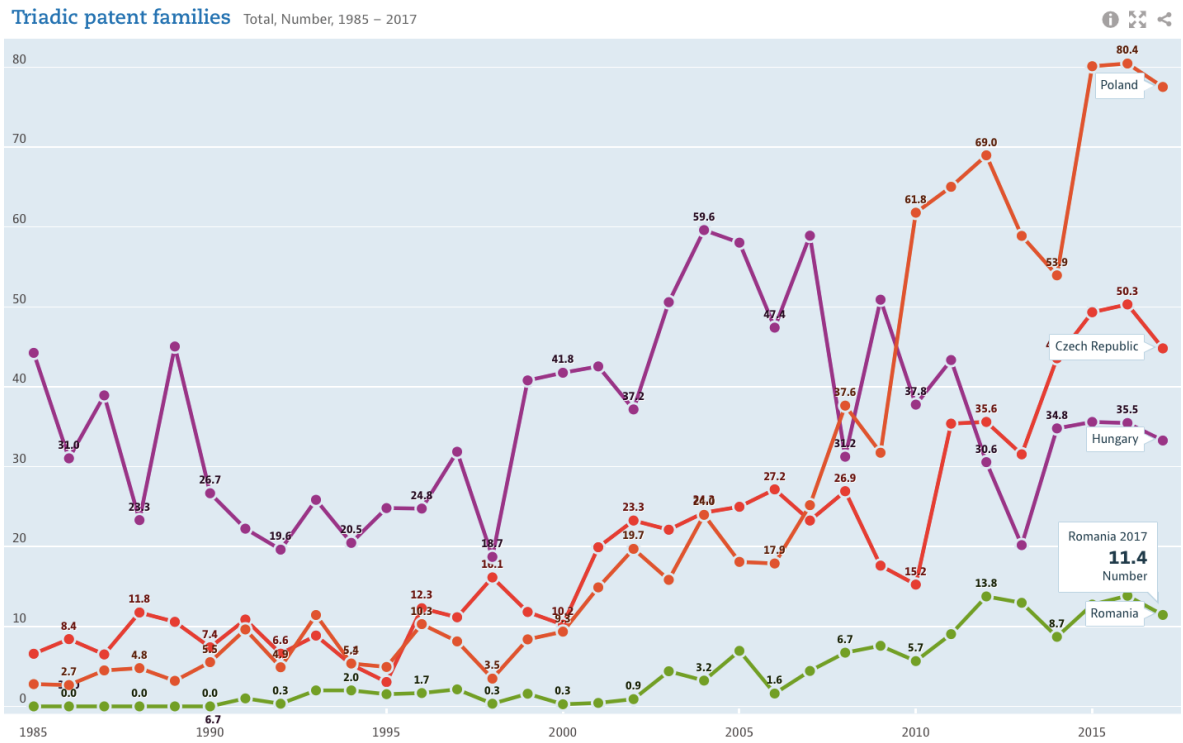


Figure 13 Triadic patents 1985-2015. Source: OECD, Triadic patent families (indicator). doi: 10.1787/6a8d10f4-en

[68] https://interactivetool.eu/EIS/EIS_2.html

[69] The total European patent applications refer to requests for protection of an invention directed either directly to the European Patent Office (EPO) or filed under the Patent Cooperation Treaty and designating the EPO (Euro-PCT), regardless of whether they are granted or not. The data shows the total number of applications per country. If one application has more than one inventor, the application is divided equally among all of them and subsequently among their countries of residence, thus avoiding double counting.

[70] https://uefiscdi.gov.ro/scientometrie-baze-de-date

4.5 RDI Policy and instruments

The main National Strategies during the 2014-2020 policy cycle with an impact on the long-term development of SMEs, particularly through innovation, are the **National Strategy of Research, Development and Innovation and Smart Specialisation (SNCDI)** 2014 –2020 and the National Strategy for Competitiveness (SNC) 2015-2020. The SNC defines five strategic priorities, related to improving the regulatory environment of the business environment, supporting public private partnerships, improving the ICT skills of the population, promoting the economic sectors potentially competitive and increasing the standard of living.

The SNCDI 2014-2020 was adopted on 21 October 2014 and focuses on S&T priorities selected on an evidence-based, smart specialisation aware foresight exercise, in theory including and the regional perspective.

The four smart specialisations (S2) aggregated at national level were: bio economy (based on the agricultural potential of the country), ICT (currently the most dynamic RDI sector in Romania), energy and environment (related to the challenges of energy efficiency, water resources and substitution of critical materials) and eco-technologies (focused on new-generation vehicles and equipment, the generation of bio resources, depolluting and waste reuse). The set of specialisations was subsequently expanded by political decision in the adopted form of the NS 2020 to include: space and security, energy production and new materials and Health as a priority of national interest.

The National Plan for RDI 2015-2020 (National Plan 3, Planul National 3 - PN3), was approved by HG 583/2015 in July 2015, with a total budget of maximum RON 15,000 million (more than €3,300 million). This amount is based on the target of 1% public investement for R&D by 2020 and the forecast of GDP growth. The implementation period is from the date of approval to 31.12.2020, payments continuing to be dispersed until the end of 2023. The first calls were launched in 2016. The responsibility for its management and execution belongs to MCI, which outsourced the management for most of the programmes.

The **Competitiveness Operational Program (Programul Operational Competitivitate POC),** with a total budget of €1,583 million (EU contribution: €1,329 million), funded through European Regional Funds and managed by the Management Authority (MA) of the Ministry of the European Fund is distributed across two priority axis (PA) out of which PA1. Research, development and innovation supporting economic competitiveness and the development of businesses with a total budget € 952.57 million support RDI.

The Operational Programme Regional Development (Programul Operational Regional POR) 2014-2020, Priority Axis 1, 'Technology transfer', with a €206.5 million fund, aims to support the "creation, modernization and extension of the innovation transfer infrastructure".[71] The ROP is coordinated by the Ministry of Regional Development and Public Administration.

Other funding lines which disperse public funds for R&D are:

- The ***Nucleu programme*** (programul Nucleu)
- The *sectorial plans* of various branch ministries.
- The *Research Plan of the Romanian Academy* and its institutes
- The component '*Investment in agriculture and rural development'* of the *Operational Programme Rural Development* allocates a budget of €88 million mainly for support action in R&D agriculture.
- Other sectorial policies
- Contribution to international organisations

[71] Ministry of Regional Development and Public Administration, Presentation on Regional OP (2014), available at http://goo.gl/JfgxCP.

- Funding of RI of national interest
- Cross-border, transnational and interregional co-operation, among which the most notable is the Danube one.

The draft versions of the PN3 and the POC, AP1 were elaborated in the same process as SNCDI 2014-2020. The POC was adopted relatively swiftly, while the PN3 followed almost one year after the adoption of the Strategy, subsequent to consultations and controversies related to the authority ensuring the administration of the programmes. Four smart specialisations (S3), defined at national level, were aggregated through the foresight-based process, but subsequently expanded by political decision and lobbying pressure to include Space and security, energy production and new materials (ERAWATCH Report 2014, R Gheorghiu).

The three main RDI funding instruments (1) POC/Priority Axis 1, (2) POR/Priority Axis 1, Technology transfer and (3) the PN3 address the smart specialisation (S2) domains. The two OPs funding RDI target exclusively the S2 domains (POC at national level, ROP at regional level). Most of the PN3 provide support for excellence, implicitly, but not exclusively targeting the S2 areas.

Regional Innovation Smart Specialisation Strategies (RIS3) With the aim to support the preparation of the calls under Regional Operational Programmes, Priority Axis 1, 'Technology transfer', all seven regions eligible for cohesion funds had to develop by March 2017 a concept note which provides a detailed explanation regarding the economic sectors and type of services for which the Technologic Transfer Offices (TTO) could be funded and the SMEs which may implement results of the TT regional smart specialisation areas. For the regions which did not have RIS3 at that time, the concept note had to identify also the S2 priorities. In this process, the regions updated the economic specialisation profiles, undertook a SWOT economic and innovation potential analysis and identified the regional RDI niches with the support of entrepreunarial discovery workshops. The North East and North West Regions benefited from the support provided by EC, DG-JRC through the "Lagging Regions" pilot project[72]. Currently (September 2019), Bucharest-Ilfov Region, the only region without a RIS3 Strategy is in process of finalising it. The complementarities and matching between the regional and national smart specialisation fields are summarised in the relevant Annex.

One of the important outcomes was the start of the dialogue with the business sector in a participatory manner, the collaboration between the central governing authority for R&D, ADRs and EC (M Chioncel, RIO Country Report 2017).

Policy MIX

Various other strategies elaborated by the Romanian Government for the period 2014-2020, can influence or directly contribute to the achievement of SNCDI objectives, as further detailed in Annex "Policy Mix. Strategies & Legislation"

- The strategy of the Romanian Academy for the period 2014-2020, whose priority directions are connected with SNCDI;
- The EU Macro-regional strategy Danube Delta[73], and Integrated Territorial Investments - Danube Delta;
- The National Strategy for Lifelong Learning 2015-2020 has as strategic objectives the increase of participation in lifelong learning and the increase of the relevance of education and vocational training systems for the labor market;
- The Strategy of Education and Vocational Training 2016-2020 envisages the development of competences regarding innovation, creativity and

[72] The project aims to provide support for a coherent, coordinated approach for the RIS3 design, develop and enhance engagement of relevant stakeholders

[73] https://ec.europa.eu/regional_policy/en/policy/cooperation/macro-regional-strategies/danube/

entrepreneurship within the vocational training programs (implementing through Programme Human Capacity (POCU) and ROP)
- The National Export Strategy (SNE) 2014-2020
- The National Health Strategy 2014-2020
- National Strategy for Tertiary Education 2015-2020.
- The governmental strategy for developing the sector of small and medium enterprises and improving the business environment in Romania - horizon 2020
- The Energy Strategy of Romania 2016-2030.
- National Strategy on Climate Change 2013-2020

Various other programmes, while not targeting explicitly the innovation, can impact the innovation performance in general and of the private sector, in particular:

- The *Operational Program "SME Initiative"* with an allocation of €100 million of the European Regional Development Fund (ERDF) and managed by the MA ROP - Ministry of Regional Development and Public Administration, will facilitate the access to finance for the Romanian SMEs.
- The Large Infrastructure Operational Program (LIOP) aiming at promoting sustainable economic growth and efficient use of natural resources can improve the overall framework for business given that one of the main hampering factor in doing business is the access to road infrastructures.

Various other legislation related to labor market, taxation affect the innovation ecosystem. Particularly, to be noted the tax legislation that encourages the activity of the RDI, namely the exemption from the payment of the profit tax for the companies that carry out the activities of the RDI, respectively the exemption from the payment of the income tax for the researchers.

Romania adopted a set of strategies setting out a broad range of research, innovation, entrepreunership, business objectives. A coordination mechanism with structures on three levels (strategic committee, thematic inter-institutional, operational) was supposed to ensure the coherence of the interventions, complementarities and synergies in the programming and implementation. The coordination mechanism was aimed to function in parallel with the institutional framework designed for implementation. However, this coordination mechansim was not functional.

5 DRIVERS/BARRIERS FOR INNOVATION

Economic growth is based on three main components: capital accumulation - including investments in real estate, equipment and human resources, population growth (and, consequently, labor force), and (3) technological progress (*Todaro, M. P (1997 Economic Development 6th Edition, New York).* According to the exogenous growth model, the technological progress is perceived as an external element, sustained only by the natural elapse of the time, the emphasis being placed on the intensity of capital accumulation (Robert M. Solow, Nobel prize winner). On the other side, in the theory of endogenous growth model, the technological progress is considered the driver of economic growth. The theory builds on the idea that growth takes place in the context of investments directed in a concerted manner towards technology and RDI (Paul Romer)[74]. In this context, investments in technology as well as in RDI expenditures lead to increased productivity.

While the EU28 innovation performance improved since 2008, Romania showed the highest negative trend[75] and the lowest performance in 2018, with an aggregated score of 34.13. According to EIS 2019, one of the country lowest performance is in Human capital & research.[76] The main obstacles to innovation identified for the period 2014-2016 were the high innovation costs (5.8%), followed by the lack of internal funding for innovation (4.9%), too much competition on the market (3.8%) and the lack of credit or private capital (3.7%). (INSSE, 2018)[77]

The share of innovative enterprises decreased in all enterprise size classes. The top major obstacles for SMEs are: the bureaucracy (first place), excessive taxation and unfair competition (SIPOCA 5 report, 2018). These obstacles are also among the main pbstacle faced by EU SMEs. However, some obstacles are specific to Romania, such as excessive controls performed by public authorities, increase of the wages, hiring, training and retaining of the human capital, inflation, delays of payments, low quality of the infrastructures.

While the relative importance of these obstacle varies with the size of the business, the bureaucracy, corruption, excessive taxation are among the first three for all size business. The national entrepreneurs feel that they are in a permanent threat. Through the state they nominated both public administration institutions, legislation, government, parliament. Starting from remarks like "*nobody does anything for us*", "*there is no interest in developing business*", "*have other interests and we do not count*", `*unclear legislation and excessive bureaucracy allow the authorities to control certain socio-professional categories*". Respondents expressed the opinion that the legislation is sometimes contradictory, in a permanent change. Lending costs, banking procedures are considered to be large and difficult, however for many, the only form of financing is accepted with resignation. (Sipoca 5, Report)

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[74] Romer, P. M. (1990). Endogenous technological change. Journal of political Economy, 98 (5, Part 2), S71-S102.
[75] European Innovation Scoreboard, (2016), European Commission, http://ec.europa.eu/growth/industry/innovation/facts figures/scoreboards_es.
[76] the weakest sub-pillars expenditure on education as % GDP and per pupil
[77] http://www.insse.ro/cms/ro/content/inovaţia-în-întreprinderile-din-mediul-de-afaceri, INNOVATION IN BUSINESS ENTERPRISES D U R I N G 2 0 1 4 - 2 0 1 6

5.1 LOW FUNDING FOR RDI

The government has many ways of stimulating investments in innovation. This include direct support for research and development, but also taxation, regulation, and trade policies.

5.1.1 Low level of direct Funding for RDI

Expenditures on RDI activities are an indicator of a country's efforts in the direction of driving innovation (*OECD Factbook 2013, Science and Technology, OECD, 2013).* The innovation leaders in EU are those MS with the highest RDI investments (SE, DK, Fi, DE). The correlation is evident also for modest innovators: RO has had one of (if not) the lowest GERD and has had one of the lowest innovation performance in the recent years.

Studies show that the countries scoring low on research excellence are also those that spend less on R&I, a 'critical mass' 1.5 % of GDP being needed to achieve excellence (S Hardeman et al, 2013). Romania is well below this threshold level, stagnating for many years among the lo west GERD levels in EU.

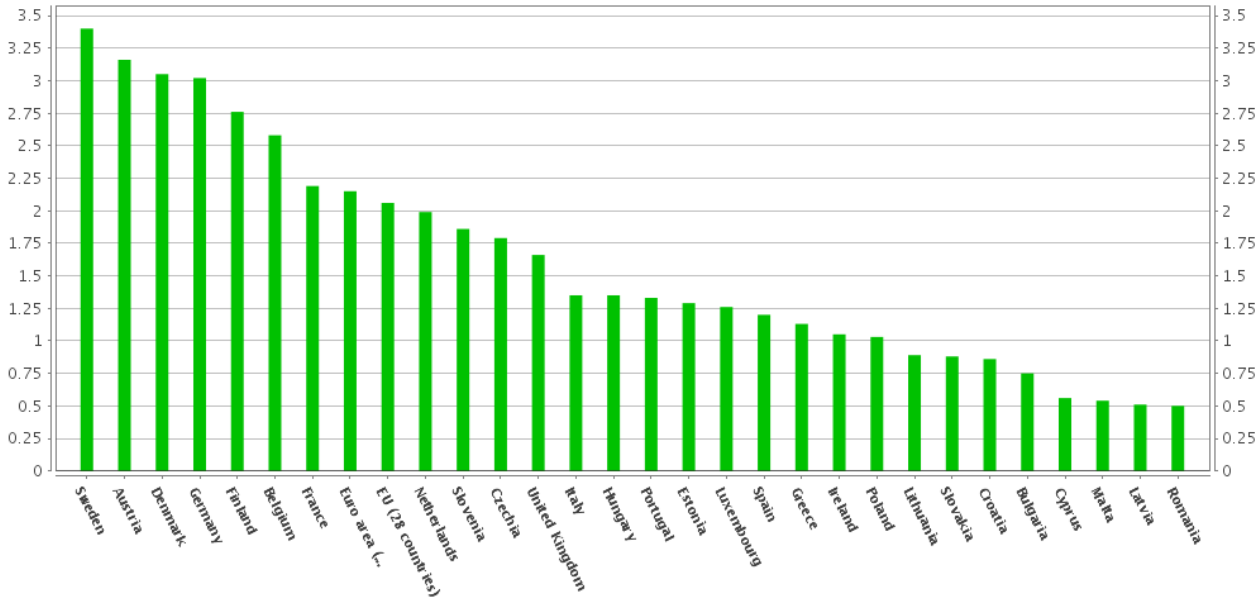


Figure 14. 2017 GERD in EU MS (Source: EUROSTAT)

The R&I system is chronically underfunded. The budget allocation is well below the targets assumed by the national strategic documents and in comparison to EU28. The GERD intensity showed a minor increase from 0.48 (2016) to 0.5 (2017), reflected in a larger nominal GERD due the GDP growth. Romania, allocated in 2017 the lowest GERD per capita in EU28 (48 EUR per capita, compared to 619 EUR the EU28 average) (Eurostat, 2019).

The government support for R&D after a slight increase in 2015 to 0.26% (compared to 0.21% GDP in 2014), dropped to 0.18% in 2018 and 2019. The R&D performed by the business sector showed also an increase from 0.16 in 2014 to 0.29% of GDP in 2017, however significantly lower than the EU28 average (1.30% of GDP).

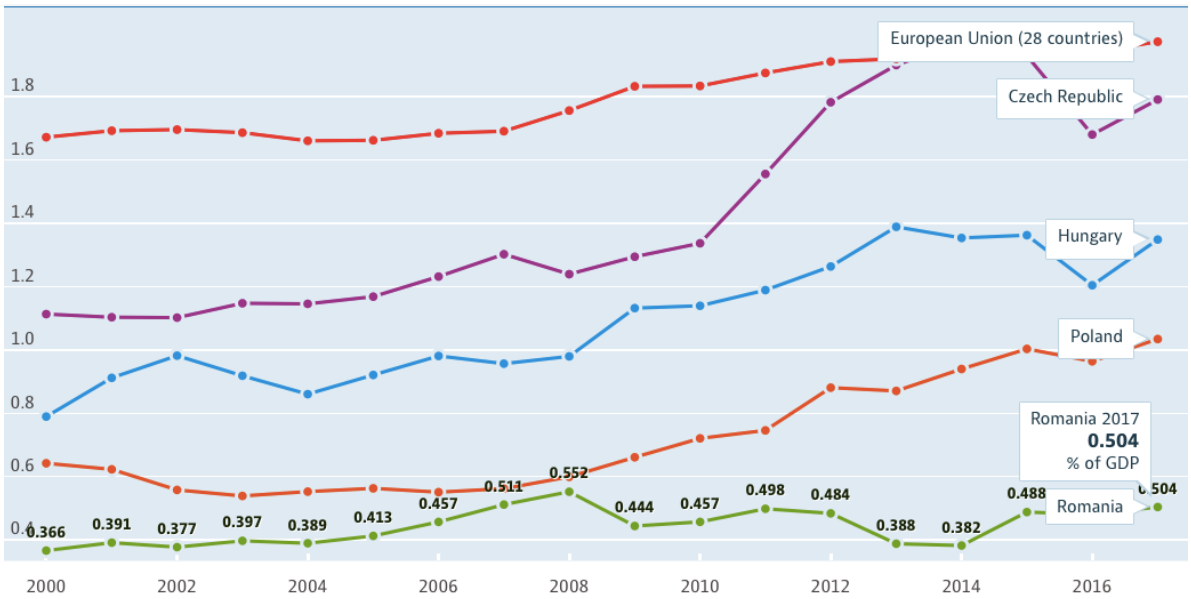


Figure 15. Gross domestic spending on R&D in selected countreis (Source: OECD, doi: 10.1787/d8b068b4-en)

The reduced and unpredictable funding, the lack of compliance to the initial planning. do not allow the RDI units to establish an institutional strategy. The lack of predictability of funding affects both the capacity of the RDI institutes to develop the existing infrastructure, to attract and retain the human resource, as well as to maximize the accumulations of knowledge (SIPOCA 27, Mid Term evaluation of SNCDI).

	2014	2015	2016	2017	2018	2019	2020
Public funds (% GDP) - projections	0.41	0.56	0.57	0.63	0.72	0.83	0.97
Real allocation	0.19	0,2	0.19	n.a	0.18	0.15	

Table 8. Public funds (% GDP) projections in SNCDI to reach the 1% target public investment vs real allocation

When comparing Romania's GERD composition by source of funding and sector of performance to EU28, it can be observed that the country's business enterprise sector lags behind, revealing the weak innovation activities of Romanian firms. BERD intensity in Romania is very low, however showing a light revival starting 2015 (increasing from 0.16% of GDP in 2014 to 0.29% in 2017. The lack of financial resources to perform RDI is highlighted by small and large companies: "*an innovative idea requires huge initial investments".*

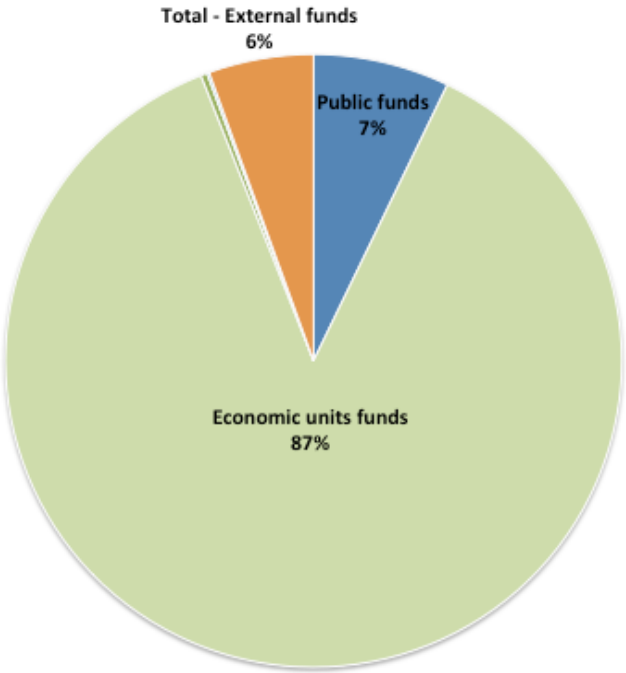


Figure 16 2017 RDI performed by BES by source of funding (Source: INS)

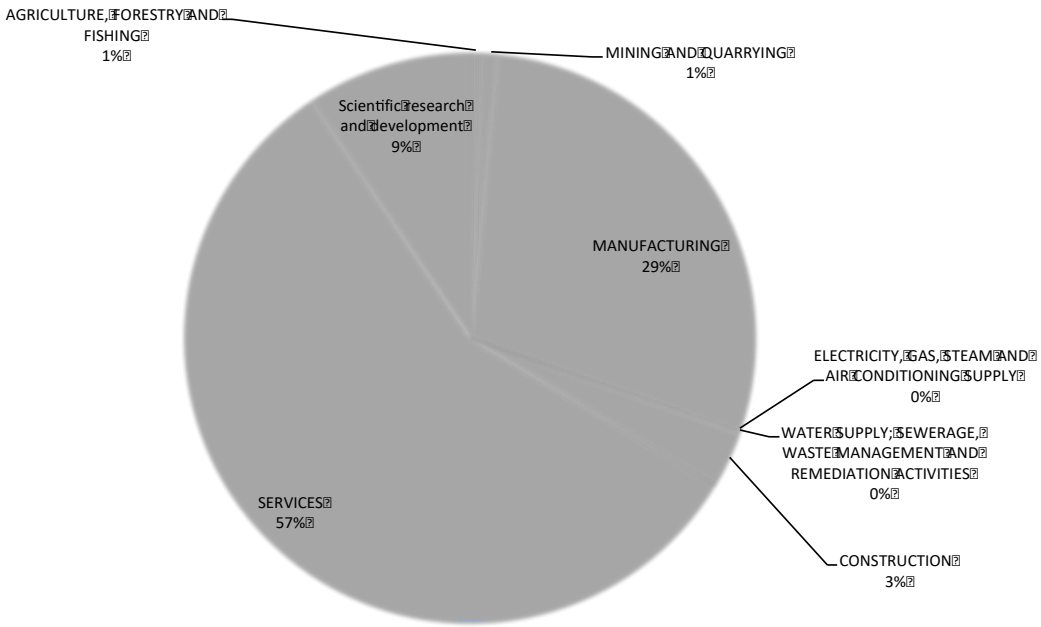


Figure 17. 2017 R&D expenditure by NACE (source: EUROSTAT)

Given the scarcity of the funds and their unpredictable allocation due to the lack of commitment to the targets assumed, there is high competition, a certain level of frustration given the limited funds, the time invested in applications and the low success rate. Even when successful, budget cuts can occur during the implementation phase, the reimbursement of the amounts stipulated by contracts is difficult and not within the agreed deadlines.

The respondents complaining about the insufficient public funding for RDI refer to the fact that "*it is difficult to access the public funds", "the funds for R&D projects are limited", many "have applied for RDI funding several times, but were not successful*", *„the companies "have been involved in many RDI projects in past, but at present there is no funding available" etc.*

The lack of predictability of the public funding for RDI is particularly emphasized by the respondents form the (public) research organisations: "*there is no reliable source of funding for research activity from the state budget*", "*the RDI allocations are insufficient for salaries and research activities*" (SE, R&D Centre), "*public funding for RDI is unpredictable*".

5.1.2 Limited usage of fiscal incentives for R&D

The investment in RDI is risky: it may or may not lead to results in improved products that may bring value added to the investing companies. Also, the economic exploitation of ideas is generally exposed to a degree of rivalry. *'A user's willingness to pay for an idea may decrease directly proportionally to the level of public dissemination of that idea' (*Iancu, V (2014*).* **To mitigate these hindering factors, governments are increasingly allocating more public resources in the form of grants or fiscal incentives.**

Several fiscal incentives are currently available in Romania. The first concrete step towards encouraging R&D through fiscal incentives for R&D was realized in 2008, when introduced into national law, with applications of January 1, 2009, tax facilities regarding tax on profit, specific to this area -the additional deduction when calculating the tax on profit of 20% of R&D expenses (subsequently increased to 50% 38 from 1 February2013) and the application of the method of accelerated damping for R&D equipment. In the CIS 2016 study, while a minor share of enterprises declared that tax regulation stimulate the innovation (4%), a large share (31.3%, second in EU) considered that it creates uncertainty.[78] A higher share of SME compared to large companies (>250 employees) perceive taxation as uncertainty, as major factor hindering innovation.

The Government Ordinance OUG 32/2016 amends the Tax Code, introducing a fiscal stimulus for R&I activities. This ordinance stipulates an exemption for personnel income resulting from R&I activities. The companies which conducts exclusively RDI activities should be excepted from paying corporate tax for ten years (starting January 2017). The final form of the methodology for granting the fiscal incentives for RDI was approved in august 2017. This was vital as a secondary legislation, filling the legislative gap. (Joint order Ministry of Public Finances 2326, MCI 2855/29.08.2017).

However, **while fiscal incentives exist, they have limited impact**. According to the KPMG study[79], the following issues create difficulties and uncertainty regarding the application of the income tax exemption for R&D:

- The way to define the eligible activities for the tax exception is very general; it generates uncertainty.

- The administrative effort for drawing up the documentation required by law is high, especially if a significant number of RDI projects is performed in one year.

[78] https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do Innovative enterprises whose innovation activities have been affected by legislation or regulations by subject of the regulation/legislation, type of effect, NACE Rev. 2 activity and size class

[79] KPMG, Cercetare, dezvoltare, inovare Stimulentele fiscale și creștereaeconomică în România

- The time and financial effort to change the salary calculation can be significant for companies whose employees work in the same month in several eligible projects.

In addition to the level of facilities offered, the clarity and ease of application of legislative norms, and the width of the sphere of the eligible activities are important. Overall, companies take limited advantage of these facilities. The tax laws and the guidance intended to explain the regulations are unclear.

While entrepreneurs appreciate the fiscal facilities for RDI granted in recent years, they criticize the methodology of implementation of the legal provisions. The additional deduction for the calculation of the taxable profit on the expenses eligible for the RDI - is considered as "*a benefic measure, but not very widely applied - because of the National Agency for Fiscal Administration controls – whose employees are not specialists in RDI but must validate the RDI activities'*. '*The tax deduction for R&D activities is welcome, but the conditions of application are very difficult, it is impossible to meet all the conditions*. *The tax exemption on income from salaries for the RDI employees* - as emphasised by one of the respondents - "*was initially adopted in a totally unacceptable form: we were somehow forced to hire an accountant for each R&D employee/ engineer to calculate how many square meters of his office are used for research, how much energy he uses and so on." (SW, Automotive*). The opinion is also shared by another entrepreneur: "*The result was that at least in the Automotive field it did not apply. You cannot say in a company that you will only do one thing, you have to do everything you are asked for in the job description*" (SM, Automotive).

The exemption from corporate income tax for the RDI companies - is also commented by the respondents: they said that only those companies whose main object of activity is research and development can benefit from these exemptions.

Companies feel uncertain about the methodology for tax deduction for R&D activities and find difficult to identify which R&D projects are eligible for deductions. Improving the tax guidelines for innovative businesses could significantly increase the impact of the fiscal incentives.

5.1.3 Fragmentation of the RDI system. Low efficiency of the public allocation for RDI

"*The system remains underfunded and highly polarised, with a limited number of actors concentrating the output. Its performance is low and the research is not aligned to the economic needs. The number of ISI publications has increased gradually, however, indicators of excellence*[80] *show that the research may be disconnected from the international research trends. SNCDI 2014-2020 stipulates that performance principles will apply for institutional funding. However, the prospects of implementation and its relevance to funding to date are not clear. The higher education (HE) financing arrangement has been criticized for dissipating funds among too many universities, in the absence of appropriate mechanisms for rewarding the quality of teaching and research" (M Chioncel, RIO 2017).*

While the number of researchers has reduced more than half (from 38612 to around 17,000) from 1995 to 2017, over the same period the total number of R&D centers has increased. The number of researchers in the public national R&D entities decreased

[80] such as the percentage of scientific publications among the top most cited publications worldwide, participation in FP7/H2020

from 9828 (1995) to 6413 (2017) but the number of government organisatons increased from 120 to 190 (2017), leading to more fragmentation.

The Romanian RDI policy may be seen more „supply" oriented rather than visionary and „mission" oriented. Currently the R&D policy and the attached financial instruments target mainly the supply side of the system, represented to a large extent by state owned R&D Institutes. With the fall of the centralised economy, a sharp fall in innovation demand followed. The recovery was triggered mainly by large multinational companies which built up their own research capacities and innovation ecosystems, as the existing RDI supplying actors were not agile enough to keep up the pace. A large majority of the SMEs did not and still do not have enough capacity to absorb innovation results, being mainly concentrated in traditional low skilled – low tech sectors such as wood and furniture, textiles, agro food (with the remarkable exception of the ICT sector), not representing a coherent voice in setting up the research agenda.

5.1.4 Limited competitive funding based on rigurous institutional evaluation

Institutional evaluation has been discussed extensively in Romania.

Evaluation and funding of HEIs. The financing arrangement for HEIs had been extensively criticized for dissipating funds among too many universities, in the absence of appropriate mechanisms for rewarding the quality of teaching and research or responding to societal needs (Andreescu et al., 2012). This inefficient allocation of public money, 'complement' the chronic underfunding of the HEIs.

Universities receive their funding for educational activities. A performance-based funding scheme for universities based on a set of "quality indicators" was introduced in 2003 and abolished in 2011. However, the funds were almost entirely correlated with the number of students and the impact of the quality indicators was arguably very limited (Zulean et al., 2015. CNFIS, 2013).

Universities went through a classification exercise, undertaken by the Association of European Universities in 2011 and ranking of academic fields in the following year. The classification in research-intensive, research-and-education and teaching-intensive was designed to be tied to specific funding lines available to the best performers and the right to organise doctoral and masters studies. Twelve public universities were classified as research intensive (category I), around 30 public HEIs as education and research universities (and/or artistic creation) – category II and the rest (some newly created public universities and all the private universities) as HEIs focused on education (category III). The evaluation exercise was however heavily contested and just one year later, the newly appointed government decided through the Emergency Order 21/2012, that allocation of public funds to HEIs in the academic year 2012-2013 will be independent of the evaluation and ranking. The National Council Funding Higher Education had proposed methodologies for an 'Institutional Development Fund' for universities to be granted to the highest-scoring HEIs. Calls for projects under specific themes were finally opened in 2017.

According to the Law of Education, the HEIs should be evaluated regularly, using various benchmarking and ranking tools. HEIs are evaluated according to specific methodologies and applied by the Romanian Agency for Quality Assurance in Higher Education (ARACIS). The aim of the evaluation is twofold: (1) HEIs must receive the accreditation by ARACIS or another European agency applying the international standards in order to be eligible for public funding, (2) to rank the studies and universities.

EVALUATION of the national R&D institutes

An evaluation procedure for entities part of the national R&I system was adopted under Government Decision 1062/2011 and applied only to roughly one third of the national R&D institutes. The 2011 regulatory framework stipulates that all R&D units in order to be entitled to R&D public funds must be evaluated and ranked by their research performance into performance classes. All the evaluated institutes were ranked in the A category (further subdivided in A+, A, A-).

All entities of the public RDI system should produce annual self-evaluation reports. The reports in theory should involve benchmarking and all sorts of comparative analysis as analytical tools. Nevertheless, given that most of the institutions do not have dedicated staff (as time allocation, knowledge and expertise) and data repositories, these reports are mainly a list of achievements. *The reports vary in extent and substance, but generally they list activities and accomplishments.*

5.2 POLICIES

The national policies relevant for the innovation ecosystem have some particularities

- They generally target short-term results, overlapping with budget cycles. Some areas need long term strategies, which should transcend the political changes and interference.
- There are many strategies, policies, funding instruments, with a degree of overlap, managed by many public institutions, with different institutional cultures. There is a significant degree of fragmentation, lack of coordination and communication.
- The policies often do not take into account the needs of business.
- While in theory, many Strategies complement the SNCDI in creating a sound policy mix, there is no evidence of their impact. Sometimes there is significant discrepancy between these strategies and their implementation. This occurs either due to the inadequate design or the absence of the implementating actions (therefore the strategies remaining just rethorics), the low funding or inefficient management of the funds.
- The policies with economic impact are based on figures at macroenomic level, which are generated by a small number of companies.

  "*The Romanian economy is highly polarized and heterogeneous. In this context, translating the favorable or unfavorable effects reported by the macro figures to the individual companies may not be so relevant. The overwhelming majority of companies in the economy achieve significantly different results from the average values expressed by macro figures. The trends at the aggregate level were generated by a small number of companies*" Excerpt From: BNR. "Notebooks, No. 42.

5.2.1 Fragmentation of governance, policies/lack of efficient coordination

Various Strategies, overlapping, at different governance levels were designed and implemented during 2014-2020 policy cycles. These deploy various funding instruments which were not necessarily designed/nor implemented in a coordinated

and integrated manner. This brings an additional layer of complexity which the beneficiaries face in accessing information, additional efforts to understand and comply to criteria, implementation procedures.

The governance of the RDI is also hindered by a fragmentation amongst Ministries and Agencies responsible for research, economic development, education and regional development, with distinct institutional settings and culture, implementing, distinct monitoring indicators and systems, evaluation procedures and timings. This was a significant drawback of the Mid Term evaluation of the impact of the SNCDI on the S2 domains.

While coordination mechanisms were in theory designed in SNCDI 2014-2020, there is no evidence that they were functional/operational until August 2019, when the Committee for the Coordination of the Smart Specialisation was established by Ministry Order. There was absence of an overarching strategy/governance to provide direction and purpose to the policy.

A comment that appears in both the Mid Term Evaluation of the SNCDI and the interviews performed by UEFISCDI is that the current financing framework does not cover coherently all the stages of the innovation process. There is a **funding gap between research, transfer of the innovative outputs into production, and further into market**: *"At present, the structural funds for RDI are given to only for research projects and this creates a difficulty. The last components, the production component, and marketing should also be considered"*. While marketing of a new product and market research to identify the requirements for new products, are steps in innovation process they are de facto not covered by RDI policy. All the relevant policies should be designed in coordination, considering their interplay.

The midterm evaluation of the SNCDI 2007-2013 and NP2007-2013 highlights that '*little is said about the actors that should employ and implement these tools and particularly their qualification and readiness, hence the functioning of ministries, agencies, advisory bodies. research institutions, particularly universities, the National Institutes, not least the Romanian Academy*.' (Technopolis, 2012). To date, such an **evaluation of the whole RDI governance**, at national and regional level, to the best of author's knowledge **has not been performed**. There is no visible evidence of the reform of public administration, which should provide for an administrative apparatus, restructured to include expertise and activities which are strongly needed for policy design, foresight studies, evaluation.

The EC Recommendations since 2013 (including in 2017) reinforces that the **weak capacity of the public administration to develop and implement policie**s remains a core challenge for Romania. *"Romania's administrative and policy-making capacity has been suffering from opaque processes and decision-making, little recourse to quality evidence, weak coordination across sectorial policies and widespread corruption' (*EC, 2017).

The incoherence of the policy is also an important weaknesses of the Romanian cluster landscape. While the Ministry of Economy is the main actor responsible for the cluster policy, funds are only available under the ERDF Competitiveness Programme, managed by the Ministry of European Funds (Management Authority) and the Ministry of Innovation and Research (Intermediate Body). Furthermore, content of the calls do not match real needs of clusters, nor do they come in time. In that regard, the launching of a small cluster support scheme in the frame of the National RDI Programme in 2017 is to be seen as a temporary yet salutary solution. (*Source: Daniel Cosnita: Romanian Clusters).*

5.2.2 Limited evidence based policy making

There is limited practice of evidence based policy making. This is largely the result of the lack of sound evaluation of policies/programmes.

The ex-post impact evaluation of the National Plan II for RDI (PN2), neither of the POS-CCE programme, was not perfomed. A mid-term evaluation of **National Strategy for RDI 2007–2013 (SNCDI 2007–2013)** was published in 2012, but there is no ex post evaluation.

The Project "*Development of the Administrative Capacity of the Ministry of Research and Innovation for the implementation of actions set out in the National Strategy for Research, Technological Development and Innovation 2014-2020 (code SIPOCA 27*[81]*)"* provided for the implementation of a monitoring and evaluation mechanism (main beneficiary MCI). Within the project, methodologies for the evaluation of the impact of the National Strategy at aggregated level and on the four smart specialisation domains and Health were developed. Six midterm evaluation reports were finalised in July 2019 and are available on the official webpage of the project. [82]

The analysis builds on surveys covering firms, HE and INRDIs, and five thematic focus groups. The evaluation covers four PN3 programmes (582 projects finalised by March 2019) targeting explicitly the smart specialisation areas and having projects finalised by December 2018 ((1) *Bridge Grant, (2) Experimental Demonstrative Project (Proiect experimental demonstrativ PET, (3) Transfer to the economic operator (4) Innovation cheques*. The project/programme indicators for all the programmes were made available by UEFISCDI to the team of evaluators, in a structured database. This included input/project output indicators/per project/programme.

Within the POC, AP1 (2014-2020), around 220 projects were contracted until the end of 2018, with a total value of RON 3.08 billion. Of these, however, only 21% (**46 projects**) were completed at the time of the Mid Term Impact Evaluation (March 2019), with a total financing value of about RON 259 million. Aggregated data on these 46 projects were provided for the evaluation by the responsible OI for POC, AP. The information was not structured on instruments.

Qualitative and quantitative methods were applied (including an attempt of counterfactual impact evaluation). Given the short time between finalisation of the projects and the evaluation, the low RDI investement/number of projects in a specific domain, the lack of integrated approach in measuring the impact of all RDI instruments on a specific smart specialisation domain, the lack of clear baseline indicators, the difficulties in avoiding the bias of selection of the entities in the non-beneficiaries group, the results of the quantitative analysis should be treated with caution. Bearing this in mind, the evaluation shows a positive, yet modest (given the low funding) impact of all instruments evaluated at micro level, contributing to the general objectives of SNCDI 2014-2020. Dominance of some sub-field were identified.

The design of the programmes and the mix of the programmes were assessed mainly as appropriate.

The main problems highlighted by the RDI performers were related to the low funding, high competition, lack of continuity of the competitive funding which created problems particularly in retaining temporary staff and affected the continuity of the research activities, and also limited the capacity to access external funding. The lack of planned funding, based on annual calendars of competitions, represents a hindrance in establishing partnerships with large companies, which establish their development strategies generally 12 months in advance.

[81] http://sipoca27.ro
[82] The methodologies and the reports are available at http://sipoca27.ro/rezultate/

The institutional framework of governance, did not integrate all the relevant stakeholders. The lack of an essential structure – Consiliul National Politici Stiinta Tehnologie Inovare, envisaged by SNCDI 2020, has generated some major consequences.

Other obstacles relate to heavy and complex bureaucracy related to programmes implemented through structural funds. In some situations, the evaluation process was assessed as too long and subjective, further delayed by the long period between results of the evaluation and the contracting phase. The evaluation indicates a need to align output/outcome indicators to specific needs: business is not interested in ISI papers, academics&researchers are.

Among the positive aspects: the support/guidance received from the UEFISCDI monitoring teams, the projects monitoring UEFISCDI platform.

The project also made operational a platform integrating the Romanian Registry of Researchers, including more than 28,800 profiles[83], the National Registry of Research Infrastructures[84] and the Registry of Research Results.

5.2.3 Limited evaluation of the RDI programmes

According to the Mid Term Evaluation Report, the distribution of public RDI funds during 2015-2018 is represented in the diagram.

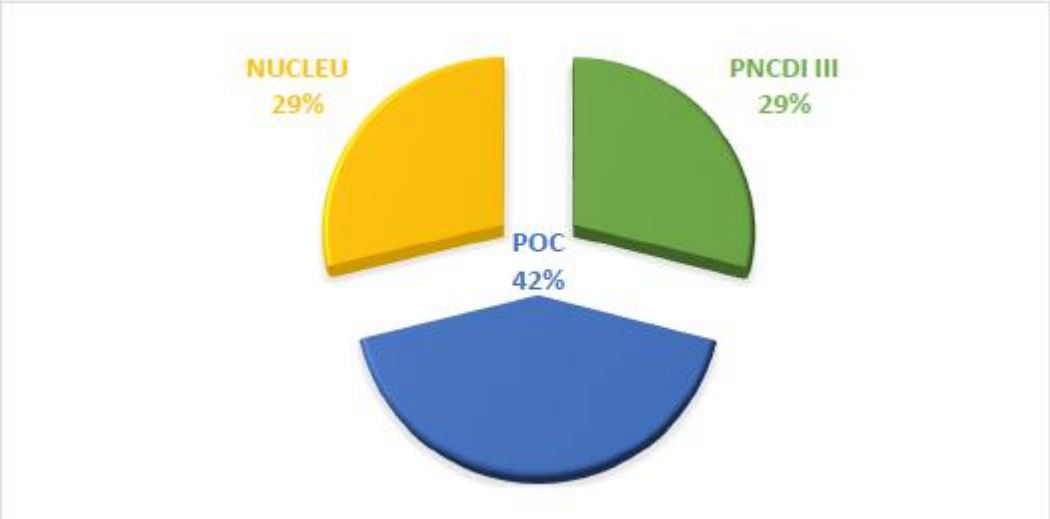


Figure 18 Distribution of the public funds for R&D during the 2015-2018 period. Source: Studiu de evaluare a impactului SNCDI 2014-2020, agregat la nivel national, evaluare intermediara[85]

There were planned distinct evaluations for the impact of POC, AP1 on the smart specialisation domains, but also the Evaluation of the Impact of the National Strategy for RDI on the smart specialisation domains, which should include all the implementation instruments of the strategies, targeting the smart specialisation domains.

Competitiveness Operational Program (Programul Operational Competitivitate POC), Priority Axis 1 - POC, AP1

[83] www.brainmap.ro
[84] www.erris.gov.ro
[85] http://sipoca27.ro/wp-content/uploads/2019/09/R1.1.4_STUDIU%20EVALUARE%20IMPACT%20AGREGAT%20NATIONAL.pdf

To date (September 2019), according to the information publicly available, within POC, AP1, 221 projects were contracted, counting to 667,415,917 Euro (1 euro=4.6531 RON), representing approx 70% of the total of the budget allocated to this PA.[86]

Major delays in the implementation of POC, AP1 put at risk the efficiency, efficiency of the SNCDI. The reasons triggering these delays are related to the significant delays in evaluation. In some cases, this led to 2-3 years delay from the launch of the call to the contracting phase. These delays are linked to the nomination of evaluators. Romanian experts have good experience in peer review, and are searchable in Brainmap platform. However, given a controversy related to the selection of the evaluators, in May 2018[87], MCI officially requested experts/institutions to support the technical-financial evaluation of proposals submitted under specific funding instruments POC, AP1 (see complete list in the footnote)[88], in pro-bono regime. Eventually, in September 2018, MCI opened a request for service consultation[89] for the evaluation. The evaluation was outsourced to private companies, with a very limited number of experts. This put under doubts the confidentiality of the evaluation process.

On the official website, Annual POC implementation Reports are available. In the 2018 Annual Report is *highlighted that 'due to the delays in the process of purchasing the evaluation services, no evaluation reports were prepared during the reference period*." At the end of 2018, in terms of financial progress, 133% and 441% of the target was achieved for less developed, respectively more developed regions. These POC annual reports, signal the following implementation problems POC, AP1:

- The mismatch between the provisions of the OP and the reality arising from the implementation (including technological progress).
- Delays in the evaluation process of some project proposals.
- Delays in the implementation of the major ELI NP project.
- The calculation mode / The erroneous reporting of the project indicators.
- Difficult setting up of the reimbursement / payment request files and the purchase file.
- The impossibility to carry out transfers from the research organizations to the companies with which they signed subsidiary contracts.
- Uncertainties related to filling-in the reimbursement / pre-financing applications.
- Difficulties in updating data in the electronic system MySMIS.

According to the Plan of the Evaluation of POC[90], to date, several evaluations should have been finalised:

[86] http://mfe.gov.ro/wp-content/uploads/2019/06/10ce91d94af809a60b4ba4adc7fa3e71.pdf
[87] http://www.poc.research.gov.ro/ro/articol/4234/despre-oi-cercetare-comunicare-axa-1-poc-anunt-pentru-experti-evaluatori
[88] POC/62/1/3/Stimularea cererii întreprinderilor pentru inovare prin proiecte CDI derulate de întreprinderi individual sau în parteneriat cu institute de CD si universitați, în scopul inovarii de procese si de produse în sectoarele economice care prezinta potențial de crestere- SECTIUNEA C
POC/77/1/2/Crearea de sinergii cu acțiunile de CDI ale programului-cadru ORIZONT 2020 al Uniunii Europene și alte programe CDI internaționale- RO-EIT
POC/78/1/2/Crearea de sinergii cu acțiunile de CDI ale programului-cadru ORIZONT 2020 al Uniunii Europene și alte programe CDI internaționale- ESFRI-ERIC
POC/80/1/2/Crearea de sinergii cu acțiunile de CDI ale programului-cadru ORIZONT 2020 al Uniunii Europene și alte programe CDI internaționale- CENTRE SUPORT
POC/81/1/2/Crearea de sinergii cu acțiunile de CDI ale programului-cadru ORIZONT 2020 al Uniunii Europene și alte programe CDI internaționale- CATEDRE
[89] https://infocentrum.ro/Servicii_de_consultanta_pentru_evaluarea_proiectelor_primite_in_cadrul_Axei_Prioritare_1_POC-217283-1.html
[90] http://www.fonduri-ue.ro/images/files/programe/COMPETITIVITATE/POC/Plan.Evaluare.POC.pdf

- The evaluation of the impact POC actions on the RDI capacities in the smart specalisations domains and Health (first semester 2019)
- Evaluations of the POC actions regarding private investement in RDI (first semester 2019)
- Two evaluations of the POC actions regarding the knowledge, technological and human resources trasfer, between public and private (2017, and 2019)

No additional public data are available on the official website regarding these evaluations. To the author's best knowledge the evaluations have not yet been performed.

National Plan for Research, Development and Innovation (PN3).

The implementation of the National Plan for RDI (PN3) started with delay, in 2016. Additional delays were caused by the political change in January 2017, leading to dismissal of the four RDI advisory councils, changes in priority actions of SNCDI, the exclusion of the foreign expert evaluators.[91, 92]

All the information regarding the guidelines, evaluation process and results and a summary of the funding, including descriptive statistics (distribution by region/ domain) of the instruments funded by PN3 and managed by the Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI) is available on the agency website. There is a one-stop-shop platform https://uefiscdi-direct.ro, with all the upcoming, open, closed calls. The Agency also makes available Annual Reports[93] that provides descriptive statistics regarding the implementation evaluation, analysis of the results of all the programmes under its management. The information is provided in a structured, transparent manner per instrument/aggregated per year.

The presentation of all the relevant information in a structured, easily searchable way, the availability of annual reports recommends the UEFISCDI as an example of good practice.

In line with its official responsibilities, the body responsible for the evaluation of PN3 is MCI. Besides the evaluation performed within SIPOCA27 project no other PN3 evaluations are available.

NUCLEU (CORE) programme

A significant share of the state R&D funds is allocated to the NUCLEU Programme, to which only National R&D Institutes have access. No evaluation reports of the programme, neither any descriptive statistics (per domain, type of RDI activity etc.) are available.[94] In 2015, the evaluation performed by Zulean highlighted the lack of information related to Nucleu Programme in a comprehensive format. (Zulean et al, 2015)[95]. The situation persists in the current policy cycle. There is no evidence of evaluation, the results, impact of the programme are still missing a transparent, compressive format. The NUCLEU programme has raised significant concern [96] regarding the lack of transparency, '*the obscure spiral through which is circulated a*

[91] http://civitas.dogaru.net/nu-reorganizarii-organismele-consultative-ale-ministerului-cercetarii-si-inovarii/
[92] http://www.eua.be/activities-services/news/newsitem/2017/05/30/eua-statement-on-the-recent-developments-in-romania-regarding-the-research-policy-framework
[93] https://uefiscdi.gov.ro/rapoarte-de-activitate
[94] http://www.research.gov.ro/ro/articol/3768/programe-na-ionale-programe-nucleu
[95] Zulean, M., Ionita, I., Viiu, G.A. (2015), Raport de evaluare a guvernantei sistemului public de cercetare, dezvoltare si inovare din Romania, 2007-2013 (Assessment of the governance of the RDI system in Romania 2007-2013)
[96] https://mic-mic-anc.ro/2018/02/14/spirala-obscura-prin-care-circula-o-treime-din-bugetul-public-al-ministerului-cercetarii-si-inovarii/

*third of the MCI budge*t", the opening of calls over short period of times, often during holiday period.

The author, based on the evidence publicly available (or better said its absence) can just observe the lack of coherent, consistent evidence regarding the impact of the funds allocation.

Regional Operational Programme – Priority Axis 1 (POR, AP1)

The guidelines for POR, AP1 (Technological Transfer) were opened for public consultation in June 2017. The competition was launcehd in February 2018.[97] 66,000,000 EUR were devoted to this funding action. The first evaluation for POR, AP1 (technological Transfer) is scheduled for 2019, third semester.

The information regarding the funded projects by ROP is not available per funding instrument/ AP. No annual reports regarding the implementation, descriptive statistics, funds allocation per region, smart specialisation domain could be found on the official website of the Ministry in charge. The site provides just a list of approved financing.[98, 99]

5.3 LOW LEVEL OF COLLABORATION (PUBLIC-PRIVATE, PRIVATE-PRIVATE)

The resource of knowledge is the most important 'commodity' in the quintuple helix, and the circulation of knowledge continually stimulates new knowledge. All helices in the quintuple helix influence each other with knowledge, in order to promote sustainability through new, advanced and pioneering innovations.

In the EIS 2019[100], Romania has the forth worst score in linkages but drops to the **lowest position in the dimension 'innovative SMEs collaborating with others**. The position significantly increases when assessing the private co-funding of RDI public investments, likely due to the co-funding shares imposed in the projects funded by structural funds. The Romanian business, historically, has low engagement with academia and public research organisations. The SMEs do not know the means of engaging and most often lack the resources to pursue RDI activity and collaboration. On the other side, the financial returns available to universities and research institutes from working with small businesses are often not sufficient to justify significant engagement. The government can facilitate such collaborations, either through funding collaborative projects, advisory support, collaborative platforms, events and connecting hubs that can bring the entrepreneurs and innovators together.

Products developed by the Romanian RDI sector are poorly capitalized on the market. Many foreign companies are present on the Romanian market, but they are not interested in patenting the activity in the country. On the other side, the domestic companies most often do not have the strength needed to impose themselves on the market, so they generally follow market trends, without generally having the capacity to influence it.

5.3.1 Low level, unpredictable public funding of the public-private collaboration

[97] http://www.fonduri-ue.ro/calendar-lansari
[98] https://www.mdrap.ro/dezvoltare-regionala/-4970/-7166
[99] http://www.inforegio.ro/ro/implementare/stadiul-implementarii-financiare
[100] https://interactivetool.eu/EIS/EIS_2.html

Various schemes under PN3 and POC offered support to RDI public-private collaboration, either through collaborative research or research performed by HEIs and PROs for enterprises. However, the level of financing is low in the overall context of underfunded RDI system. Sometimes, such collaborations were implemented rather in an opportunistic approach since the eligibility criteria required a private partner in the consortium, but with no real collaboration implemented. Nevertheless, such projects may foster the possibility for future collaborations.

Lack of predictability for R&D funding. There are funding instruments supporting collaborative projects. In theory multi-annual funding is ensured through the SNCDI. However, the allocation of funds below the committed budgets generated discontinuities in funding, significant unpredictability and very high competition. While for the public RDI sector, this funding, however difficult to access, is the main source of funding, the business sector has other priorities. For business, the complexity of bureaucracy procedures related to programmes financed by structural funds, the high competition and the time required for the preparation of proposals may deem such efforts too high.

Good Practice. Experimental demonstration project

Biomaterials functionalized for implants for total arthroplasty

The aim of the BioArt project is to demonstrate the feasibility and applicability of a new TRL4 level technological chain, used to obtain new innovative biomaterials for implants used in total hip, knee and shoulder arthroplasty, by developing new synthesis and thermo-mechanical processing technologies. alloy and for the functionalization of its surface and by coating with two different types of thin layers, using PVD deposition techniques. It aims to achieve functionalized biomaterials, based on the knowledge already acquired by the team (TRL3). Starting from the current state of knowledge, we propose the complete development of a set of biomaterials for total hip / knee / shoulder arthroplasty, to solve the following undesirable issues: i) reduction of bone tissue density at the place of implantation, due to the lack of mechanical stresses, which increases the risk of bone fractures. ii) excessive wear of the movable components of the joints, or even fractures arising from the use of oxidized materials, which limit the size of the femoral head and cause metallosis or inflammation due to the particles generated by the wear.iii) metallosis, osteolysis and reduced osteoconductive properties of the metallic components of the metal rods inserted in the bone tissue in case of total arthroplasty interventions without cementation.

The objective of the project is to demonstrate the feasibility at the TRL4 level of the technologies to obtain: a new Ti-based bioalloy with superior mechanical properties (low elasticity mode, high wear and corrosion resistance, breaking and hardness resistance), covered with thin layers based on biocompatible multicomponent carbonitrides with reduced wear, rubbing and corrosion rate (for mobile joints) and doped hydroxyapatite for rapid implant Osseo integration in bone tissue.

Results: 1 patent. 3 publications. 7 conferences. 21 products and technologies

Source: Nicoleta Dumitrache, UEFISCDI

5.3.2 Low willingness to collaborate

In addition to scarce funding and missing intermediating structure, the evidence indicates that the lack of willingness to collaborate represents a significant barrier. Interesting to observe that both sides (public and private) highlight the lack of willingness of the other side, while correctly identifying the lack of collaboration as a significant weakness.

There is a weak collaborative culture amongst SMEs firms, and a reluctance to engage with partners who are external to the firm or social networks. This is partially the

result of an RDI structure which does not facilitate the connection of public research to the economic environment, a poor communication and framework that could facilitate the communication, but also due to the traditional pattern of a culture lacking such collaboration and inertia/ fear for change. Many academics lack the contacts to develop connections with private sector, while the administrative structures within the HEIs have limited capacity or willingness to involve in such collaborations.

While all strategic documents, either national or EU, acknowledge the need of research to be connected to economic needs, the two sectors, RDI public and the business sector, function under distinct constraining factors. On one side, the business needs to compete with large international players, within a rather unpredictable regulatory framework, most SME focus on survival and do not have the means, the capacity or the will to plan growth based on innovation. If innovation happens, the business sector interest is to transfer this in a new product, technology. On the other side, the academic&research staff undergoes annual evaluations, against high performance criteria mainly focusing on scientific output (*'publish or perish'*), regardless the very scarce or absent budget for research. Some academic academics have high teaching loads, which limit their ability to undertake research. Both sides function in silos and in the absence of appropriate regulation to mitigate the pressure resulted from distinct needs, in the absence of connecting hubs, events communication is difficult to happen.

5.3.3 Low level of Knowledge transfer

The innovation and technology transfer infrastructure in Romania has developed in the last years to some, yet limited extent. Recent national policy efforts have been concentrated in facilitating the transfer by creating **structures that can mediate the transfer** (i.e. KTOs). However, the low funding, the limited human resources and commercialization capacity of these offices have not yet provided for the cultural shift toward improved collaboration.

While, the POR, AP1 funded such KTOs no evaluation is available. While some public R&D have KTOs, there is no evidence of their efficiency in terms of funding, activity, human resources and expertise.

The respondents in the Mid Term Evaluation identified that it is a clear need for training regarding the application of the legal framework for Intellectual Property Rights R&D products to the economic environment.

The innovation process requires specialized managers in the field, i.e. innovation managers, combining management, marketing, RDI expertise and knowledge. All these skills should be acquired through a complementary scientific, technical and economic university training and professional experience.

Evidence (author's analysis of the vacancies on the about market) indicates very low demand from companies for such profile. SMEs and mainly micro and small companies do not have the financial capacity to develop in house RDI departments. Specialised promoters of innovation and technological transfer, having the capacity to identify those patents, inventions, know-how, innovative solutions that can be implemented in the company, can mitigate this weakness.

Science and technology expertise alone is not enough to ensure innovation. The skills of finance, business development, production, and management are useful. Recent efforts were considered to embed entrepreneurship in STEM education. However, the lack of specialised trainers deem to limited desired results.

5.3.4 Limited flow of knowledge

Knowledge transfer does not generally take place from one institution to another, such as from a university to a company. Rather, people are transferred, and they circulate ideas and use experience. In Romania, the job-to-job mobility of HRST is the lowest in EU (2% compared to 7.8% in EU). Romanian HEIs and PROs systems remain traditional, rather closed systems, tending to penalise than support mobility. Few programmes encourage such type of knowledge flow (i.e., PN3 programmes, Bridge Grant). However, their impact in the context of low funding and in the absence of solid programme evaluation remain difficult to be documentated.

5.3.5 Limited and fragmented support to clusters[101]

Clusters are drivers of competitiveness based on innovation and internationalisation. At the end of July 2019, **74** cluster initiatives were registered at the Ministry of Economy, Trade and Business Environment, body which is responsible for the cluster development as part of the industrial policy. Out of them, **42 clusters** are members of the Romanian Cluster Association – CLUSTERO**,** the representative body at national, European and international level (www.clustero.eu).

Romanian clusters are generated according to the so called "4 leaves clover" model, a quadruple helix, which in addition to industry, academia and policy, emphasis the role of catalyst institutions such as technology transfer centres, chambers of commerce, consultants etc.

Romanian clusters rank on top position in EU when it comes to cluster excellence, as assessed by the European Secretariat for Cluster Analysis Over the past 6 years (60 Romanian clusters have been awarded bronze label (20 valid as of July 2019). 14 silver label (6 valid as of July 2019) and 3 gold label.

In the absence of a coherent cluster policy, Romanian clusters have developed sustainable business models of various types ranging from clusters strongly supported by public regional actors (as it is the case of IMAGO MOL and Euronest, of which the management in embedded in the ADR North East and, respectively, the County Council of Iasi) to research driven clusters (as it is the case of IMDAGRO POL, of which the management is ensured by the National R&D Institute for Agricultural Machinery – INMA) up to **industry driven** clusters, which represent the majority.

The financing support schemes for clusters have been set in place since 2010 but the financing has been characterised by incoherence and mismatch with the real cluster needs. In the current policy cycle only two schemes:

- **2015**, Innovative Clusters, POC 2014-2020. Very few projects submitted largely due to the huge financing effort and the much too high minimum value of the project

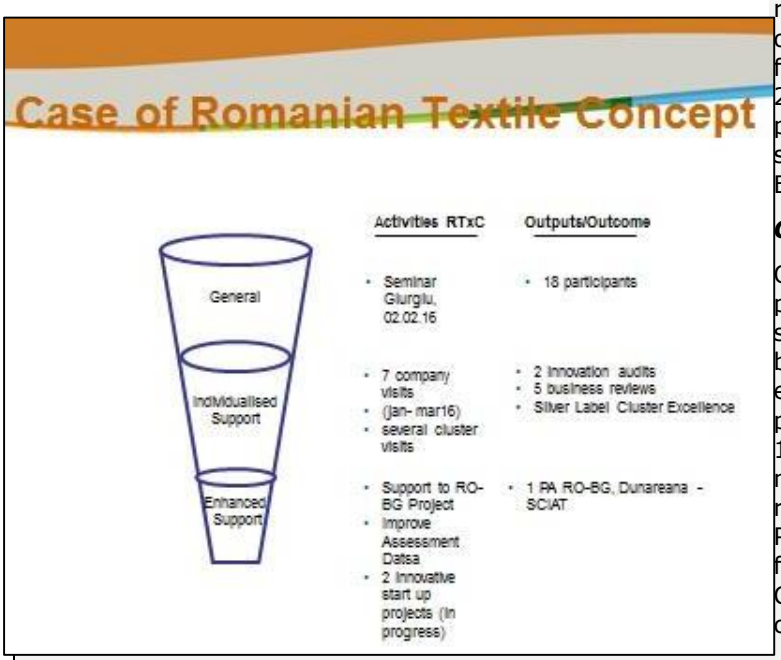
[101] This section was developed based on the information received from Daniel Cosnita – President of Romanian Cluster Association

- **2018**: Innovation Clusters, PN3 National RDI Programme (Scheme elaborated in cooperation between the Ministry for Innovation and Research, the RDI Financing Agency (UEFISCDI) and CLUSTERO)
- **2019**: Innovative Clusters, POC 2014-2020 - expected to be launched .

Lack of appropriate cluster financing (instruments meeting needs) will result in a loss of momentum in cluster development in Romania. Development of VCs must entail actions to speed up cross-sectorial and cross-regional flow of knowledge and information.

Good Practice. Romanian Textile Concept

In order to enhance the level of innovation and internationalization of SME clusters, CLUSTERO has started a close cooperation with the management of Romanian Textile Concept. The methodology follows a 3 step "funnel "approach: 1) a presentation seminar where benefits of cluster membership, available financial and non-financial instruments for SME development and international best practice are presented 2) first company visits together with the cluster manager where an innovation audit or business review is performed, followed by recommendations accompanied by proposed measures and according deadlines. The recommendations include orientation towards specific financial (Structural Funds, Horizon 2020, SME Instrument, INTERREG programmes) and non-financial support services (EEN, Senior Expert Services, etc.).



Output and results

Output: 18 cluster SMEs participating to the information seminar, 2 innovation audits and 5 business reviews performed, 1 enhanced innovation audit performed (Improve methodology), 1 RO-BG CBC Project submitted,1 new innovative start up. As a result, 1 international Commercial PA has been already achieved so far. Furthermore, Romanian Textile Concept obtained silver label for cluster excellence.

Source: *Daniel Cosnita - "Romanian Clusters"*

5.3.6 Incipient stage of Regional concentration. Absence of science parks

Proximity matters: innovation can be facilitated by a concentration of talent that increases the rate of interaction. Innovation might be facilitated by the interaction among potential innovators. Physical proximity between venture capitalists and entrepreneurs is often critical. The symbiotic relationship between research parks and the surrounding region is crucial to the innovation ecosystem.

"Science parks have the role to create an environment that encourages innovation, offer industry access for faculty and students, and serve as a landing pad for industry recruitment." Research parks are where academic culture meets corporate culture" [102]. Science parks can facilitate networking, cultural exchange and the movement of personnel. They can also function as clusters of capacity/knowledge that can attract businesses to a region. Romania, to date, does not have Science Parks. The lack of Science Parks, as locus where entrepreneurs, researchers and innovators work together limit the flow of idea.

Box. MAGURELE SCIENCE PARK

Magurele Science Park is an essential project for the realization of the regional development objectives of the Nuclear Physics project and for the economic valorization of the research results from the Măgurele platform.

The Scientific Park from Măgurele will allow the convergence of the most competitive sectors of the Romanian research, and innovative entrepreneurship, starting with the European impact project ELI-NP.

It will contribute to the development of an attractive location and ecosystem for national and international knowledge-based institutions and companies, contributing therefore to the economic development at regional and national level.

Source: https://www.magurelesciencepark.ro/en/

5.3.7 Limited sharing knowledge platforms/collaborative spaces

The Start up Barometer 2019 shows the importance of sharing knowledge/communities platforms as the most important source of interaction and inspiration.[103] While many recent initiatives try to provide the right context for open dialogue, communication, as observed by respondents in the UEFISCDI interviews: "*today, there is no connected community, but several disparate communities doing good things, but who do not know how to connect*" .

BOX. BrainMap

Brainmap (https://www.brainmap.ro) is an online platform, connecting more than 28800 researchers, innovators, technicians and entrepreneurs. Besides a connecting hub, it also presents a searchable platform for expertise required for example in proposals' evaluation, projects.

However, the recent activity, related to technology start-ups, internet-related technology, entrepreneurial hubs, clusters signals the potential beginning of a new period of innovation.

[102] The Role of Research Parks." National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. 2013. Trends in the Innovation Ecosystem: Can Past Successes Help Inform Future Strategies? Summary of Two Workshops. Washington, DC: The National Academies Press. doi: 10.17226/18509 https://www.nap.edu/read/18509/chapter/7#38).
[103] https://www.impacthub.ro/barometrul-startup-urilor-2019/

The innovative initiatives emerged primarily in the field of ICT (e.g., How to Web, Innovation Labs, RICAP) and in major urban areas such as Bucharest, Cluj, Timisoara, Iaşi or Braşov.[104]

Innovation Café (Cafeneaua de Inovare)

Cafeneaua de Inovare (Innovation Café) is an event happening twice a year, aiming to facilitate and promote a collaborative framework between the actors supporting the innovation environment in Romania in discussions about innovative ideas and proposals to develop the innovation ecosystem. It represents a flexible networking framework facilitating the exchange of experience and know-how among innovative entrepreneurs, investors, venture capitalists, innovators, NGOs and policy makers, contributing to the development of new partnerships between them.

The Innovation Café offers a tested model for long term quadruple helix cooperation and engagement. It is an open format event addressing the most challenging innovation topics at national level, trying to involve all active players in the ecosystem in an informal debate about the future of innovation, contributing to the pool of evidences for public policies recommendations.

Cafeneaua de Inovare (Innovation Café) is a registered trademark of (UEFISCDI). It was acknowledged as a good practice by the European experts in 2016 under the aegis of H2020 Policy Support Facility for Romania[105] as well as inside the Interreg Europe project[106] MAinstreaming Responsible Innovation in European S3. www.cafeneauadeinovare.ro

BOX. Online platform RePatriot

The 'Repatriation through Entrepreneurship' (RePatriot) action aims to bring national entrepreneurs around the world together, to share ideas and search for solutions. RePatriot addresses the Romanians from the Diaspora who want to reconnect with the country, to invest in Romania and / or to relocate home and rebuild their life and career here. The online website offer information about the opportunities to be an entrepreneur in Romania, success stories of entrepreneurs who have managed to build their businesses, guides for entrepreneurs, the funding and sponsorship opportunities, and information about starting a business in Romania.

Cluj IT Cluster

One of the most known and successful concerted effort to create an ecosystem to spawn innovative companies is the "Cluj IT Cluster" (CITC) (www.clujit.ro/en/), a cluster of organizations active in the field of ICT. Romanian IT, launched by a group of Romanian IT specialists from Paris, aims to create a network of centers that bring together the national IT professionals&entrepreneurs from the country and from abroad.

RomanianStartups.com

RomanianStartups.com platform brings together Romanian technology and Internet related startups, founders, accelerators/incubators, events, co-working spaces, mentors, investors and

[104] See, for example, the distribution by city of the approx.. 300 tech start-ups on Romanian Startups, probably the most important platform for tech startups in the country (http://goo.gl/on850J).
[105] https://rio.jrc.ec.europa.eu/en/policy-support-facility/specific-support-romania
[106] https://www.interregeurope.eu/marie/

makes it a one-stop-shop for all the information needed to get an overall view of what is happening in the Romanian tech field. The locations are irrelevant, the condition imposed being at least one of these entities' co-founder is Romanian.

Techsylvania

Techsylvania (https://techsylvania.com) is one of the leading technology event that gathers tech enthusiasts, business people and developers each year. During the Startup Avalanche which takes during Techsylvania with the support of Spherik Accelerator, the seed-stage startups are challenged in a competition to showcase their business for awareness and reward. Over 3.000 engineers, founders, investors, executives and CEOs of IT & digital companies, banks and pioneers of growing start-ups from across the world meet at Techsylvania, in the heart of Transylvania, for inspiration and networking.Attendees from 27 countries, mainly European, come to Techsylvania which is the gateway to Eastern Europe tech ecosystem.

Innovation Labs

The Innovation Lab (https://www.innovationlabs.ro/) is an accelerating and mentoring program anchored in 11 prestigious universities in Bucharest, Cluj-Napoca, Iasi, Sibiu, Timisoara and Tel Aviv in the ICT field. In March 2019, over 480 young people enrolled in the five national Hackathon Innovation Labs, proposing over 160 digital product ideas. In the Hackathons, 111 teams entered, developing their ideas in prototypes with mentors, during 24 hours of fire. The TechHub Bucharest demo night is another event dedicated to early stage startups.

Rubik Hub Piatra Neamt https://rubikhub.ro/ourstory/

Rubik Hub, Piatra Neamt is a private initiative of North-East ADR that established a business incubator & coworking space in 2016. Its mission is to develop and connect communities, to educate and accelerate startups and create global successful businesses. Today with the support of private an academia partners the following programs are available: (1) Bootcamp is a 3-day intensive program which offers the basic tools and knowledge to start a startup or a project. (2) Rubik Garage is a pre-accelerator for early-stage start-ups. It is a free program with the aim to provide support to startup to overcome any bottlenecks and identify the development needs. In 6 months support programme a personalized roadmap for the startup is designed (3) Office Hours by Rubik gives access to free session with a mentor for feedback, validation, a deadlock, another perspective helpful for you to take the project to the next level.

Startup Spinner Makeathon

This is an event dedicated to startup founders, helping them to move to a higher level, Each team will be assigned a mentor along with whom they will work intensively throughout the event to identify bottlenecks, solve problems and set short or long term goals. In addition to the working hours spent with dedicated mentors, they will also have the opportunity to learn how to work on specific tools (Business Model Canvas, Team Mission Fit, Business Idea Canvas), each presented in a workshop.

5.4 Low quality of large infrastructures (roads, railways). Inefficient usage of RIs

The low quality of the large infrastructure (transport in particular, telecommunications, energy) etc. is listed also as one of the top ten major challenges faced by SMEs in The White Book of SMEs (2019).[107] Romanian private companies do not have the financial resources to invest in research, and their access to public RDI infrastructure is difficult.

An exercise in mapping the infrastructures and research equipment and services existing in Romania and their use has been performed, and the data and information are available through the ERRIS portal ("Engage in Romanian Research Infrastructures System", https://erris.ro/index.php? . The platform evidences the high number of

[107] http://cnipmmr.ro/wp-content/uploads/2019/07/Prezentare-Ovidiu-Nicolescu.pdf

research equipments. While recent investments in RIs increased the quality of infrastructures, often the investments were made for the 'sake of investing/ additional income'. Often the investment in research infrastructures did not respond to national strategic priorities, or have been duplicated at territorial level, underused due to the lack of adequate skilled human resources and subsequent funds for maintenance and for relevant research activities (A Curaj, S2E Country Report 2015). Both, public and private RDI sectors, observe that graduates lack hands-on experience in state-of-art technologies, their training requiring significant resources.

5.5 LOW INTEGRATION IN ERA. DISCONNECTION FROM INTERNATIONAL RDI TRENDS

To date, Romania with 673 signed grants, (representing 2.97% of the total number of Horizon2020 funded projects) amounting EUR 183,3 Million (0.45% of EU total). has a low share of the H2020 funding. The success rate is around 11.96%, but the number of applications is very low (7060 applications, representing 1.12% of the total number of applications), which denotes the lack of interest in applying.

Romania has only six ERC grants (0.13% of the total), 105 MSCA (0.55%) and three EIC participations (0.18%).

The private sector, with 293 beneficiaries (of 75,42 Million Euro) has the highest participation (41.2%) among the RO beneficiaries of H2020 programmes in terms of the net EU contribution. It is followed by Public Research organisations (23%), HEIs (16,5%) and public body (8.6%).

The top performer in terms of number of projects is UEFISCDI (with EUR 9.33 Million). The two top beneficiaries in terms of EU net contribution are CLARIANT and SIVECO (followed by UEFISCDI)[108]. The top three Universities as number of participants are University Polytechnics Bucharest, University of Bucharest, Technical University Cluj (TUC). In terms of EU net contribution, the ranking change UPB still leading the ranking, followed by TUC and UB.

5.6 ECONOMIC / Market structural factors

Romania's competitiveness is affected by a weak R&I capacity doubled by the low demand for R&I due to structural factors.

5.6.1 Economic specialisation

Romania is specialised in labour-intensive, capital-driven and marketing-driven industries. The agriculture and manufacturing play a stronger role compared to other EU28 countries.

Wood & Furniture, Textiles and AgroFood play a major role in the national economy in terms of contribution to GDP, employment, exports. however they are "low skilled – low tech" sectors based on competitive advantages such as massive production capacities or low wages. The population working in agriculture is aging, the training level is very low, while the farm structure is dominated by subsistence and semi-subsistence farms lacking modern fixed and financial capital. (Popescu A, 2013 (a), (b)). The sector in terms of value added is dominated by multinationals. The country is

[108] https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/0c8af38b-b73c-4da2-ba41-73ea34ab7ac4/state/analysis/select/Country/Romania

a net provider of unprocessed agricultural products, requiring know-how, technology, innovation to become a producer of processed and value added products. R&D in Romania cannot assure more than 15% of the required vegetable seeds on the market, and this opens the way to FDI in agriculture. However, given the subsistence farming structure, the low training and technical endowment, lack of risk management strategies, further exacerbated by the recent extreme weather events frame agriculture as a sector with high potential for growth, but mainly unable to do the shift due to the above underlined features.

The R&D investments are concentrated in high, medium technology, accounting only for a small share of the total private companies. The innovative and knowledge-based development (high-tech and knowledge-intensive services sectors) in Romania has been relatively modest. According to the report "Analysis regarding the evolution and current state of the SME sector and business enviroment" (Analiză cu privire la evoluția și situația actuală a sectorului IMM și a mediului de afaceri din România), the time evolution of the SME industrial structure is not very favourable. The share of SMEs using advanced technology is low, decreasing from 2.7% in 2008 to 2.02% in 2017. The group of SMEs using advanced medium technology has increased its share from 6.94% in 2008 to 7.27% in 2017. Overall, these two groups shows a slight cumulated increase of 0.08%.[109]

The business environment has not succeeded to trigger the increase of the share of companies with high potential to create added value.

5.6.2 Size of the business

The potential for innovation of the private sector is related also to the business size structure.

The Romanian SMEs show very low innovation activity, with low, to null performance in all the components (product/process. marketing/organizational, innovating in house) (EIS, 2019).

On one side, **SMEs** and mainly micro and small companies do not have the financial strength to support and develop RDI department / activity for product/process innovation. Innovation requires also market research: it has to respond to a demand to create a new or improved product/ process. This requires competences and capacity in performing research on retails markets, partnership with major industry events, sophisticated market strategies. Many SMEs do not have the capacity to develop and implement these useful tools, particularly in the context of other significant pressures as the volatile legal framework, strive to find and retain employees.

On the other side, multinationals (MNCs), given the IPR provisions transfer the RDI results to the headquarters. '*Often the innovative projects are taken over by the large foreign companies, which bring them back to the Romanian market at much higher prices." (BI, ICT).*

5.6.3 Position in the value chain

The Romanian companies are mainly producers, with no significant roles in the other value chain segments. Romania has a growing automotive industry, with a network of suppliers and components manufacturers. Most of the Romanian suppliers work in

[109] POCA project Creșterea capacității administrative a Ministerului pentruMediul de Afaceri, Comerț și Antreprenoriat de dezvoltare și implementare a sistemului de politici publice bazate pe dovezi"code SIPOCA 5, http://imm.gov.ro/wp-content/uploads/2018/11/Sipoca5-R1.1.pdf

Joint Ventures with foreign partners, in which the Romanian party provides production facilities, utilities and engineering services, whilst the international car manufacturers bring in their brand, knowhow and services. The concept design takes place elsewhere, the national enterprises being involved just in their execution.

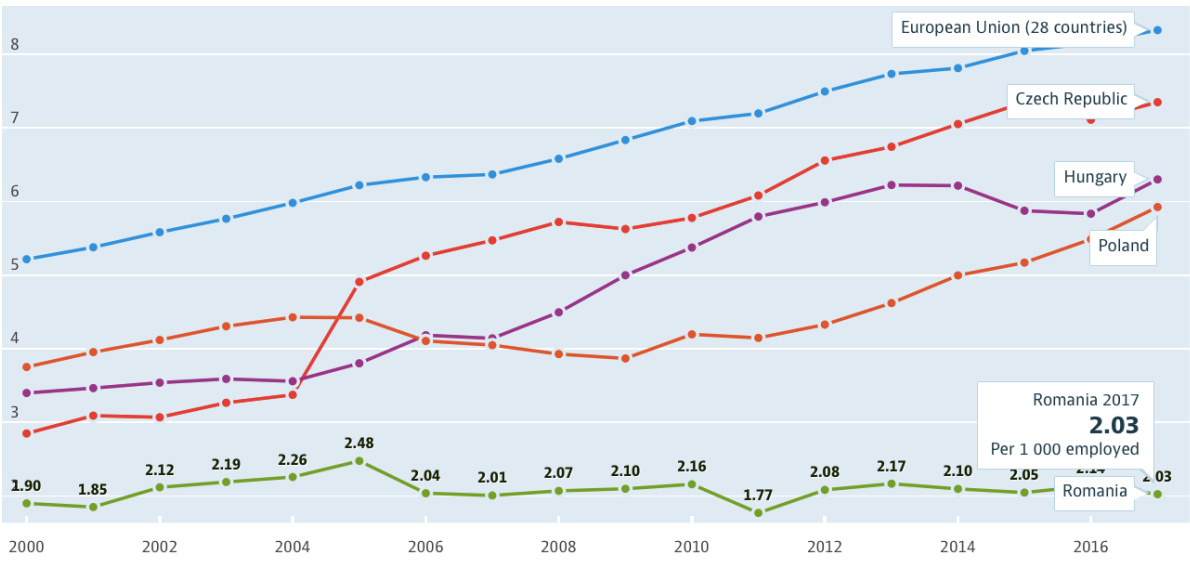
The survey respondents in the field of automotive parts and assemblies reveal that: "*The RDI activity in the production of harnesses is very concentrated within few global companies. None of the wiring developers in Romania develops new products, but works according to the client's desing plans.*" (SM, Automotive). From the perspective of the shipbuilding industry "*the RDI activities take place in the concept design, in which Romanian companies are not yet involved*." (SE, Shipbuilding). The ICT sector has a similar perspective: "*The national software development market is dominated by execution, by projects that come from abroad to be implemented here and less by the generation of new products." (V, ICT*). The same "monopoly of multinationals" is noticed also in agri-food. The Romanian market is very attractive, given that "*at present, R&D in Romania cannot assure more than 15% of the required vegetable seeds on the market - and this opens the way to foreign agricultural inputs*" (SE, Agriculture).

5.7 HUMAN CAPITAL

Human capital is the essential factor of competitiveness in a knowledge society, the main driver of development and economic growth and strongly influences the innovation level of society knowledge.

The share of researchers in the total working population is strongly correlated with the production of innovative solutions. Countries with high share tend to be also leaders in innovation. [110]

In Romania, the share of Human resources in science and technology (HRST) in 2018 was 27.9%, the lowest in EU (compared to 47.5 in EU and 36.8 in BG) (EUROSTAT, 2019). In the 2019 European Innovation Scoreboard, one of the weakest innovation dimensions is the Human resources and one of Romania's lowest indicator scores are on Lifelong learning. [111]



[110] Science, Research and Innovation performance of the EU, (2016) European Commission.
[111] the weakest sub-pillars expenditure on education as % GDP and per pupil

Figure 19. Time evolution in selected countries, over the period 2000-2017, of the number of researchers per 1000 employees (Source: OECD. doi: 10.1787/20ddfb0f-en)

5.7.1 Socio-demographic problems disrupting the labor market

Romania's population has been in a continuous decline, from 22.4 million to 19.5 million between 2000 and 2018. **There is a negative natural increase** (INSSE, 2019 Romania in Figures). On the short and medium term, mortality is not expected to contribute significantly to reducing the demographic decline in Romania. The birth rate and measures to reduce the emigration remain the components on which it could be acted with efficient outcomes (INSSE, 2019 – Romania in Figures).[112]

According to a recently released OECD study (July 2019), **Romanian diaspora is the fifth largest in the world** (after Mexico, China, India and Poland) and has the **highest growth rate** in recent years. In 2015/16, around **3.6 million**, 17% of all people born in Romania were living in OECD countries. Between 2009 and 2018, more than a fourth (26%) of Romanians living in Romania expressed a desire to permanently settle abroad if they had the opportunity. (OECD, 2019)

Companies try to adapt, try to attract talents from university, developing fully paid internship, policies regarding employees motivation, regular in class and online courses for professional improvement (MCR 2018).

Opportunity. While the workforce crisis is very deep and based on the demographic forecast may further exacerbate, it '*may create the opportunity for Romanian companies to shift the focus from competitive cost to extra value creation". If one of the country advantages was until recently the low cost base, investing in developing talents can create value added*. (MCR (2018), Interview Managing Partner Romania & Global AMROP University Lead).

5.7.2 Brain Drain

Around **760,000** (22% of the total national emigrants) highly educated Romanians live in OECD countries, In 2015/2016 Romania has the **highest emigration rate of highly educated. This increased more rapidly than the number of tertiary graduates in RO**. (OECD, 2019)

The number of physicians is low compared to EU averages: 2.8 doctors per 1 000 population compared to 3.5 in the EU. Although the number of nursing graduates and medical graduates steadily increased, there was also a high rate of emigrating health workers over the past years.

The brain drain is driven by many factors that are not necessarily related to the design of the strategic RDI policy. The brain drain can not be reversed without a coherent approach to tackle this phenomenon. The recent reform of the public wages attempts to tackle the most common causes of dissatisfaction, such as low salaries as well as low social status and recognition. However, these measures should be complemented by a consistent reform, tackling other reasons such as limited career development opportunities and the poor working conditions, the lack of equipment and supplies.

While the reversal and the control of the brain drain needs a consistent and coherent process, reflected in many policies, the RDI policy can take advantage of the Romanian diaspora. This can bring knowledge, expertise, can support networking.

[112] INSSE, 2019, Romania in Figures

Conference "Diaspora in Scientific Research and Higher Education Romania - Diaspora and friends" 2008, 2010, 2012, 2016

Romanian Diaspora tries to bring together Romanians residents and from abroad. Several editions of the conference Romanian scientific diaspora have been organised. The conference is organised by UEFISCDI, in partnership with ministries, agencies, private organisations, NGOs, brought together more than 4000 Romanians, working& living abroad, many top professionals in their field. The Conference creates the space for dialogue and cooperation.

5.7.3 Attractiveness of scientific careers in public system

To the best of authors' knowledge, there are no publicly available studies assessing on a rigorous methodology the attractiveness and the satisfaction of the academic and scientific staff. Nevertheless, some aspects should be considered.

In the context of significant reduction of the number of students due to the demographic decline, the decrease of the number of pupils passing the baccalaureate and the high number of Romanians studying abroad (to which still adds the long term effects of the Bologna restructuring), in many S&T fields the **academic staff schemes** are frozen, with **low chances of new openings or career progress**. Advancing to a higher academic position is not a promotion based on the mere fulfillment of the requirements but it is conditioned by the availability of teaching.

Given the unpredictability of the R&D funding, R&D institutions can not design long term institutional strategies, neither have the capacity to retain young staff. Overall, the discussion may switch **from attractiveness to limited opportunities to enter the system**. The relatively high number of PhD graduates during the 2007-2015 cycle, in the context of underfunded education and RDI system, the notorious plagiarism cases, triggered concern regarding the quality of PhD studies. The increase of the number of PhD holders had not been reflected in a similar HRST/researchers trend.

The input to the system is the lowest in EU28, yet according to some studies the scientific performance for career progression in many fields is evaluated against criteria 'to which academics in top world ranked universities may not comply'. The frequent changes of the regulation generated a system extremely heterogeneous and inconsistent with itself, across fields, academic positions, many of the current high rank academic staff being below the criteria against they evaluate their younger colleagues or compared to peers from other fields. (M CHIONCEL, RIO 2017).

A large share of the staff in HEIs, education, research and medical system remains underpaid, when comparing with EU28 and other national professionals in the public system (justice system, local administration, police). The salaries are prescribed in bands, with low flexibility for merit based deviation, therefore the financial capacity to reward the individuals is limited.

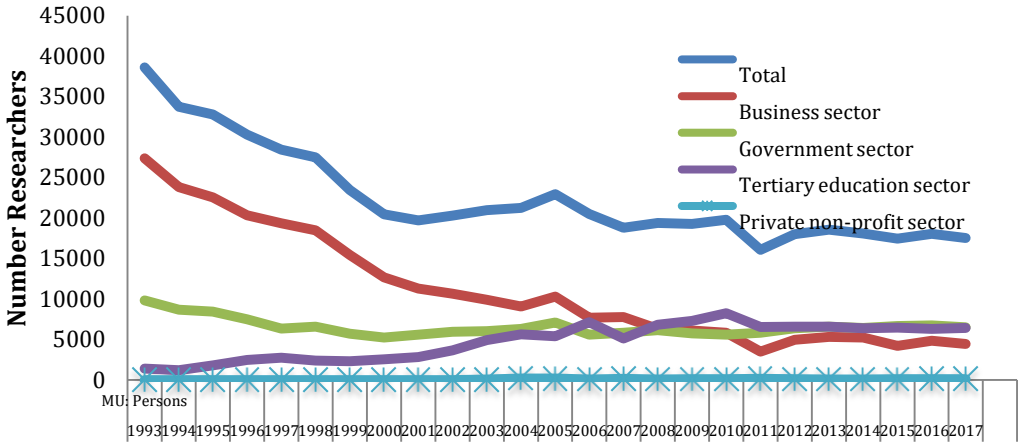


Figure 20 Romania: time evolution of the number of researchers, full-time employed[113] during 1995-2017 (source: INS).

5.7.4 Regional disparities. Hidden unemployment

Romania's prosperity is not equally shared. A large population (around 40%) is disconnected from the drivers of growth. '*Around half of it does not work, while other remains engaged in subsistence agriculture*" (World Bank, 2018). Most of these people live in poor rural areas, with very few job options, highly unskilled and own small areas of arable land, usually used just to cultivate their own food.[114]

Romania has at the same time substantial unused labour potential, and several groups such as young people, Roma, the long- term unemployed and people with disabilities have difficulties in accessing the labour market. (EC 2018 Country Specific Recommendation).[115]

Despite the emerging of a severe workforce crisis, governments have never designed effective policies/strategies to make these people interested in taking real jobs. **The lack of opportunities is not compensated by labor force mobility**. "*Low internal mobility further reinforces Romania's dual development challenge – less than 2 percent of the population reports having moved in the past five years, implying that structural constraints inhibit internal mobility toward economic opportunities*," World Bank experts point out.[116]

5.8 EDUCATION AND TRAINING

[113] The employees from the R&D activity are expressed not only as a physical number of persons, but also in a conventional measurement unit called full-time equivalent, which is based on the evaluation unit representing a person who works full time during a certain period and on the conversion of the number of part-time workers in a full-time workers equivalent, taking into account the hours of work dedicated to the R&D activity. The evaluation of human resources was performed as follows: - persons working full time in the research-development sector (90% of time or more). - persons mainly working in the research-development sector (50-90% of the time). - persons working part time in the research-development sector (less than 50% of the time).

[114] The latest official data

[115] http://data.consilium.europa.eu/doc/document/ST-9448-2018-INIT/en/pdf

[116] http://business-review.eu/business/hidden-workforce-almost-1-in-4-romanians-works-in-agriculture-the-highest-share-in-the-eu-202120.

A significant share of 18 years population will not reach the baccalaureate level, and even when succeeding the quality of the potential students will not be high. Early school leaving is overwhelmingly a rural problem in Romania: the dropout rate was about 1.5 higher in rural secondary schools than in urban ones. PISA 2015 showed that almost 40 % of Romanian 15 year-olds do not have a minimum level of basic skills, while socio-economic background significantly affects students' performance. [117] Many of the best go abroad and do not return.

The speed at which society evolves now comes with the concept of "life-long learning". Both children and young people, as well as adults, need to learn new concepts in order to be well integrated into society. Yet, Romania has the lowest level In EU in life-long learning.

The Ministry for National Education **has had over 27 education ministers since 1989**. Political change at the ministerial level is often mirrored by institutional re-organisations and policy changes. Although a Coalition for Education was signed by all the parties, there was no coherence and consistency in policy making. Frequent changes further aggravated the low funding level.

5.8.1 Low level and low efficiency of the Funding

The **underfunding of the education system** and the inefficient allocation of the low funds hold likely the most severe long term consequences on the whole society. In 2016, Romania invested 2.58% of GDP in education (EUROSTAT, 2019), significantly below the level (6%) stated by the national law of education.

Education in Romania is chronically underfunded, with spending per student in primary and lower secondary education less than one-third of the EU average (Eurostat, 2019). In 2016 (the latest EUROSTAT data available), the allocation per student in tertiary education (levels 5-8) was 2,330 EURO, the second lowest budget in EU (EUROSTAT, 2019). The expenditure has decreased in the 2006-16 period (0.08% and 0.05%), significantly below the EU28 average (0.47%) in 2016. The negative impact on the quality of education was demonstrated, among others, by poor results in PISA surveys (EUROSTAT, 2019).

[117] https://ec.europa.eu/education/sites/education/files/document-library-docs/et-monitor-report-2018-romania_en_0.pdf

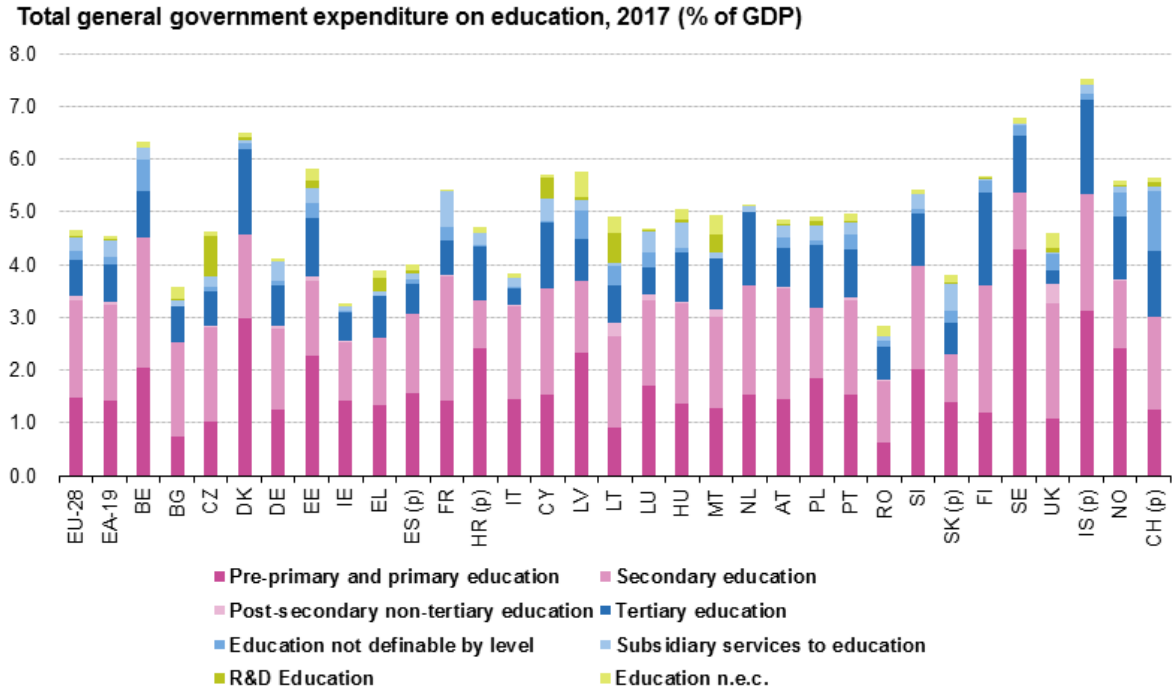


Figure 21. Total general government expenditure on Education, 2017 (Source: EUROSTAT)

Many schools in urban area are overcrowded, particularly those having a good reputation according to the results in the national examinations, while a significant share (60%) are underutilised (especially in rural areas).

School transportation services are overall insufficient and inadequate, while accessibility worsens as students advance through the school system. 38% of schools in rural areas have outside toilets, without running water or sewage (7 % in urban areas) and only 20% have a library (60 % in urban areas). (EC, Education and Training Monitor, 2018)[118]

Positive change will also require adequate resourcing.

5.8.2 Traditional and rigid system

5.8.2.1 Pre-university system

The challenges for the Romanian pre-university education system are the early school leaving rates and limited vocational training, reflected in the high number of young people who are not in education, employment or training. Dropout rates are high, especially in rural areas, and one in five students fail to make the transition to upper secondary education, recognised by many EU countries as the minimum level of attainment needed in a knowledge economy. (OECD, 2018).

The rate (18.1 % in 2017) of early leavers from education and training (ages 18-24) remains one of the highest in the EU, significantly above the EU average (10.6 %) and the national target for 2020 (11.3 %)[119]

[118] https://ec.europa.eu/education/sites/education/files/document-library-docs/et-monitor-report-2018-romania_en_0.pdf
[119] https://ec.europa.eu/education/sites/education/files/document-library-docs/et-monitor-report-2018-romania_en_0.pdf

Romania currently enables only a minority of its students to excel. And the high achievers, in the recent years are candidates for universities abroad and most often do not return.

International surveys point to severe deficiencies in basic skills among Romanian teenagers (EC, Country Report 2017. EUROSTAT, 2019 – PISA RESULTS). The proportion of 15 years old underachieving is high: in reading around 38.7% (compared to 19.7% EU average), in math 39.9%, in science (38.5%) The evaluation system put pressure on teachers to "teach to perform best in the test", which limits learning opportunities and narrows the curriculum and often penalise students' creativity (OECD, 2018). The desire to perform well in assessments (the national wide at the 8th and 12th grade) is a strong determinant of teaching and learning practice. Pupils are less focused on learning, and more on achieving high scores in the relevant subjects. '*The range of competencies and domains assessed does not provide for a rounded assessment of student learning, neither encourage learning across the breadth of the curriculum'*. (OECD, 2018).

5.8.2.2 HE system

Supply

Tertiary educational attainment (age 30-34) in 2017 was 26.3 % compared to 40.6% EU28. Romania faces important challenges regarding the decreasing number of students in tertiary education. The upward trend in student population during the period 1990 and 2008 started reversing from the 2009/10 academic year onward. **The number of students enrolled for bachelor's degree has sharply decreased by more than half in the 2009-2017 period**. The trend which is expected to continue in line with the decrease in the general population (INS, 2016). The sharp decrease in tertiary education, particularly in private universities and in the fields of social sciences, business and law, is mainly explained by stricter quality assurance mechanisms, which resulted in fewer private university programmes, lower passing rates at the baccalaureate and the high levels of emigration. It also reflects the demographic trend, the decreasing number of high school graduates who pass the baccalaureate exam and the reduction in years of study (the effects of the Bologna process implementation started showing after 2008/09). Other possible causes leading to a drastic decrease in the number of students include the high early-leaving rate in the pre-university education system and the phenomenon of emigration, which affects the size of the cohort that can reach this educational level.

In Romania graduates in **tertiary education per 1 000 population, aged 20-29 in STEM-related fields have decreased, from 17.6% to 14.4% in a short period of time** (2013-16). The trend is consistent with the overall trend of declining students in tertiary education (OECD, 2019 (c)).

The analysis of the evolution of pupils enrolled in first year of school in 2003/2004, up to year one in HE, shows that only 27% of the cohort reached the higher education, and only about 20% completed the first year of university studies. (UEFISCDI, 2018)[120]. Losses appear at every stage of the education:

- 17.64% of the students of the first class of the 2003/2004 academic year did not reach the eighth grade in 2010/2011 (repetition, dropout, migration, deaths);
- 4% of those enrolled in the eighth grade did not complete the secondary education and 6% of those who completed secondary education did not participate in the national assessment;

[120] UEFISCDi, 2018 Analiza datelor statistice privind accesul absolvenților de bacalaureat din 2015 în învățământul superior (RO), No.3, 2018

- 28.5% of those who participated in the national assessment in 2010/2011 did not complete high school education (12th grade);
- 28% of those who completed high school (12th grade) did not pass the baccalaureate exam;
- 29.3% of those who passed the baccalaureate exam in 2014/2015 did not enroll in the Romanian higher education in the 2015/2016 academic year;
- 21% of those with 10, and around 15% of those with mark 9-10 were not registered in the national higher education system;
- 25% of first year students failed to promote in the second year of study.

In 2015/2016, 42.22% of the first year students were enrolled in social sciences fields. Out of these, 36.37% were enrolled in public universities and 79.63% in private universities.

HES performance

A university does not merely prepare young people for the wide variety of roles in an innovative economy. its higher mission is to "discover and invent the future."

The culture of a university influences its success in producing innovation and can influence the culture of a region. Public investments are essential if universities are to fulfill these missions**.**

The Romanian **HE landscape** remains quite homogenous three decades after the change of the political system, although in some dimensions appears increasingly diverse. After 1989, the system expanded, many new public and private universities were established, although the public funding remained low. In 2018, there were 93 accredited Higher Education Institutions (HEIs) (55 public universities). Although diverse as size and coverage of specialties, the universities are almost identical in their organizational structures and have very similar programs in the same subject, partly due to overly prescriptive accreditation regulations. They offer "Bologna-type" bachelor degree, master and PhD programs – and little beyond this. Romania has very low engagement in lifelong learning, far below the EU average and the 'distance' or "open" education programs are limited as numbers and questionable as quality (Andreescu L., et al, 2015).

The universities have in theory full freedom to manage their research budget and design research agendas, however, this in practice is limited due to budget constraints. The allocation of funds is not based on performance criteria, although the system is highly polarised, with few universities pooling most of the research results (see 4 top Universities).

In 2018, four universities were listed in the 1000 Top QS[121] (and only one, in top 750). None of the Romanian university has ever been included in the Shanghai top 500[122]. However, in 2018, two universities entered the Shanghai top 1000. The poor standing of Romanian HEIs in international rankings signals the low research productivity in international comparison, partially generated by the chronic underfunding and lack of block funding for research (since 1990).

Block funding for universities is provided only for education activities, through contracts between the Ministry in charge of Education and the individual HEI. The allocation is mainly based on per capita allocation and some share based on performance. The financing arrangement has been criticized for dissipating funds among too many universities, in the absence of appropriate mechanisms for rewarding the quality of teaching and research or responding to societal needs.

[121] http://www.topuniversities.com/university-rankings/world-university-rankings/2016
[122] http://www.shanghairanking.com

HEIs obtain funding for RDI activities only through project based competitive funding, open to all R&I actors. The R&D performed by HES counts in 2017 to 11% of GERD (compared to 32 % by the NRDIs). However, the HEIs are the top producers of scientific output (Thomson, 2015).

Disconnection from labour market

The higher education is disconnected from the labour market (according to interviews with stakeholders from private sector). There are 14.4 graduates in STEM for every 1000 people aged 20-29, compared to an EU average of 19.1. The number of new graduates in science and engineering for every 1000 people aged 25-34 is decreasing. Employers report that students and graduates entering the labour market often lack key socio-emotional skills and possess sufficient, though overly theoretical, academic skills (WB, 2018)[123]. The supply of skills is not keeping up with the needs of the economy. Low attainment levels in basic skills and digital skills have an adverse impact on competitiveness, employment and convergence (EC, 2018 Country Specific Recommandation).

The structure by specialization groups of students enrolled in higher education (bachelor's, master's, doctoral, postgraduate or postdoctoral programs), in the academic year 2017/2018, shows that most students were in: (1) business, administration and legal studies (23.8%), (2) engineering, processing and construction (21.0%), (3) health, social assistance (13.8%). In the private sector, the highest percentage was in business, administration and law (57.0%). (INS, 2018)[124]

Biological sciences&biomedicals studies, mathematics and natural sciences (the two groups gathering also students with the highest scores in baccalaureate) and engineering students are outnumbered by the students in socials sciences and humanist science and arts (54142 vs 64047). These figures are an indication of the alignment between smart specialisation domain and the human resources supply.

Regarding the quality of the students, two important aspects are to considered: (a) a significant share of the best performers in baccalaureate (21% of those with 10, and around 15% of those with passing mark 9-10) were not registered in the national higher education system; (b) 25% of first year students fail fail to succed to the second year of study. No additional data are available regarding the number of those who finalise the studies vs the number of those registered in the first year. Many of the top performers go abroad. While per se, this could be a strength, it changes into a weakness since the large majority does not return.

The low quality of training for applied research of young graduates is highlighted also by the Mid term evaluation of SNCDI 2020 *‚The lack of alignment at a strategic level of the competences and skills that are increasingly demanded on the market should be covered both by the education system and by a strong public-private partnership.'*

The faculties have the right to propose study programmes, the language of instructions and number of students, but these must be approved by the Ministry of Education. However, the number of state funded places is not determined by labour market forecast studies but rather follow an inherited pattern, associated to the number of staff. The students' demands for certain degrees is not necessarily determined by realistic possibilities of working in the chosen field.

The supply of PhD holders does not match the absorption capacity of the RDI labour market. The number of new doctorate graduates has varied, increasing significantly in

[123] WB (2018), World Bank, From Uneven Growth to Inclusive Development Romania's Path to SharedProsperity, Romania Systematic Country Diagnostic. Systematic Country Diagnostic, Washington.https://openknowledge.worldbank.org/bitstream/handle/10986/29864/9781464813177.pdf?sequence=2
&isAllowed=y

[124] INSE, 2018. Romania in figures

line with the implementation of PhD doctoral programmes funded through ERDF during 2007-2013. However, the increase over that period of the number of PhD holders was not reflected in a in increased number of researchers/ HRST. The quality of the PhD theses has been under significant debate given the famous, past plagiarism cases.

Curriculum in HE

The interviews performed with relevant stakeholders (SIPOCA 27 survey conducted by UEFISCDI) highlight that there is an acute shortage of workforce in general, and even more of well trained workforce/ with relevant research skills. The curriculum is outdated and unadjusted to the market needs (as highlighted by many of the stakeholders): "*The school is disconnected from industry*." At the same time, the respondents also observe that '*the attitude and the theoretical background were better before. Young people are missing that drive and passion. It is very important to develop partnerships to work together and inspire the passion for knowledge."*

Law 258/2007 on the industrial training for students stipulates the framework and the obligation to carry out the training. The lack of financial instruments to cover the usage of the equipment and the time allotted by the private sector sraff to the training activities affect the quality of these training stages.

The accreditation of the undergraduate study programmes is based on the evaluation performed by ARACIS, or any other agency registered in the European register for the quality assurance in Higher Education. The long procedures for accreditation, the underfunding of the system (lack of infrastructures and often of interest given the scarcity of funds), the lack of collaboration in designing training agenda between HEIs and private sector led to misalignment between the skills acquired in universities and those requested by private sectors. Often the innovative sectors (i.e IT) develop faster than the curriculum given the slow accreditation process. RDI centres have modern technologies on which graduates do not have hands on experience.

5.8.3 Regional disparities

Low skills and early school leaving are concentrated among students from socio-economically disadvantaged backgrounds. With 70% of the poorest population living in rural areas, educational inequities in Romania are closely associated with disparities between rural and urban areas. As students' progress through the education system, the significant underrepresentation on of rural youth worsens (National Strategy for Higher Education (NSHE, 2018))**.** Roughly 45% of all Romanian youth live in rural areas, but only 24% of students in tertiary education come from rural areas.

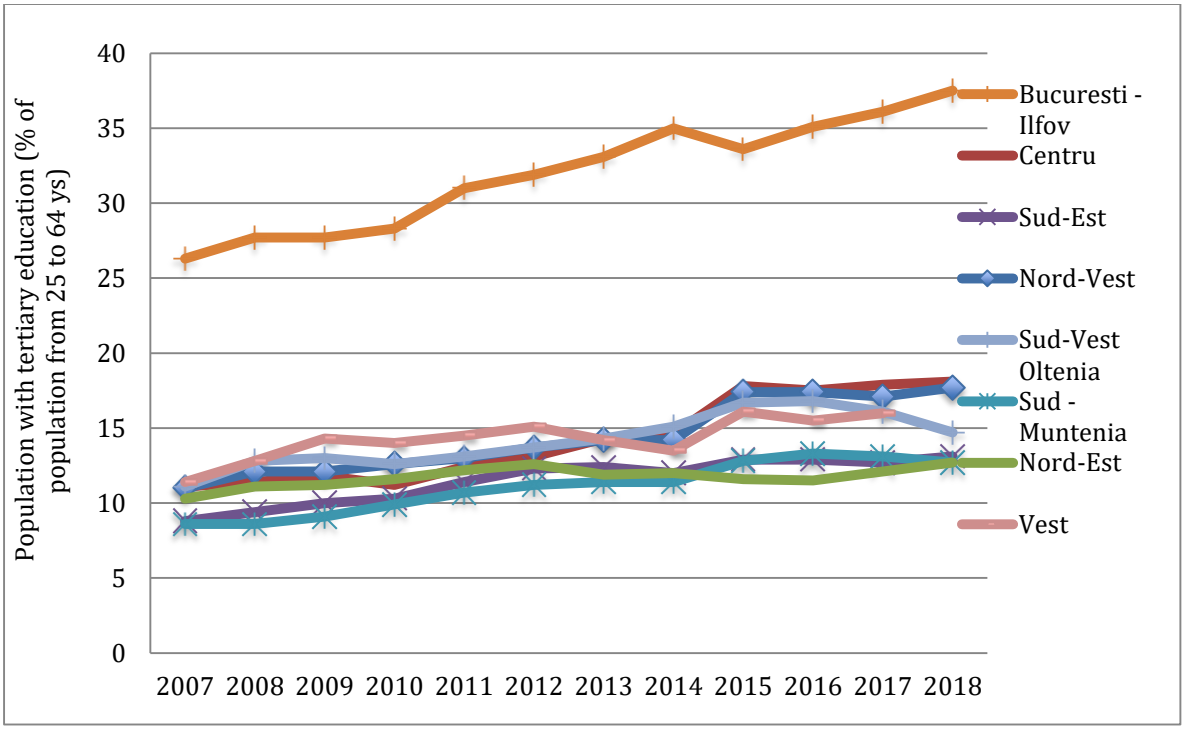


Figure 22. Time evolution of tertiary educational attainment, age group 25-64 by NUTS 2 region (Source: Eurostat)

If the share of early leavers is 8% in Bucharest (2018), this increases to 21.3% in South East, 19.5% N-E, and 18.8% Centru Region, closely related to the level of poverty.

5.8.4 Limited vocational training and life long training

The participation in long life training is very low (EUROSTAT, 2019). The labour market relevance of vocational education and training (VET) is still a challenge (EC, 2018). Romania's participation in continuing vocational training (CVT) courses as a percentage of persons employed in all companies is of 21%, below the EU28 average of 41%. The limited availability of vocational and life long training is also highlighted by companies, which often try to compensate the limited public support (MCR 2016, 2017, 2018). In the search of adequate skills and human resources, the companies which can afford this, started offering more competitive packages, that include in-house training.

Recently, legislative measures have been implemented to support dual education and lifelong learning.

The Emergency Order no 81/2016 regarding the revision of the Education Law no.1/2011 provides the legal framework for the professional and technical education, including the dual one (Romanian Government, November 2016), while the Law no. 176/2018 provides the framework for internships. Based on the data transmitted to the National Authority for Initial Vocational Training in Romania (ANFPISDR), at present, at national level there are 177 units of dual education (compared with 73 school units in 2017)[125]. In 2019, more than 500 economic operators were involved in the dual system.

[125] http://adev.ro/pzg4z9

The recent implementation of the vocational training may release some of the labour skills shortage. However, the early school leaving rates and limited vocational training remain, despite recent efforts, significant challenges of the Romanian pre-university education system.

5.9 LEGISLATION/REGULATION/TAXATION

5.9.1 Lack of predictability of the legal framework. Risky business environment

Groupama Asigurari's Risk Assessment which analysed the risk perception among 1500 Romanian managers identifies that the unpredictability of the legal framework, the unstable legislation, regulation and competition are cross-cutting factors that strongly affect the business environment (Major Romanian Companies, 2018).

The National Council for Small and Medium Private Enterprises in Romania (CNIPMMR) analysed the changes made by the government **in 2017** to the legislative framework and concluded that **1,388 normative acts were adopted**, respectively 278 laws, 117 ordinances of emergency, 30 simple ordinances and 963 Government decisions. To these are added the 3,344 orders issued only by the Minister of Finance and 1,907 orders issued by the Minister of Labor."[126] These practices increase bureaucracy and cause additional pressure particularly on small businesses, who have limited capacity to manage bureaucratic procedures and adapt to frequent legislative changes.

Ensuring a stable and predictable legal framework, reduction of the bureaucracy and of the tax burden are key elements to ensuring a competitive business environment. Ensure legislative stability and improve predictability support business and investment planning. Legislation has been constantly highlighted by the business community as a hindrance to the development of the current activity or in making new investments. This limits the companies' capacity to focus on development and innovation.

5.9.2 Taxation

The predictability and the transparency of the taxation system in Romania remain a significant problem. In the last 10 years, good progress has been made in this direction – the number of adjustments and amendments of the tax legislation has decreased. The hope is that this number will go further down in the next years and that any changes will be announced with more time in advance, so that taxpayers may adjust their expectations, business models and plans in due time.

The Romanian economy has been the subject of a major tax cut in 2015. The VAT decrease from 24% to 9% for food and non-alcoholic drinks led to retail prices dropping and therefore contributed to the consumption. Smaller taxes mean more money to reinvest that can be beneficial to the economy overall. However, there is concern that even apparently good decisions are taken without prior impact assessment and this may mean unsustainable decisions on long term that can induce new wave of instability.

Concerns regarding the fiscal developments are usually strongly correlated to the fundamentals of the Romanian economy, its strengths and weaknesses (like reliance on consumption), the nature and sustainability of the current GDP growth, the increased volatility.

[126] POCA project Creșterea capacității administrative a Ministerului pentruMediul de Afaceri, Comerț și Antreprenoriat de dezvoltare și implementare a sistemului de politici publice bazate pe dovezi"code SIPOCA 5
https://www.digi24.ro/stiri/actualitate/politica/consiliul-imm-urilor-in-2017-290-de-modificari-la-codul-fiscal-861338

5.9.3 High and complex administrative bureaucracy

Excessive bureaucracy suffocates small entrepreneurs: they do not have the time, human and financial resources to go through the procedures required for licensing, authorization, filing of statements etc. The reduced digitization of all operations carried out by companies in relation to public authorities, many redundant documents requested by public authorities, and frequent declarations to be submitted to ANAF limit the companies' capacity to devote time and resources to business development.

Overly cautious or burdensome regulations affect the innovation. Many studies lead to the same observation: main challenges for Romanians entrepreneurs remain bureaucracy, excessive taxation, excessive controls performed rather in a punitive manner. Access to, and implementation of projects funded through public funds, particularly structural funds and those for public authorities have the disadvantages of cumbersome and time-consuming procurement process and heavy bureaucracy in proposal preparation and project implementation. Entrepreneurs do not have the education and knowledge they need to apply for the funding offered through various schemes, funded either by national or ERDF money. Excessive bureaucracy related to project implementation, lack of the knowledge required to write a proposal, the high costs required by consulting firms are barriers to access such funds by small entrepreneurs.

5.9.4 Market/business competition

Most CEOs, from large companies/multinational (as resulted from analysis of MCRs reports) and SMEs (as resulted from the interviews performed by UEFISCDI) underline the impact of a highly competitive business environment. Competition although can be a driver for growth, if adequate and fair competitive framework environment is not provided, it can inhibit the development of newly arising companies, which may not have the force to compete with well established enterprises, particularly in the context of the workforce crisis and fluctuating legislation.

SMEs can not compete with the wages offered by MNCs, and MNCs and SMEs altogether, find a strong competitor in the public administration, since the recent salaries increase in this sector. Often SMEs invest significant time and money in training young graduates, but fail to have a good long-term staff retention rate, due to the fact that "*it is very difficult to maintain wages at a competitive level compared to large companies*" (C, ITC). The issue of the competitiveness of the salaries in relation to big companies is felt especially among the respondents from the ICT sector.

MNCs have the financial strength and why not say the know-how, capacity in planning long term strategy and in providing competitive advantages to their employees. In the context of the workforce crisis, particularly from this segment of large companies, there has been an increasing trend of competitive packages including well being of the employees, looking beyond wages: flexible working arrangements, medical support, in house training, access to sport facilities. It can be seen as a positive shift, however slow, towards quality of life in broader terms.

"The macro economic success of Romania relies heavily on how successful Romanian companies are at microeconomic level. Companies these days have to perform in a ***very complicated and unpredictable environment****. This* ***requires a highly competent and sophisticated corporate governance which not so many Romanian companies have used so far****. Confronted with the scarcity of the domestic capital, Romanian companies have no other choice but to compensate for this*

*by having a state of- the-art corporate governance which would help them utilize, in the most efficient way, the available resources for maximum res*ults. (A Craciun, MCR)

From SMEs' perspective, the MNCs "*inhibit entrepreneurship" (BI, ICT),* because they have much higher financial strengths*: "The salaries are above average in multinationals, the working conditions are very good and those who have entrepreneurial "spirit" prefer not to go on their own*" (W, Automotive). Under these circumstances, the conclusion of an entrepreneur is that "*the tendency is to transfer the High-Tech activities to companies with foreign capita*l." (SW, Electronics - UEFISCDI survey).

5.9.5 Intellectual property

Romania had a number of regulations on Intellectual Property (IP) with several contradictions on invention ownership, use and its transfer, creating negative views among domestic as well potential foreign investors. The IP regulations favored the individuals until 2014, when the amendments of the law governing patents was changed. The Law no. 83/2014 regarding service inventions, regulates the status of inventions created by an individual/group of inventors when the individual inventor or at least one member of the inventor group is employed by a legal person of public or private law in Romania. The law aims to stimulate technological innovation in Romania.

According to Start-up Nation study prepared by CNIPMMR 2019[127] a large majority (around 97.4%) of the companies do not have a form of protection of the IP.

According to the Thomson data, the national IT and automatisation are the sectors with higher patent activity. Besides the national advantage, this may be also generated by the short product lifecycle and the effort to control the sector. The balance between patents awarded to business versus individuals may be also a result of the change of IP regulations in 2014.

Pharmaceuticals poses specific difficulties since it takes a long time for innovations to reach the market. RDI stakeholders in the field complain that public support for RDI is provided just for initial phases of the research. Most often the research results do not reach even the first stage of trials given the lack of funding.

The MNCs usually move the IP to the country where they move their company (headquarters). This process usually happens at the investors' request. There is no real incentive to maintain IP in Romania.[128] ICT and automotive industries, in particular, comment that the *R&D results in MNCs are transferred as intellectual property to the headquarters. we have to find a solution to keep the IP rights in Romania*" (C, Automotive).

Entrepreneurs who considers IPR a barrier highlight the high patenting costs, the "*lack of support for the preparation and filing of patents by the Romanian State Office for Inventions and Trademarks*" (C, Pharma) or "*the low capacity to exploit the patent to its real value*" (SE, Biotechnology).

Product certification and approvals, as well as conformity of production pose additional challenges to the innovative entrepreneurs: "*the whole process is expensive. the cost of all certifications and approvals for a new cosmetic is about 800 euro*" (NE, Pharma), "*we do not have the necessary time and money to go through the certification process*" (NE, Biotechnology), "*for financial reasons, a large number of new biological creations were not certified and patented. in time, they have been lost or were "adopted" by the competing companies from abroad. the Romanian market is now "invaded" by seeds*

[127] http://cnipmmr.ro/wp-content/uploads/2019/05/CATALOG-INTERIOR.pdf
[128] Manual of good practices for applying the legislation on service inventions (UEFISCDI 2015) can offer some support

produced by private companies that use our creation under other names, thus infringing the copyright law." (SE, R&D Centre).

5.10 LIMITED Financial support for business investment

The prevalence of venture deals reflects both the availability of, and demand for, funding for SMEs aiming to grow. The OECD (2014) emphasizes the importance of venture funds not only as a source of funding, but also in stimulating entrepreneurship, supporting young companies and replacing or complementing traditional bank finance. Businesses have little motivation to invest in R&I, most of them neither have the financial strength to invest in RDI, preferring to import technology. While the private sector is in general reluctant in taking financial risks which arise from R&I, financial services and instruments to mitigate the risk have been hardly available. (Chioncel M, 2017).

In Romania, access to financing for SMEs is limited due to both supply- and demand-side constraints, the SMEs being perceived as risky for banks due to their high share of non-performing loans.

The **venture capital** (VC) market is at incipient stage, with few visible venture capital providers on the market. In 2018, in Romania, the venture capital investments intensity, less than 0.001% of GDP, was the lowest in EU28. RO ranks slightly better in terms of aggregate deal value (the 26th position) and number of deals (the 24th position) (EC 2018, Annual Report on European SMEs 2017/2018**)**. Financing (VC, business angels etc.) is available mainly for pre-seed and seed stages via EIF-backed funds. As the advantage of low labour cost is fading out, there is a risk that some companies (particularly ICT) will disappear. These companies need to develop new business models, integrating innovation and should have access to business angels funding.

Business Angels, allocate, on average, between €10,000 and €200,000 in companies in ICT, innovative technologies under predefined conditions, and taking a high degree of risk. In 2016, the IT & C sector remained the main economic sector beneficiary of these types of funding, being closely followed by the medical and media field. These Business Angels have not benefited from benefits tax for any gains generated by such investments. [129]

Although the RO market for **corporate venture capital** (CVC) is still in its early stage, the national startup ecosystem is beginning to become more attractive to such complex investors.

There are a number of domestic **crowd funding platforms**.[130] However, most projects raise minor amounts. According to the statista portal[131] , the transaction value in the "Crowdfunding" segment amounts to US$0.9m in 2019.

Access to both early stage and later stage funding, as well as to venture capital are among the challenges to innovation identified by the companies participating in the UEFISCDI survey ("*the investors for the 10-100,000 Euro market are missing*" while other respondents point to the fact that "*there are no business angels in the area, no persons or financial entities to appreciate if an idea is good and could generate high revenues at a later stage and to invest in it.*"

[129] http://www.revistadestatistica.ro/supliment/wp-content/uploads/2018/02/RRSS_02_2018_A4_EN.pdf
[130] http://crestemidei.ro. http://multifinantare.ro, http://www.wearehere.ro, http://potsieu.ro. http://www.kazuu.ro/. https://www.sprijina.ro
[131] https://www.statista.com/outlook/335/148/crowdfunding/romania#

5.11 Low culture for innovation

Innovation tends to take place in an environment characterized by an entrepreneurial spirit, a variety of supporting institutions, adequate funding, and the creation and exchange of ideas. Openness to new ideas and tolerance for failure are important features of a culture stimulating innovation. "*The lack of education of the entrepreneurs in the industry and the mentality of many to make a quick profit, the resistance in adopting new technologies and the lack of knowledge in the field is observed in the large number of bankruptcies" (MCR).*

Bringing innovative ideas to market takes time, requires a culture that supports innovative ideas and people. Innovation requires also educated customers: poorly educated clients prefer to copy existing concepts. The ability of a community to take risks is crucial to innovation.

There is a reduced demand for new and innovative products and services, due to tlack of market maturity. Not only that the national clients may lack sophistication, and are less receptive to new ideas, domestic companies consider that the purchase power of the Romanian customers is low, often preffering cheaper but less quality products from import. *Customers are perceived by the innovative entrepreneurs as "poorly educated", "reluctant", "lacking openness to new concepts", "having unrealistic expectations" and "adversity at risk", "high appetite for imported products" and "lack of interest for innovative products*" (UEFISCDI survey)

The 2019 Startup Barometer[132] gives solid evidence that one of the main obstacle of the ecosystem is the fear of failure.

Analysing the drivers for innovation as identified in the NESTA study (Hughes et al. 2011),[133] the national innovation culture can be assessed as weak, the working environment in the public system remains rigid, lacking openness for new ideas and incentives to support them. This is the mixed result of rigid mentalities, scarce financial, time and human resources, very rigid administrative frameworks that hamper the creative thinking, little awareness of the value of innovation, lack of strong leaders who can induce the cultural shift, all of these resulting in apathy and indifference.

Neither the education system, both at pre-university and university levels, creates a good seeding environment for innovative behaviour and creative ideas. The system has remained very traditional and rigid, the curricula focusing on memorisation, extensive extra-school work and lacks the creativity component. The heavy weight of national examinations leaves little space to more individualised approaches to learning. Often creativity is penalised rather than encouraged. The system remains heavy and rigid, creative thinking being rather penalised by the rigid evaluation system, a system which can not put the seeds for the shift required for a culture for innovation.

The entrepreneurial education/activity is still at incipient stages, yet more developed in Technical Universities, mainly due to their training orientation, providing education to the future engineers/managers/entrepreneurs. Although some universities may claim that they integrate the entrepreneurial education, the extent is limited due to lack of tradition and availability of human resources.

The barriers regarding the entrepreneurial culture are generated, from the perspective

[132] https://www.impacthub.ro/barometrul-startup-urilor-2019/

[133] Open culture, staff share experiences, Managers prioritize innovation, Managers support testing of new ideas, Staff understand the value of innovation, Space for creative thinking, Ability to operate independently as a team, Allow time for projects, Dedicate funds Allocate the right people.

of the respondents, *especially by the education environment, the absence of a ‚culture of failure' and "the fear of starting the development of a product because it costs money and time*"

6 DIGITIZATION

6.1 PERFORMENCE

Enhancing digital literacy, digital skills, connectivity, and the usage of online commerce, services by the business, public and users community, the adoption of digital technologies are important drivers in generating jobs, labour productivity growth and the overall development of a digital economy. Romania, with an overall Digital Economies and Society Index DESI[134] score of 36.5 (compared to 52.5 of EU), is part of catching up cluster, ranking the second lowest in EU28. The performance has slightly improved in almost all of the DESI dimensions, but the progress is slow (Digital Economy and Society Index (DESI, 2019)) and the growth rate is lower than in other EU countries. Only a fraction (42%) of businesses is digitally active, and only 33% Romanian workers use a computer in their daily activities, while the number of Romanian businesses that sell products online is even lower (7%).

Human capital. More than one fifth of Romanians have never used the internet, partially due also to the low share of people with at least basic digital skills (DESI 2019). Only 29% of people aged between 16 and 74 have basic digital skills (compared to EU28 average of 57%) and 10% have advanced digital skills (against an EU average of 31 %). Romania also has the lowest ICT usage rates amongst the internet users in employment. Across competence dimensions, the largest skills deficit, both among the active labour force and the population at large, relates to the use of software for content manipulation. In 2018, Romania has also one of the lowest shares of ICT specialists in total employment (2.1 %). The ranking improves to 16th position, with regards female ICT specialists in total employment (1.3 % of women in employment, slightly below the EU average of 1.4 %) and has the third highest share of women among all ICT specialists.

Connectivity. Romania performs best in the Connectivity dimension (ranking on the 22nd position), due to the wide availability of fast and ultrafast fixed broadband networks, however with a strong urban-rural divide. Although the coverage with fixed lines (89%) and mobile (63%) is below the EU average, 70% of the connections are fast and the costs are low. A significantly higher ratio of homes (55%) subscribe to fast broadband than the EU average (41 %).

Use of Internet. Romania continues to be on the lowest position in EU: 21 % of individuals aged 16-74 have never used the internet (compared to the EU average of 11%). Yet, it is on the top position when it comes to use of social networks (86 % of internet users compared to 65 % in the EU28). Romanians used video calls (51 %) also above the EU average (49 %). However, the use of banking, shopping as well as music, videos and games (10 %, 26 % and 63 % respectively) is below the EU average.

Integration of digital technology. Romania did not improve in this dimension in the last two years. In 2018, Romania is placed on the 27th position in the EU28 ranking, well below the EU average. Only 9 % of Romanian enterprises are using social media

[134] The Digital Economy and Society Index (DESI) is a composite index developed by the European Commission (DG CNECT) to assess the development of EU countries towards a digital economy and society, aggregating a set of relevant indicators structured around 5 dimensions: Connectivity, Human Capital, Use of Internet, Integration of Digital Technology and Digital Public Services.

(compared to 21 % EU average), 7% use the cloud services (compared to 18% inEU28). A larger share uses big data analysis (11 % versus 12 % EU average), where the country ranks 14th. In 2018, only 8 % of total SMEs are selling online (against an EU average of 17%) and even less (2 %) of them are selling online cross-border (8% EU average). The e-commerce turnover is also low (5% against 10% in EU28). In 2018, e-commerce in Romania grew 30%, reaching a total of €3.5 billion. This represents the highest growth in Europe for the second consecutive year, demonstrating the huge potential for developing online stores in the country. [135]

Digital public services. Romania's rank decreased each year one position since 2016, dropping to the lowest position in 2018. Certain indicators, as the interaction between public authorities and citizens, are better. With 82 % of internet users versus 64 % EU average, Romania ranks seventh regarding e-government users. This contrasts with the low scores for pre-filled forms and online service completion, which could indicate a systemic problem with the quality and usability of the services offered. Although the use of medical data exchange is low (19 % of general practitioners versus 43 % EU average), but e-prescription services are more widespread (39 % versus 50 % EU average). Romania is just slightly below the EU average as regards open data policy and the national open data portal (62 % versus 64 %).

According to Barometer of digitization in Romania 2018, things are improving. In 2018, 46% of companies, compared to 60% in 2017, did not make digital transformation the central part of their business strategy. In 2018, 60% of companies vs. 37% in 2017 of the responding companies say that they have taken advantage of the digitization to have a competitive advantage. 50% (2018) vs. 46% (2017) say that reducing costs and simplifying processes are the benefits of integrating the digitization process. A large share of companies say that the main obstacle to digitization is the fact that they do not have 'digital' consumers (40% in 2018 vs. 55% in 2017).[136]

6.2 Obstacles for digitization

Romanian ITs are employed in top tech companies, high school pupils are among the best performers in international IT competitions and are accepted in top IT universities. But RO ranks on the 27th position among the EU28 MS as aggregated DESI score. The paradox of the RO economy.

Romania adopted its National Strategy on the Digital Agenda for Romania for 2020 (SNADR) in February 2015. The SNADR is the steering document for all digital matters, including digital skills. The strategy focuses on: providing ICT infrastructure in schools. developing pupils' and teachers' digital skills. using ICT in the learning process and in lifelong learning, updating the ICT skills of public administration staff, and ensuring e-inclusion by developing digital skills and e-skills. In 2018, the Romanian Government launched the tender for a project entitled 'Wireless Campus' - a national integrated platform that will provide wireless internet in 4,500 state-run schools. The project will get a RON 117 million (EUR 25 million) financing from the ERDF and RON 32.8 million (EUR 7 million) from the state budget. All, are recent developments, the implementation and the impact still to be observed over time.

Barriers in Human capital dimension. The country has **very good IT specialists**, **but they are too few**. The country ranking in terms of graduates (17th) decreases to 27th in the number of employees. Many of the best go abroad.

[135] https://www.eu-startups.com/2019/07/romanian-startup-blugento-raises-e1-million-to-scale-its-e-commerce-solutions-internationally/

[136] Barometrul digitizarii, available at https://valoria.ro/portfolio/barometrul-digitalizarii-companiile-din-romania-2018/

An important share of its student population still does not reach basic levels of competence and leave school before graduating from upper secondary education. One of the specialisation in high schools is mathematics-informatics. Some of the high schools have a very strong reputation in international IT competitions. Yet, this represents a small share, and the human capital is lost for the country since most of these graduates go to study abroad and do not return. As with the rest of education, while the top students in Romania have high performance, a large bulk of them in the context of heavy curricula, lack of interest from teachers and students altogether, lack of school IT resources, will not acquire the basic competences in general, and IT skills in particular. If to this, we add the high drop out share, the results are not positive despite the good fame of the national IT school.

A 2016 study for the Orange Foundation showed that almost all rural schools have a minimal technological endowment (internet, computers).The report also showed that most of the students already have access to the internet at home and the main problem is related to the lack of trained teachers who can use the internet in the act of teaching. "*The new technologies are used at a relatively limited time. there is a need for training in the digital area*".[137]

Box. Opening Opportunities

This is a mentorship program, in which IT experts mentor teams of high school pupils in computer science, product development, and team work in less -developed regions in Romania. The program is developed by Asociatia Techsoup, in which enthusiast professionals, support teams of high schoolers in developing tech products and learning what team work is all about.

The program creates the context for a meaningful first-time interaction with app building, with mentors from the IT industry as main drivers of inspiration. It was created for students aged 15-18 who don't share the same opportunities of becoming creators of technology as others. https://www.openingopportunities.ro

The number of ICT places in public universities is limited and there is a lack of ICT graduates. Several Romanian universities have started offering online courses (MOOC), while several private companies investing in digital skills, offer IT specialisation programmes. There are several initiatives from the private sector.

BOX Google Digital Workshop hub[138]

In October 2018, the University of Bucharest, together with Google Romania, launched an innovation hub for digital skills, the Google Digital Workshop hub.

[137] https://www.edupedu.ro/guvernul-pregateste-mega-contractul-de-209-milioane-de-lei-pentru-wireless-in-scoli/

[138] https://unibuc.ro/free-programming-classes-and-support-for-startup-development-offered-to-the-students-of-the-university-of-bucharest-in-the-new-hub-google-digital-workshop/?lang=en

Google partnership with the University of Bucharest, the Technical University of Cluj-Napoca and the Polytechnic University of Timișoara will evolve into two directions: free programming classes (Java, Android – beginners, Android – advanced).

The tax exemption provided for IT professionals in the country aims to retain the ICT specialists. There is an overall low level of life-long learning that could help many adults to gain the relevant digital skills. .

The low GDP per capita, the level of attainment in education ("*the main obstacle to digitization is the fact that they do not have 'digital' consumers*"), the poverty level, particularly in rural areas, significant regional disparities in GDP per capita, insufficient implementation of the SNADR, all are factors that affect the RO digital economy.

"Digitalisation and open data are key drivers of innovation today. We highly recommend that the Romanian government builds its entrepreneurial ecosystem based on e-government and support for digital start-ups, induces transparency by opening access to data it owns, and stimulates digital transformation at all levels of education," (Daria Tataj, H2020 PSF expert)[139]*.*

Connectivity

This is the only major criterion in the DESI index that Romania is not in last is connectivity. Romania has the highest share of ultrafast broadband subscriptions– approximately 1.7 times the average for Digital Frontrunners, according to McKinsey study.[140]

Yet, 10% of the population of Romania does not have access to internet connections, largely because their connection is not economically viable. For a faster transition to a digital society, the government must develop policies to cover these areas (the RO-NET project being one of them. the project supports deployment of backhaul networks in 'white areas' and was granted ERDF financing of EUR 45 million). A new grant scheme for next-generation networks (NGN) deployment, with a total estimated budget of EUR 64 million, was set up to provide support to private operators deploying backhaul and last-mile access infrastructure for additional localities in underserved (white) areas. The first call of the project was launched in October 2018.[141]

Use of Internet

[139] https://rio.jrc.ec.europa.eu/en/file/12145/download?token=0n9R0Eb9
[140] The Rise of Digital Challengers, McKinsey (2019)
[141] To address the urban-rural digital divide, under the 2014-2020 financial framework, the Romanian Operational Programme for Competitiveness has earmarked EUR 100 million from the European Regional Development Fund (ERDF), while the 2014-2020 Rural Development Operational Programme had initially foreseen an indicative amount of EUR 25 million from the European Agricultural Fund for Rural Development (EAFRD) under LEADER4, out of which less than EUR 2 million were effectively allocated to broadband infrastructure measures. The RoNet project to support deployment of backhaul networks in 'white areas' was granted ERDF financing of EUR 45 million, to finalise the intended coverage in the current financing period, ensuring broadband backhaul infrastructure for a target of 721 localities.

89% of the population of Romania has Internet access. Efforts to reduce costs and make the Internet accessible (Romanians pay 1.1% of their income for the Internet) have led to an increase in education and consumption of digital products.

There is a need to consolidate the trust in digital services. To do this, standards should be established and information provided. The users should know what (especially from a legal point of view) what means issuing an electronic invoice, signing an electronic contract, the legal value of a digital signature, the rights and obligations of data processing with personal character.

Integration of digital technology.

Digitalization can be an extraordinary source of optimization of business processes, leading to cost savings. The business environment must always aim to be more advanced than the public administration in terms of digitization. Yet, companies operating in Romania are reluctant to adopt new technologies, highlighting as one major obstacle to digitization the lack of 'digital' consumers. The loops again closes in education system.

Digital public services

The national administration's IT system is fragmented, with a **low level of interoperability, as each public institution focused on its own digital public service**. This generates a significant administrative burden for citizens and businesses. A significant number of papers are still required by the administration, even if/when electronic systems in theory exist. Authorities need to be pushed to increasingly use digital technologies.

The high salaries for the IT specialists in the private sector, complemented by the tax exemption, make this category of professionals among the top paid jobs. However, the **salaries in the public IT sector are not correlated with the market**. The public sector, where is a significant need of IT specialists in order to ensure implementation and functioning of digital services can not compete with the wages in the IT private sector. Those who take positions in the public sector are often disconnected from innovation.

The doctors remain under a significant burden to fill in papers and do not benefit by centralised registries for epidemiological studies. The medical ID card had created significant problems in periods when the system failed to respond.

7 CONCLUSIONS

Innovation is critical in the modern economy. The innovation ecosystem encompasses many pillars, from business dynamism, to human capital (education, years of schooling) and its optimal allocation (labour market functioning), the availability of venture capital.

A strong innovation ecosystem requires macroeconomic stability, strong institutions, good infrastructure, ICT readiness, stable regulatory frameworks and a market that is receptive to new ideas. **Investing in people (education, health, well being) is a fundamental building block of growth**. There is need also for strong entrepreneurial culture, companies embracing disruptive ideas, multistakeholder collaboration, critical thinking, meritocracy, social trust, a strong entrepreneurial culture and innovation capability.

The digitalization affects not only the industry but also the customers' needs. With the right skills, workers can become the actors of the economic transformation rather than becoming victims of it. (Global Competitiveness Report, 2018)

This section includes *some suggestions,* based on the conclusions of the report***, without any intention to cover exhaustively all the obstacles and the directions of action, neither to impose any action. They represent some of the author's opinion based on the conclusions of the report.***

RDI System and Policy. Regulation

- Increase RDI funding and its efficiency. Invest more and invest wisely ! Ensure multi-annual, predictable funding. The national education and RDI system should perform in a stable framework, based on multi-annual budgets and strategic priorities, regardless the political changes.
- There is a impetous need of tackling the demographic problems and the high emigration: provide sistemic support to retain and attract the high professionals
- Invest in building administrative capacity of the public authority designated to coordinate the RDI strategic processes, to ensure corelation between sectorial and territorial policies (strategies, plans and programs, national and regional) and their msnagement bodies, to develop and promote an unitary framework for RDI policy implementation, monitoring and evaluation.
- There is need of evidence based policy making, proper monitoring and evaluation of policies.
- Invest in actions to mobilyze enterprises in RDI policy making process (smart specialization governance and entrepreneurial discovery process)
- .
- Develop funding programs for public RDI organisations, based on institutional performance assement system, to ensure the relevance of the research to the regional/national needs, to the societal challenges and alignment to the international trends
- Strategies require realistic targets, in line with the political will.
- Distinct strategies targetting explicitly or implicitly the innovation system should be designed and implemented in a coordinated manner. The strategies should be linked to the implementation plan, funding sources and sound management system.
- Embed monitoring and evaluation mechanisms in the strategies, performed in an integrated approach, with coordinated planning, avoiding duplication of financial and administrative efforts and reasons for not performig a sound evaluation.
- Design the policy instruments/input, output, outcome indicators based on the individual intervention logic.
- Ensure mid-term evaluations and flexible funding for national RDI funding schemes to allow corrections.
- Develop "Stairway to excellence" programs, to qualify for financing, eligible projects submitted in the Horizon Europe calls
- Introduce selection system for RDI projects based on relevance and estimated impact qualification criteria
- Create a national "one stop shop" for RDI funding programs with unitary comunication system for the presentation of the calls and capacity to support development of RDI and TT project.

- Academic/research staff have conflicts of interest/commitments that need to be understood and properly managed.
- There are several fiscal incentives for RDI. There is a need for clear, unambigous guidelines for their implementation.
- Normative acts are needed to support innovation with all that it entails (i.e Advantageous rules on "private use" of research facilities etc)

- Formulate and promote regulatory initiatives to encourage research activities, support access to public research infrastructures, valorise research results, encourage innovation and digitalisation in SMEs
- In order to mitigate the high migration of highly qualified personnel, creation of legal framework for freelancing collaboration in research projects funded by public funds.
- Ensure stable legal framework, taxation. Ensure digital processing of the bureaucracy workload related to project design and implementation.
- Expand the research and development RDI tax reduction to provide some benefit to companies collaborating with HEIs/PROs.
- Create favorable rules on "private use" of research facilities.
- Develop legal framework/ design funding instruments that consider the specificities of the innovative companies.
- Provide incentives for MNC to maintain IP in Romania.

RDI funding

- Ensure budget allocation based on transparent, rigorous, periodic (strategic, funding programs and institutional) performance evaluation mechanisms
- .Promote applied research, collaborative research, business incubations and technology transfer funding.
- Develop smart specialization funding programs (grants and financing instruments) capable to cover the entire life cycle of research and innovation, especially invest in programs dedicated to research to market, research societal challenges oriented, applied research, collaborative research-industry programs, start-ups' incubation and accelleration.
- Invest in developing RDI and TT intermediaries, their capacity to align industry demand with research and education offer, to ensure transfer of know how and technology uptake in areas with potential for smart specialization.
- Invest in developing networking and cooperation among RDI performers, to enourage transfer of know-how, promote joint national and transnational investments in early product validation, commercialization and patenting in areas with potential for smart specialization
- Development of actions that speed up cross-sectorial and cross- regional connectivity, including clusters support.
- Invest in developing industrial activities in specific value chains with potential of smart specialization and cross sectorial spillover effects.
- Invest in developing DIHs and innovative clusters in areas with potential for smart specialization.
- Invest in propagation of digitalisation in all areas of activity
- Invest in increasing interoperability of IT national system
- Increase and review public funding for RD structures to introduce multiannual funding and institutional performance assessment system.
- Encourage risk-taking: provide venture capital support schemes for innovation, support risk-sharing through joint-ventures; support business angels through fiscal incentives.
- Integrate urban innovation districts in urban growth poles, based on integrated urban development strtegy.
-

- Create cluster knowledge including in rural and peri-urban towns to facilitate networking and exchange of knowledge and establishment of sustainable innovative environments for entrepreneurial discoveries
- Provide support to create and devellop Science Parks.

- Focus on champions/ cvasi champions (start-ups/SME) that have the potential and the desire to innovate and grow. Identify High Growth Innovative Enterprises, their needs. Create funding instruments for HGIE.
- Design instruments for all stages of innovative start-ups (Seed Stage, Startup Stage, Growth Stage, Later Stage and Steady Stage).
- Provide support for patenting.
- Provide support for scaling up innovative companies.
- Provide support to companies that have taken steps towards developing services and products on external sales market

Education

- Increase the investment in Education, Health. Economic growth has not been reflected in an improved quality of life. There has been and it is going to be a high outward flow of Romanians, seeking better lives, careers in the context of low quality of life and lack of career prospects.
- While tertiary education may seem more important for innovation, the systemic problems of the entire education system should be considered. Regardless the level of the education, its quality affects the society as a whole, its ability to perform towards a sustainable growth. An education system is also a strong component of the quality of life – employees and employers want for their families access to a good education, health, social security system.
- There is a need to correlate the number of state funded places in public HEIs to the labour market demand.
- The university curricula should be correlated to the demand of specialists from the market. This involves also a more flexible studies recognition regulation/process.
- Invest in propaging the innovation culture – education at all levels, vocational training and specialization programs, including mobility of students, masterands, PhDs and teachers.
- Reform the Education System – to be more focused on student learning/ reach achievements and not on subjective evaluations.
- Support the education system, create a favourable enviroment able to retain quality staff, to provide for their continuous training.
- Review institutional assessment system of HEIS to propague high quality standards, to attract students and researchers in areas with potential for smart specialization and technology development.
- Provide the regulatory framework and financial support for in house training programmes for Master and PhD students, internships. Develop and sustain incentives for the HEIs and VETs that align their education offer with the market needs.
- Invest in developing the strategic management capacity of the public universities and VET schools.
- Provide support for training and research networks similar to Marie Curie Schemes with dual aim: training and research.
- Invest in increasing competences of local public authorities to administrate digital public services.

8 ABBREVIATIONS

ADR	Regional Development Agency (Agentia de Dezvoltare Regionala)
AR	Academia Romana
ARACIS	Romanian Agency for Quality Assurance in Higher Education
COP /POC	Competitiveness Operational Programme (Programul Operational Competitivitate)
EDP	Entrepreneurial Discovery Process
EIF	European Investment Fund
ELI-NP	Extreme Light Infrastructure
ERDF	European Regional Development Fund
ERRIS	Engage in the Romanian Research Infrastructure System (platform)
ESIF	European Structural and Investment funds
EU28	The 28 Member States of the EU
FDI	Foreign Direct Investment
FTE	Full-time equivalent (researchers)
GD	Governmental Decision
GDP	Gross Domestic Product
GERD	Gross domestic expenditure on R&D
GVA	Gross Value Added
HEIs	Higher Education Institutions
HGE	High growth enterprises
HGIE	High growth innovative enterprises
HRS	Human Resources in Science and Technology
HRST	Human Resources in Science and Technology
ICT	Information Communication Technology
IDF	Institutional Development Fund
INCD	Institute Nationale de Cercetare, Dezvoltare
KIT	Knowledge and Innovation transfer
KTO	Knowledge Transfer Offices
MCI	Ministry of Research and Innovation (Ministerul Cercetarii si Dezvoltarii)
MNC	Multinational company
MNE	Ministry of National Education
MNER	Ministry of National Education and Research (Ministerul Educatiei Nationale si Cercetarii)
NASRI	National Authority for Scientific Research and Innovation (Autoritatea Nationala pentru Cercetare Stiintifica si Inovare)
NCIE	National Council for Innovation and Entrepreneurship (Consiliului Naţional pentru Inovare şi Antreprenoriat – CNIA,
NCSTIP	National Council for Science, Technology and Innovation Policy (Consiliul National pentru Cercetare, Tehnologie si Inovare)
NES	National Strategy for Export

PN3	National Plan for Research, Development, and Innovation, 2015-2020 Planul National pentru Cercetare, Dezvoltare, Inovare 3
NRT	National registry of Trade (Oficiul Roman de Comert)
NS	National Strategy
SNCDI	National Strategy for Research, Development, and Innovation, 2014-2020 (Strategia Nationala pentru CDI)
OP	Operational programme
R&D	Research and development
R&I	Research and innovation
RA	Romanian Academy (Academia Romana)
ReNITT	Romanian network for innovation and technological transfer (Reteaua Nationala pentru Inovare si Transfer Tehnologic)
RI	Research infrastructure
ROP POR	Regional Operational Programme Programul Operational regional
S2E	Stairway to Excellence
SF	Structural Funds
SNARD	National Strategy on the Digital Agenda for Romania
UEFISCDI	Executive Agency for Higher Education, Research, Development and Innovation Funding (Unitatea Executiva pentru Finantarea Invatamantului Superior, a Cercetarii, Dezvoltarii si Inovarii)
VAT	Value Added Tax
VC	Venture capital

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APPENDIX 1. RDI Programmes

The NPRDI (PN3) 2015-2020 with various project-based funding programmes, aiming to cover the whole spectrum of innovation activities from idea to market and from short to long term has launched many of its financing instruments in 2016. The main programmes and sub-programmes and their specific aims are detailed below:

Programme 1. Development of the national RDI system

- **Sub-programme 1.1 Human Resources** supports doctoral and postdoctoral projects, including a new industrial doctorate, the reintegration of diaspora researchers, for young researcher teams, mobility and rewards for scientific results. projects for young researcher teams. Managed by the Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI).
- **Sub-programme 1.2 Institutional Performance provides support for strategic development in POR, and research-business cooperation.**
- **Sub-programme 1.3 R&D Infrastructures** supports investments in regional, national and pan-European Ris, connecting the domestic to international RIs**.** This sub-programme is partly managed by The Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI)
- **Sub-programme 1.4 Support** mainly targets the creation of competence centres and technological services. equipment for RDI policy management. and support for evidence-based policy, access to scientific literature, and science communication. This sub-programme is partly managed by The Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI)

Programme 2. Increasing the competitiveness of the Romanian economy through RDI

Sub-programme 2.1 Competitiveness through RDI funds experimental demonstration and experimental development projects. technology transfer projects. projects outsourcing research to public R&D partners. innovation vouchers. innovative solutions. the establishment of R&D departments in companies. technological platforms. and the creation of clusters. This sub programme is coordinated by (UEFISCDI).

Programme 3 European and international cooperation. This programme through six distinct sub-programme has the aim to strengthen the RDI national system through international cooperation, increase the international visibility and participation of the RDI system in Horison2020, European Innovation Partnerships (EIP), Joint Programme Initiatives (JPIs), support RO representation in pan-European, international programmes and organisations.

Subprogram 3.1. Bilateral / Multilateral supports the bilateral and multilateral cooperation in RDI through complex projects and mobility. (Bilateral cooperation Romania – France, RO - Community Wallonia-Belgium. Romania – Moldova). Management authority UEFISCDI

Subprogram 3.2 Horizon 2020. Support is provided for national participation in the following EU collaborations (RI-links2. ERA4CS. ACT.ProSafe. NEURON. SYNAMERA. ERA-GAS. Waterworks 2015. ENSUF - ERA-NET co-fund Smart Urban Futures. INNOVOUCHER. Columbus. BSH - Black Sea Horizon. E-Rare 3. ERA-Net Plus Smart Grids. ERA-NET Smart Cities and Communities. Waterworks 2014). Management authority UEFISCDI

Subprogram 3.3 European and international initiatives and programs has the aim to 'foster economic and technological performance of Romanian companies by financing those entities that have the ability to transform ideas into products and innovative technologies with real market potential. provide support to realization of new products and technologies, based on research results showing potential for commercial exploitation. stimulate SMEs to consider innovation as a growth strategy, both by developing their own research capabilities, and by accessing experimental facilities

available in research entities in Romania. supporting cooperation between research organizations and industry. (fully coordinated by UEFISCDI)

Sub-programme 3.4. Support to common technological initiatives (JTI, JU)

Sub-programme 3.5 Support has the main aims to increase the visibility of RO RDI system are international level, support the sustainability of national participation in the projects funded by H2020 and the capacity of future participation in H2020 competitions**.** The financing is awarded to national institutions which had won a H2020 competition.

Programme 4 Fundamental and frontier research. The program has the aim to support fundamental research in emerging areas in which Romania is interested to conduct frontier scientific research, increase the performance, international visibility of the national RDI in areas holding research potential, adoption of international valuation standards for fundamental research projects.

Programme 5 Research in fields of strategic interest

Sub-programme 5.1 supports nuclear physics and high-power lasers research, particularly in connection with the future ELI-NP infrastructure**.**

Sub-programme 5.2 supports participation in activities and projects in atomic and subatomic physics (such as EURATOM, CERN, FAIR, CEA, F4E).

Sub-programme 5.3 funds the STAR programme for advanced space research and technology.

Sub-programme 5.4 supports research in river-delta-sea systems, particularly in connection with the future DANUBIUS-RI infrastructure.

OPERATIONAL PROGRAMME COMPETITIVENESS (POC)

The main objective of POC is to contribute to the increase of the economic competitiveness by investing in RDI and ICT. The main directions of investments aim to stimulate the innovation of the business sector through public support to private RDI and private RI, development of centers of research excellence centers, clusters and networks, stimulate the knowledge transfer The following main action lines are foreseen in POC:

DEVELOP RD&I CAPACITIES INFRASTRUCTURES

Action 1.1.1 : Large RD Infrastructures (€416million, 44% POC)

- Creating new RD investment in public RD institutions.
- Investment for RD departments in enterprises.
- Innovative clusters.
- Support to research pan-European infrastructures (ELI-NP stage II €175 million. and DANUBIUS Centre €47 mil)

DEVELOP RD&I CAPACITIES–SYNERGIES

Action 1.1.2. Development of networks of RDI centres which are nationally coordinated and linked to international related, as well as ensuring researchers' access to scientific publishing and international data

- GRID and RoEduNet
- Facility access to scientific publishing (ANELIS)

Action 1.1.3 : Creating synergies with RD&I actions of Horizon 2020 and other I nternational RD&I programmes: Complement JTI. RO-EIT. RO-ESFRI-ERIC. Finalist-IMM. Centre-support. ERA CHAIRS. Teaming

DEVELOP RD&I CAPACITIES–PEOPLE

Action 1.1.4: Attracting high-skilled personnel from abroad to foster RD capacities.

STRENGTHEN RESEARCH AND INNOVATION CAPACITY IN ENTERPRISES

Action 1.2.1: Stimulating enterprises' demand for innovation through RD&I projects carried out either by the enterprise itself or in partnership with RD institutes and universities, in order to innovate processes and products in economic sectors with growth potential

- Innovative technological projects
- Innovative spin-offs and start-ups
- Innovative newly created enterprises

FINANCIAL INSTRUMENTS FOR INNOVATIVE ENTERPRISES

Action 1.2.2 : Credits, guarantees and risk capital measures for innovative SMEs and research organizations searching for market demands

- Accelerator and seed stage for innovative ideas
- Portfolio Risk Sharing Loan for innovative SMEs and research organizations answering market demands.
- Creating a research and innovation offer on business needs

Action 1.2.3:Knowledge Transfer Partnerships Research organizations' offer shall include 4 categories of R&I activities:

- consultancy and expertise for knowledge transfer
- access to RD&I facilities
- transfer of research skills by providing RD&I services
- collaborative partnerships

APPENDIX 2. Policy mix

Politicy Strategia	RDI relevant Directions of implementation	Developed by
Regional Strategies for Smart Specialisation Strategiile de Specializare Inteligentă ale regiunilor(RIS)	RIS 3 North-West RIS 3 Center RIS 3 North-East RIS 3 South-East RIS 3 South- Muntenia ADR South-West Oltenia RIS 3 West ADR Bucharest-Ilfov (in prpgress)	ADR North-West ADR Center ADR North-East ADR South-East ADR South-Muntenia ADR South-West Oltenia ADR West ADR Bucharest-Ilfov
National Strategy for Competitivity 2014-2020	Long-term institutionalization of industrial / technological / CDI foresight centers in public-private collaborative regime Supporting SMEs to launch innovative products or services through venture capital funds, grants, collaborative projects Improving the position of exporter of Romania in 10 economic sectors with potential for intelligent specialization Increasing the attractiveness of investments in the 10 sectors with the potential for intelligent specialization	Ministry of Economy
National Strategy for Export 2014-2020 Strategia Nationala de	[Support for enterprises regarding the acquisition, transfer and adaptation of advanced technologies Support for the creation and development of innovative companies, especially in the high-tech fields	Ministry of Economy

Export	Stimulating public and private investments in innovative companies Encouraging greater participation of enterprises in publicly funded research, development and innovation programs Direct support for companies for developing in-house research capabilities: hiring staff Territorial economic concentrations - Supporting innovative clusters	
NS Health 2014-2020 Strategia Nationala de Sanatate	Promoting R&D in Health Development of research, development, innovation capacity for the health sector aiming at results that could be integrated into practice Development of research in public health and health services, for the development of evidence-based health policies	Ministery of Health
The Strategy for Rural Development 2014-2020 Strategia de Dezvoltare Rurală 2014-2020 prin PNDR 2014-2020 – instrument secundar de implementare a SNCDI	Encourage innovation, cooperation and the creation of a knowledge base in rural areas Strengthening the links between agriculture, food production and forestry, on the one hand, and research and innovation, on the other, including for better environmental management and improved environmental performance Encourage lifelong learning and vocational training in the agricultural and forestry sectors	Ministry of Agriculture and Rural Development Ministerul Agriculturii și Dezvoltării Rurale
NS for Tertiary Education 2015-2020 Strategia Nationala Invatamant Superior	Tertiary education as a driver of growth based on knowledge and high qualification. The investments will be made with priority in areas with growth potential that contributes to increasing the employability of the graduates of higher education in competitive sectors / smart specializations.	Ministerul Educației
National Strategy for life-long Learning SN de Învățare pe Tot Parcursul Vieții 2015-2020, (și prin POCU și POR – instrumente secundare de implementare a SNCDI)	Improving the level of knowledge / skills / aptitudes related to the economic sectors / domains identified by SNC and SNCDI Increasing the number of employees benefiting from tools, methods, practices, etc. standard of human resources management and improved working conditions in order to adapt the activity to the dynamics of the economic sectors with competitive potential identified according by NSC / SNCDI 2014-2020 Diversification of educational offers in tertiary university and non-university technical education organized within accredited higher education institutions correlated with the needs of the labor market in the economic sectors / domains identified by SNC and SNCDI Increasing the number of university and non-tertiary tertiary education graduates who find a job as a result of access to learning activities at a potential job / research / innovation, with an emphasis on the economic sectors with competitive potential identified according to the NSC and SNCDI 2014-2020 Increased participation in on-the-job learning programs of students and apprentices in non-university secondary and tertiary education, with an emphasis on the potentially competitive economic sectors Increasing the number of vocational training programs for the economic sectors with competitive potential	Ministry of National Education Ministerul Educației Ministry of Labour and Social Justice Ministerul Muncii și Justiției Sociale
National Strategy for	[Grow regional economies by developing the specific	Ministry of

Regional Development SN pentru Dezvoltare Regională (și prin POR)	infrastructure for innovation and research and by stimulating economic competitiveness] Development of research and innovation infrastructure: Development of business incubators, technological, scientific parks, industrial and business parks, competence centers, clusters Development of business networks Support for the development of the economic activity within the specific infrastructure of innovation and research Adopting new technologies Development of innovative systems Increasing the competitiveness of SMEs_: Developing the entrepreneurial spirit, in particular by facilitating the economic exploitation of new ideas and by encouraging the creation of new productive enterprises Developing SMEs, in particular to promote technology transfer	Regional Development and Public Administration Ministerul Dezvoltării Regionale și Administrației Publice Regional Development Agencies Agențiile pentru Dezvoltare Regională
National Strategy for Education and Professional Development Strategia Educației și Formării Profesionale 2016-2020	Development of competences regarding innovation, creativity and entrepreneurship within vocational training programs.	Ministry of Education Ministerul Educației
NS for Digital Agenda 2020 SN privind agenda digitală pentru 2020	[Research and development and innovation in ICT] Promoting innovative groups and competing poles for regional growth Encouraging research on regional infrastructure development. Dissemination of participation in ICT Innovation, Research and Development projects within the framework of initiatives Financing of ICT innovation initiatives in Romania Stimulating national research and development and innovation capabilities in cyber security - Encouraging national research / development / innovation capabilities in cyber security	Ministerul pentru Societatea Informațională
National Strategy for the Development of SMEs and improvement of the business enviroment in Romania - 2020 Horison Strategia guvernamentală pentru dezvoltarea sectorului întreprinderilor mici şi mijlocii şi îmbunătăţirea mediului de afaceri din România – orizont 2020	Encouraging technology transfer Developing a support system for innovation at national level Encouraging the technical-economic cooperation of SMEs with large enterprises, especially in the field of technological and commercial innovation Supporting the exploitation of the competitive advantages of SMEs with extensive development potential and promoting the advantages of obtaining the intellectual / industrial / commercial property right Supporting the connection of SMEs to RDI networks Supporting the activity of scientific research, technological development and innovation in the field of energy. developing public-private partnerships with the energy industry, following best practices. Developing the capacity to attract and use the sources of funding for scientific research, through participation in international consortia, as well as in European and	Romanian Government Guvernul României – Departamentul pentru IMM-uri, mediu de afaceri și turism

	international programs and projects.	
NS for Energy 2016-2030 Strategia Energetică a României 2016-2030, cu perspectiva anului 2050	Supporting the activity of scientific research, technological development and innovation in the field of energy. developing public-private partnerships with the energy industry, following best practices. Developing the capacity to attract and use the sources of funding for scientific research, through participation in international consortia, as well as in European and international programs and projects.	Ministry of Energy Ministerul Energiei
NS regarding the climate change SN a României privind schimbările climatice 2013-2020	Supporting climate change research and creation of a national climate change database	Ministry of Enviroment (Ministerul Mediului)
Fiscal Code Codul Fiscal	(Attracting, maintaining and developing in Romania the highly qualified human resource for carrying out the research-application development and / or technological development activity, as well as for strengthening the research-development system in order to increase the competitiveness of the Romanian economy) The income from the salaries and assimilated to the salaries obtained by the natural persons active in the field of research and development are exempted from the payment of the income tax. (OUG 32/2016). Exemption from the payment of the tax on the profit of the companies that exclusively carry out the activity of innovation, research and development - Government Emergency Ordinance no. 3/2017 for amending and supplementing Law no. 227/2015 regarding the Fiscal Code, published in the Official Gazette, Part I, no. 16 of January 6, 2017)	Ministry of Finance Ministerul Finanțelor

APPENDIX 3. SNCDI 2020. Target indicators

	Valoare de bază (an 2011)	Ţinta 2017	Ţinta 2020
Premise			
Cheltuieli publice cu cercetarea-dezvoltarea (% din PIB)	0,31	0,63	1,0
Număr absolvenţi de doctorat la 1.000 locuitori, cu vârsta de 25-34 ani	1,4	1,5	1,5
Număr de cercetători în sector public (echivalent normă întreagă)	12.409	15.000	17.000
Publicaţii ştiinţifice în top 10% dintre cele mai citate publicaţii din lume (% din totalul publicaţiilor ştiinţifice la nivelul ţării)	3,8	5	7
Co-publicaţii ştiinţifice internaţionale la 1 mil. locuitori	148	200	300
Capital de risc (% din PIB)	0,033	0,06	0,09
Antrenarea sectorului privat			
Cheltuielile de cercetare-dezvoltare ale sectorului de afaceri (% din PIB)	0,17	0,6	1,0
Număr de cercetători în sector privat (echivalent normă întreagă)	3.518	7.000	14.500
Co-publicaţii public-privat (nr./1 milion locuitori)	8,3	12	16
IMM inovative care colaborează cu alţii (%)	2,93	3,5	6
Aplicaţii brevete EPO (nr./an)	40	80	120
Aplicaţii brevete USTPO (nr./an)	17	30	60
Aplicaţii mărci comerciale comunitare (nr./1 mld. euro PIB ajustat la paritatea puterii de cumpărare)	2,14	3	4
Impact economic			
Firme inovative cu creştere rapidă (nr.)	-	50	150
IMM care introduc produse sau servicii inovative(%)	13,17	16	20
Venituri din licenţe şi brevete din străinătate (% din PIB)	0,13	0,15	0,17

APPENDIX 4. Number of CD units over 1995-2017 period (source INS, 2019, tempo online)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2003	2004	2005
Total	617	591	615	616	645	643	626	601	609	719	753	806
Public sector	157	139	161	161	149	150	153	162	185	206	199	209
Government sector	120	105	120	122	109	114	109	110	116	120	120	124
HES	37	34	41	39	40	36	44	52	69	86	79	85
Private sector	460	452	454	455	496	493	473	439	424	513	554	597
Business sector	460	452	454	455	496	493	473	439	424	488	523	563
Private non-profit sector	:	:	:	:	:	:	:	:	:	25	31	34

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total	884	787	775	667	660	1166	970	920	773	781	792	713
Public sector	285	251	267	231	231	268	269	273	286	298	293	276
Government sector	177	165	164	134	129	177	174	186	192	204	200	190
HES	108	86	103	97	102	91	95	87	94	94	93	86
Private sector	599	536	508	436	429	898	701	647	487	483	499	437
Business sector	559	506	491	426	410	884	683	623	460	462	476	414
Private non-profit sector	40	30	17	10	19	14	18	24	27	21	23	23

APPENDIX 5. Number of total/open access ISI, SCOPUS worldwide and Romanian publications

Years	ISI Publications	OA	%OA	ISI Romanian	OA Romanian	%OA Romanian
2018	2.338.776	652.348	27,89%	9.821	2.907	29,60%
2017	2.279.672	674.271	29,58%	9.694	2.643	27,26%
2016	2.240.798	648.151	28,93%	9.860	2.314	23,47%
2015	2.151.032	596.543	27,73%	9.918	2.106	21,23%
2014	2.089.917	551.292	26,38%	9.131	1.975	21,63%
2013	2.036.389	514.417	25,26%	9.893	1.891	19,11%
2012	1.943.011	469.367	24,16%	8.740	1.614	18,47%
2011	1.861.376	422.796	22,71%	8.242	1.261	15,30%
2010	1.782.781	383.188	21,49%	8.608	1.152	13,38%
2009	1.736.269	350.471	20,19%	7.738	937	12,11%
2008	1.663.250	310.880	18,69%	6.504	804	12,36%
2007	1.575.007	261.806	16,62%	4.955	488	9,85%
2006	1.503.455	224.466	14,93%	3.601	383	10,64%
2005	1.438.101	204.222	14,20%	3.003	314	10,46%
2004	1.358.512	188.106	13,85%	2.690	241	8,96%
2003	1.270.546	164.645	12,96%	2.517	183	7,27%
2002	1.235.948	137.595	11,13%	2.427	142	5,85%
2001	1.192.289	134.725	11,30%	2.156	146	6,77%
2000	1.206.412	124.763	10,34%	2.111	158	7,48%
Total	32.903.541	7.014.052	21,32%	121.609	21.659	17,81%

Years	SCOPUS Publications	OA	%OA	Romanian	OA Romanian	%OA Romanian
2018	3.151.299	779.785	24,74%	15.997	4.407	27,55%
2017	3.098.431	729.628	23,55%	16.453	4.491	27,30%
2016	2.964.247	659.482	22,25%	15.450	2.893	18,72%
2015	2.878.864	602.781	20,94%	15.503	2.451	15,81%
2014	2.915.469	545.377	18,71%	15.178	2.091	13,78%
2013	2.861.256	480.477	16,79%	15.453	1.934	12,52%
2012	2.748.115	428.230	15,58%	14.618	1.775	12,14%
2011	2.620.454	373.790	14,26%	13.689	1.240	9,06%
2010	2.459.511	314.289	12,78%	13.358	933	6,98%
2009	2.338.241	287.962	12,32%	11.454	722	6,30%
2008	2.228.259	254.756	11,43%	9.051	561	6,20%

2007	2.132.849	219.577	10,30%	6.746	388	5,75%
2006	2.003.260	205.139	10,24%	5.006	295	5,89%
2005	1.914.310	182.428	9,53%	4.743	223	4,70%
2004	1.685.195	162.824	9,66%	3.918	197	5,03%
2003	1.569.977	146.183	9,31%	3.818	181	4,74%
2002	1.487.694	130.242	8,75%	3.325	136	4,09%
2001	1.418.717	120.195	8,47%	3.174	122	3,84%
2000	1.308.935	105.359	8,05%	3.114	103	3,31%
Total	**43.785.083**	**6.728.504**	**15,37%**	**190.048**	**25.143**	**13,23%**

APPENDIX 6. Top 10 Romanian institutions with the highest publication/ patenting activity , 2005 – 2014

Rank	Institution	City	Number of papers
1	Polytechnic University of Bucharest	Bucharest	7,115
2	University of Bucharest	Bucharest	6,605
3	Babes Bolyai University from Cluj	Cluj-Napoca	6,440
4	Romanian Academy of Sciences	Bucharest	5,195
5	Alexandru Ioan Cuza University	Iasi	3,943
6	GH Asachi Technical University	Iasi	3,119
7	Horia Hulubei National Institute of Physics & Nuclear Engineering	Magurele	2,990
8	Iuliu Hatieganu University of Medicine & Pharmacy	Cluj-Napoca	2,593
9	Carol Davila University of Medicine & Pharmacy	Bucharest	2,451
10	Grigore T Popa University of Medicine & Pharmacy	Iasi	2,310

Source: Thomson Reuters (2015), Bibliometric Analysis of Romania's Research Output, 2005-2014 (funded by UEFISCDI)

	Organisation	Number of patents
1	UNIV SUCEAVA STEFAN CEL MARE	328
2	UNIV BRASOV TRANSILVANIA	141
3	INST NAT CERC DEZVOLTARE ELECTROCHIMIE	111
4	CONTINENTAL TEVES & CO OHG AG	111
5	UNIV IASI TEHNICA ASACHI GHEORGHE	110
6	INST NAT CERC DEZVOLTARE MASINI INSTALAT	107
7	UNIV CLUJ-NAPOCA TEHNICA	100
8	UNIV POLITEHNICA DIN BUCURESTI	90
9	INST NAT CERC DEZVOLTARE FIZICA TEHNICA	92
10	INST NAT CERC DEZVOLTARE CHIM FARM	88

Source: Thomson Reuters IP Analytics, (2015): Romanian Research Output: IP Analysis (funded for UEFISCDI)

APPENDIX 7. Number of projects funded by PN3 programmes included in the Mid Term Evaluation SNCDI

denumire instrument	total	D1 Bioeconomie	D2 TiC, spatiu, securitate	D3 - Energie, mediu shimbari climatice	D4 - Econano tehnologii si materiale avansate	D5 Sanatate	D6 Patrimoniu, identitate culturala
BG	126	33	27	24	20	19	3
PED	252	48	59	44	48	46	7
PTE	57	12	15	11	15	3	1
Cecuri inovare 2017	147	54	33	29	21	6	4
TOTAL	**582**	**147**	**134**	**108**	**104**	**74**	**15**

Source: Mid Term Evaluation

APPENDIX 8. Match S2 regional/national smart specialisation domains

National	Bio economy	ICT, space, security	Energy, environment, climate change	Eco-nano technologies and advanced materials	Health
1.N-W region[142]					
Agro-food, cosmetics and	x				x
Industry of metals		x	x	x	
Furniture			x	x	
Health					
Paper, plastic	x			x	
Production technologies				x	
ICT		x	x		
2.N-E Region[143]					
Agro-food	x			x	
Bio-technologies	x				
ICT (big data, eHealth, smart cities etc)		x	x		
Energy and environment			x		
Apparel &textile				x	
Health & Tourism	x				x
3.CENTER[144]					
Automotive and			x	x	
Aeronautic industry		x		x	
Agro-food	x			x	x
Textile and leather		x		x	
Sustainable construction	x		x	x	
Forestry, wood and	x		x	x	
IT and creative industries		x			
Pharmaceutical industry and	x			x	x
Balneal tourism	x		x		x
4.South East[145]					
Maritime engineering and			x	x	
Apparel &textile				x	
Agro-food and fishery	x		x		

142 http://www.nord-vest.ro/s3/
143 http://adrnordest.ro/user/file/news/17/RIS3_Nord-Est_05_12_2017.pdf
144 http://www.adrcentru.ro/Document_Files/StrategiaSpecializareInteligenta/00002531/vbp08_1.RIS3_sep_2017.pdf
145 http://www.adrse.ro/Documente/Planificare/Comunicat_presa_Strategia_Specializare_Inteligenta_Regiunea_SE.pdf

Biotechnologies	x		x		
Eco-technologies			x	x	
Tourism					x
ICT		x			
5. South Muntenia[146]					
Construction of vehicles,			x	x	
Agriculture and food	x				
Tourism and cultural	x				
Bio economy	x		x		
Smart cities			x	x	
High technology products					
6. West					
Automotive industry				x	
Agro food	x				
Construction			x		
ICT		x			
Textile	x				
Tourism	x				x
7. South West Oltenia					
Industrial engineering and	x	x	x	x	
Energy and environment	x	x	x		
Innovative medicine	x	x	x		x
Agriculture and food	x	x	x		
Tourism and cultural heritage		x	x		

[146] http://www.adrmuntenia.ro/strategia-pentru-specializare-inteligenta-a-regiunii-sud-muntenia-pentru-perioad/static/892