

An Analysis of the Romanian Research Eco-System. Actual Risks and Challenges for Future Development

Aurelia-Ioana Biholar

Politehnica University of Timisoara, Romania
aurelia.biholar@student.upt.ro

Bosco Lopez Landa

Politehnica University of Timisoara, Romania
bosco.lopez-landa@student.upt.ro

Anca Draghici

Politehnica University of Timisoara, Romania
anca.draghici@upt.ro

Abstract

In recent years, Romania has endeavored to harmonize its research landscape with European Union regulations, reflecting its commitment to advancing scientific endeavors within the broader European framework. This article critically analyses the extent and method of Romania's alignment with European regulations in research, shedding light on both successes and areas for improvement. Despite notable progress, there exist significant research gaps concerning the measurement and enhancement of performance within Romania's national research and development institutes. These gaps comprise diverse dimensions, including infrastructure, funding mechanisms, and collaborative networks. The analysis delves into the intricate dynamics of Romania's R&D ecosystem, exploring the interplay between national institutes and broader research networks, both intern and internationally. The article identifies research gaps intertwined with management challenges, emphasizing the crucial link between effective management strategies and research excellence. It underscores the need for cohesive approaches to foster synergies within the R&D ecosystem, exceeding institutional silos and promoting collaboration. The risks inherent in neglecting to support research performance extend beyond immediate economic implications. In highlighting the risks associated with neglecting performance support in research, the article underscores potential repercussions, including diminished competitiveness, innovation stagnation, and a brain drain of talent. These risks underscore the urgency of implementing robust management strategies to fortify Romania's research landscape. By synthesizing these insights, this article advocates for integrated approaches that address regulatory, management, and research gaps cohesively.

Keywords: R&D ecosystem, research gaps; management challenges, R&D regulations

INTRODUCTION

In recent years, Romania has undertaken significant efforts to synchronize its research practices with the regulations established by the European Union. This commitment reflects the country's aspiration to play an active role in promoting scientific endeavors within the wider European framework. In this article, we embark on a comprehensive examination of Romania's research ecosystem, analyzing the extent to which it has aligned with European regulations, and highlight the risks and challenges that lie ahead for its future development.

Our investigation begins by analyzing Romania's progress in harmonizing its research landscape with European standards. Despite the laudable strides, notable gaps remain in measuring and improving research performance within the country's national research and development institutes. These gaps manifest themselves in various dimensions, including inadequate infrastructure, weaknesses in funding mechanisms and weaknesses in collaborative networks.

To gain a deeper understanding of Romania's research ecosystem, we delve into its complicated dynamics, exploring the interactions between national research institutes and wider research networks, both domestically and internationally. This analysis provides insights into the challenges and opportunities that arise from such interaction, shedding light on avenues for improvement and collaboration.

Additionally, our review uncovers management challenges that are intertwined with research gaps, highlighting the critical link between effective management strategies and research excellence. We emphasize the need for cohesive approaches to promote synergies within the research and development (R&D) ecosystem, transcending institutional boundaries and fostering collaborative efforts.

A central point of our discussion is identifying the risks associated with neglecting to adequately support research performance. Beyond the immediate economic implications, such neglect can lead to decreased competitiveness, stagnant innovation, and the potential consumption of talent - a scenario with far-reaching consequences for the research landscape of Romania. Consequently, these risks impose an urgent call for the implementation of solid management strategies to strengthen the research ecosystem in Romania. By addressing regulatory, management and research gaps in an integrated manner, Romania can improve its research capabilities and ensure sustained progress in the years to come.

In this context, this article advocates concerted efforts to navigate the risks and challenges inherent in the research scene in Romania. By synthesizing perspectives and encouraging collaboration, we can pave the way for a more resilient and vibrant research landscape that not only meets European standards, but also contributes to global scientific advances.

ROMANIA'S ALIGNMENT WITH EUROPEAN REGULATIONS AND PRACTICES

General overview of the Romanian Strategy for Research, Innovation and Smart Specialization

The Romanian Ministry of Research, Innovation and Digitalization (MCID) coordinates research, innovation and smart specialization policy, the management of national funding programs for research-development-innovation (RDI) and related legal regulations. MCID develops the National Strategy for Research, Innovation and Smart Specialization (SNCISI) which supports excellence in fundamental and applied research, encourages collaboration between the public and private sectors to address economic

and societal challenges, and promotes science, innovation and entrepreneurship as successful models for Romania's sustainable development (SNCISI, 2022).

Investing in research and development (R&D) is essential for scientific progress, solving societal challenges, developing and using technologies that improve quality of life, productivity and competitiveness, and creating sustainable jobs. Investments must be based on scientific novelty, sustainability of results, responsibility and openness to the socio-economic environment. Common priorities of these investments include developing and attracting research talent, continuously improving research infrastructure, supporting private sector innovation, partnerships and technology transfer, and strengthening innovation ecosystems around smart specializations and industrial transitions (SNCISI, 2022).

The strategic research agenda for the next period is oriented towards solving societal and technological challenges and may include missions of national and European interest, with an emphasis on smart specializations to meet the needs of the business environment. Furthermore, SNCISI 2022-2027 is structured on four general objectives (SNCISI, 2022):

- GO1. Development of the research, development and innovation system;
- GO2. Supporting innovation ecosystems associated with smart specializations;
- GO3. Mobilization towards innovation;
- GO4. Increasing European and international collaboration.

SNCISI 2022-2027 is closely related to the National Strategy for Sustainable Development of Romania 2030, contributing to the objective of strengthening scientific research, modernizing the technological capacities of industrial sectors, encouraging innovations and increasing the number of employees in research and development, as well as increasing public and private spending in these areas. According to the SNCISI 2022-2027, Romania aims to maintain a critical mass of young talents in the national research, development and innovation (RDI) sector, trained within the Romanian education system and research ecosystem, and to become an attractive destination for researchers and innovators of excellence. The 2030 vision is described in the SNCISI 2022-2027 and Romania is aiming to develop and connect scientific excellence with societal challenges to ensure a welcoming environment for researchers with international experience and to support the training of future talents (SNCISI, 2022).

Romania promotes open science and has the following goals for the period 2022-2027 (SNCISI, 2022):

- 10% increase in the number of doctoral graduates.
- Annual increase in the number of researchers from 2.0 to 3.2 per thousand employed persons by 2030.
- 20% increase in the number of "leader" level researchers.
- Increasing the number of scientific articles and their productivity.
- Increasing the quality of scientific output, including highly cited articles and patents.

In addition, according to SNCISI 2022-2027, businesses are encouraged to innovate and collaborate with research organizations. Innovation entrepreneurship is becoming an attractive option so Romania aims to (SNCISI, 2022):

- To become a moderate innovator according to the European Innovation Scoreboard;
- To increase the share of innovative enterprises and public-private collaborations;

- To increase the number of public-private co-publications and employment in innovative enterprises.

Romania integrates the research and innovation system in the European Research Area and promotes international collaboration. Targets include doubling the sums attracted from the Horizon Europe Program and increasing international scientific co-publications (SNCISI, 2022).

According to SNCISI 2022-2027, the revitalization of research depends on increased public and private investment in R&D, with the target of reaching 1% of GDP by 2027. Public investment will support private sector innovation through partnerships, talent training and technology transfer (SNCISI, 2022).

SNCISI 2022-2027 was developed in accordance with European and national policies and strategies and responds to the recommendations of the Policy Support Facility (PSF) expert report. The evaluation included the governance of the R&D and Innovation system, the evaluation of R&D and Innovation policies and strategies, the internationalization of the R&D and Innovation system, public-private partnerships and the effectiveness of the European Structural and Investment Funds (ESIF) in relation to National Research, Development and Innovation Plan (PNCDI) III (period of 2015-2020) (SNCISI, 2022).

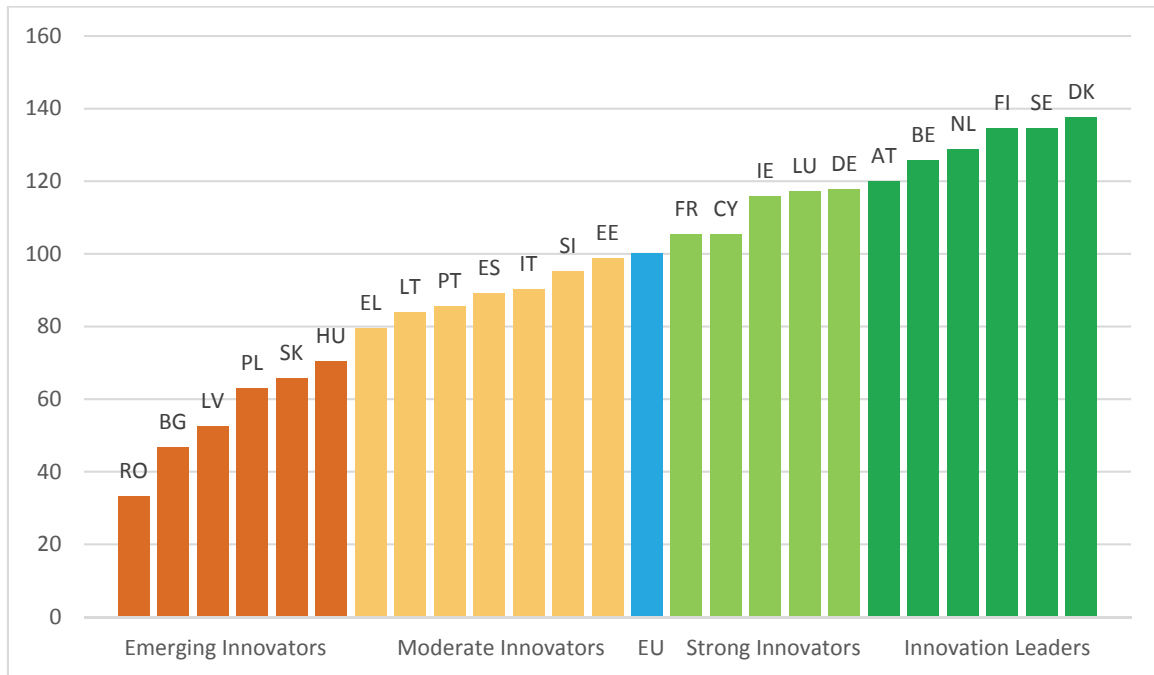
SNCISI 2022-2027 is aligned with the National Strategy for Sustainable Development of Romania 2030 and with the national regulations, responding to the Government's priorities and the favorable condition regarding the good governance of the smart specialization strategy. It ensures complementarity with the objectives of the European Research Area, promoting the mobility of researchers and investment in research and innovation, and increases the interaction between national and international universities, national and international research institutes, the business environment and other innovation actors (SNCISI, 2022).

Successes and areas for improvement

According to European Innovation Scoreboard (2023), based on their performance relative to the EU average, Member States are placed into four different performance groups: 1. *Innovation Leaders* - includes member states with a performance above 125% of the EU average; 2. *Strong Innovators* - includes member states with a performance between 100% and 125% of the EU average; 3. *Moderate Innovators* - includes member states where performance is between 70% and 100% of the EU average; 4. *Emerging Innovators* - includes member states that show a performance level below 70% of the EU average.

Along with Bulgaria, Croatia, Latvia, Poland and Slovakia, Romania is an Emerging Innovator with performance at 33.1%, well below the EU average (<70% of EU average).

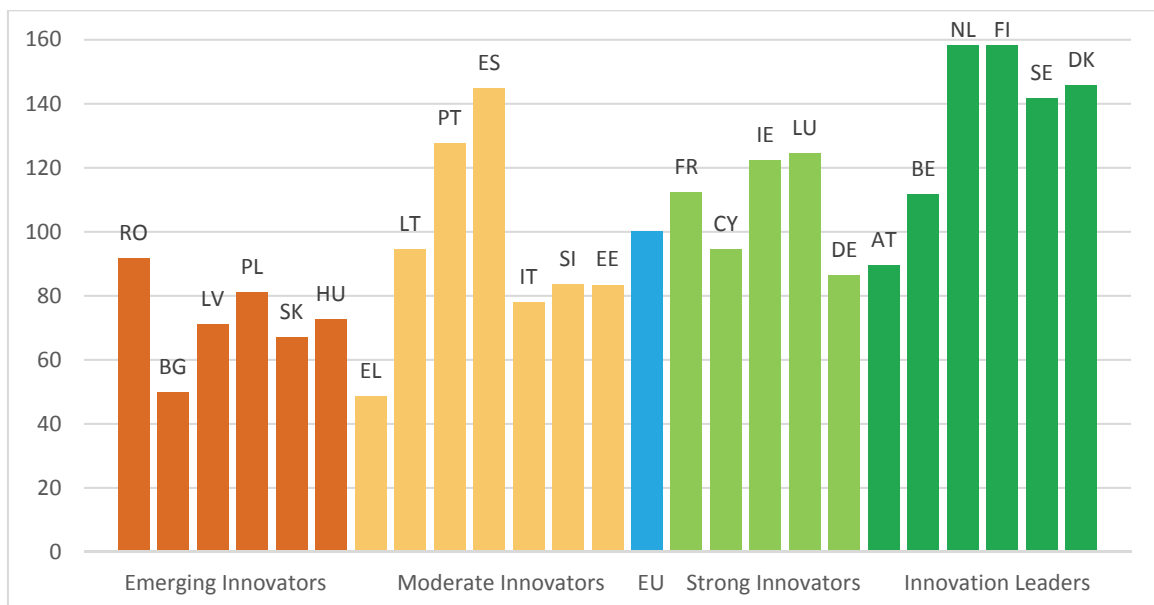
Picture 1: Performance of EU Member States' innovation systems in 2023



Adapted from European Innovation Scoreboard (2023, p. 5).

But despite being an Emerging Innovator, Romania also registers growth in 2023. Its performance in Digitalisation has improved between 2016 and 2023 and has the highest performance increase along Cyprus and Finland. *Digitalisation* dimension measures the level of digital technologies and includes two indicators: Broadband penetration among enterprises and Individuals with above basic overall digital skills (European Innovation Scoreboard, 2023).

Picture 2: Performance of EU Member States in Digitalization in 2023

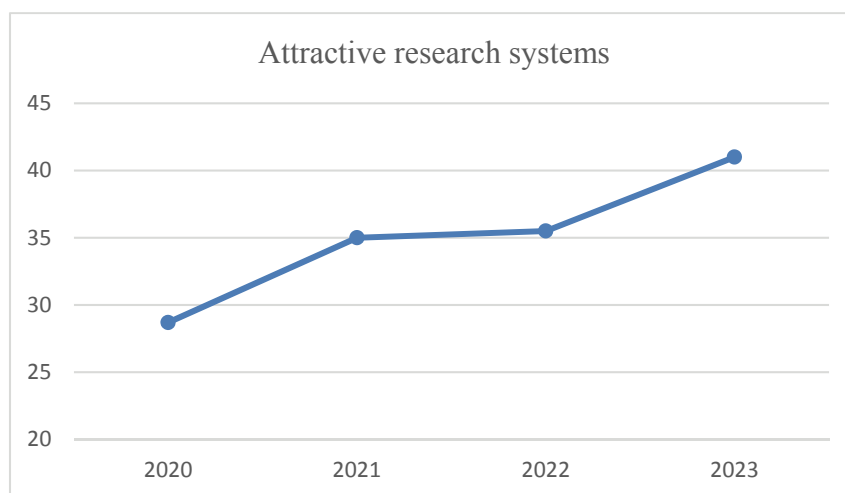


Adapted from European Innovation Scoreboard (2023, p. 22).

This evolution might have been influenced by factors like the health crisis: the COVID-19 Pandemic imposed physical restrictions, which forced the public administration to migrate interactions with citizens to the online environment. We also have to consider the constant digitization efforts: both at the level of the central public administration, as well as the local one, efforts were made to digitize services. (Voinea, 2024)

Against the performance of the country in 2016, performance increased most strongly for Research systems in 2023.

Picture 3: Performance of Romania in Research systems 2020-2023



Adapted from European Innovation Scoreboard 2023 Country profile Romania (2023, p. 5).

Strong increases since 2022 according to European Innovation Scoreboard 2023 are: Broadband penetration, Enterprises providing ICT training and most cited publications.

According to European Innovation Scoreboard 2023, although Romania's performance increased between 2020 and 2022, it decreased in 2023 most strongly for Small and Medium-sized Enterprises (SMEs) with product innovations and Innovative SMEs collaborating with others. There was also a strong increase in upgrading information-communication-technology (ICT) skills in 2023.

Romania is placed in the bottom-5 performing Member States, with lowest performance in Human resources, Firm investments, Use of information technologies, Innovators, Linkages, Intellectual assets and Employment impacts. It's performance in Environmental sustainability has declined also, being followed by Poland.

According to European Innovation Scoreboard 2023, each dimension includes some indicators, as follows:

- *Human resources* dimension includes three indicators and measures the availability of a high-skilled and educated workforce. Human resources include New doctorate graduates in science, technology, engineering, and mathematics (STEM), Population aged 25-34 with completed tertiary education, and Population aged 25-64 involved in lifelong learning activities (European Innovation Scoreboard, 2023).

- The *Firm investments* dimension includes three indicators on R&D and Non-R&D investments that firms make to generate innovations including Business R&D expenditures, Non-R&D innovation expenditures, and Innovation expenditures per person employed (European Innovation Scoreboard, 2023).
- The *Use of information technologies* dimension captures the use of information technologies including two indicators: Enterprises actively increasing the ICT skills of their personnel and Employed ICT specialists (European Innovation Scoreboard, 2023).
- The *Innovators* dimension includes two indicators measuring the share of SMEs that have introduced innovations on the market or within their organizations, covering SMEs that introduced both product and business process innovations (European Innovation Scoreboard, 2023).
- The *Linkages* dimension includes three indicators measuring innovation capabilities by looking at Collaboration efforts between innovating firms, Research collaboration between the private and public sector, and Job-to-job mobility of Human Resources in Science & Technology (HRST) (European Innovation Scoreboard, 2023).
- The *Intellectual assets* dimension captures different forms of Intellectual Property Rights (IPR) generated by the innovation process, including PCT patent applications, Trademark applications, and Design applications (European Innovation Scoreboard, 2023).
- The *Employment impacts* dimension measures the impact on employment and includes two indicators: Employment in knowledge-intensive activities and Employment in innovative enterprises (European Innovation Scoreboard, 2023).
- The *Environmental sustainability* dimension captures improvements to reducing the negative impact on the environment including three indicators: Resource productivity, Exposure to Air pollution by fine particulates PM 2.5, and the Development of environment-related technologies (European Innovation Scoreboard, 2023).

Romania shows a weak performance on Climate change related indicators with below average share of material resources coming from recycled waste materials, a below average reduction in greenhouse gas emissions, and a below average score on environmental innovation (European Innovation Scoreboard Country profile Romania, 2023).

Strong decreases since 2022 according to European Innovation Scoreboard 2023 are: Venture capital expenditures, Environment-related technologies and Sales of innovative products.

According to European Innovation Scoreboard 2023, Romania's Performance is increasing at a rate lower than that of the EU (8.5%- points). The country's performance gap to the EU is becoming larger.

MANAGEMENT CHALLENGES

The strengths of R&D management are based on capitalizing on experience from previous national R&D plans, harmonization between national and EU legislation and the implementation of various European governance models, including a Smart Specialization Strategy. However, the national strategy fails to provide a general evaluation system for all actors and research programs and lacks the necessary legislative, financial or structural instruments to stimulate R&D activities and their application in the economy. In addition, the overall management of R&D fails to deliver the multi-year funding competitions promised by the strategies and suffers from low transparency and excessive bureaucracy.

It also presents large gaps in predictability and stability, fueled by frequent changes in secondary legislation and the institutional framework (Rusu, 2019).

As Romania is deficient at the availability of a high-skilled and educated workforce, we need to address the Brain Drain Phenomenon (BDP), which determines negative effects on the medium and long term and affects the performance, predictability and efficiency of the R&D system and overall economy. which already lacks skilled human resources. Romania is part of the group of countries that have the highest percentage of export of researchers, but it has an almost irrelevant percentage of invited researchers. Potential factors determining highly skilled migration are the consistent social assistance, solid employment protection schemes and better labor market regulation, as well as the level of spend for R&D. It has been proven that welfare does not stand as a sufficient emigration reason for talents, but high R&D budgets, does (Rusu, 2019; Iacob, 2018).

The circular economy is currently one of the most promoted concepts at the level of the European Union, being the subject of numerous sustainable development strategies and policies supported by national governments and even by numerous companies around the world. Economic factors, such as gross domestic product (GDP), investment in research and development, and industrial structure, play a crucial role in determining the success of transitioning to a circular economy (Bătușaru & Sbârcea, 2023).

Table 1: Patent counts in Romania and the EU-27 associated with circular economy

Year	EU-27	RO
2020	207	5
2019	386	8
2018	316	10
2017	309	8

Adapted from Bătușaru & Sbârcea (2023, p. 71).

The technology transfer system in Romania is poorly developed, which is reflected in the reduced visibility of the results and their impact in the economic environment. The lack of training programs based on international best practices has led to the absence of a critical mass of professional technology transfer experts.

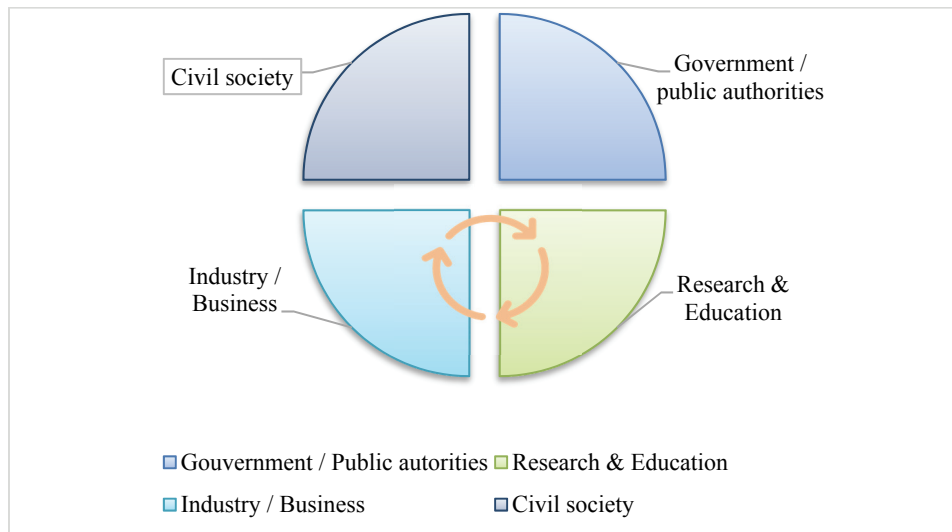
Public investment in transfer centers has focused more on the acquisition of infrastructure than on the development of expert skills and associated services. The lack of unitary executive management affects system performance by fragmenting institutional procedures and the path of research results from idea to market. Also, the lack of a culture of collaboration and trust prevents the transfer of research results to the business environment (SNCISI, 2022).

Another important aspect is the career of researchers which must be supported through specific trajectories, from PhD students to field leaders. Research institutes and universities become attractive to researchers when there is predictable funding and performance in leadership and management. Basic research remains the basis of innovation and technology transfer.

ROMANIA'S R&D ECOSYSTEM

The ecosystem is defined by the alignment structure of the multilateral set of partners that need to interact for a focal value proposition to materialize (Adner, 2017). Research has shown over time the need to bring the Quadruple Helix (QH) actors together – government/ public authorities, research and educational organizations, business actors and civil society and this model - the QH model is the basis of the policy of innovation of the European Union (Prospective Institute, 2022).

Picture 4: Main actors of Romania's R&D ecosystem



Because Romania ranks last in the EU in terms of the research performance, it turns out that there are difficulties regarding the capacity of the Romanian R&D system to support the country's transition to a knowledge-based economy.

The underfunding, together with the unpredictability of funds from the state budget, creates financial instability for stakeholders, who often must resort to bank loans. The inefficient allocation of research funds is also a major problem. These aspects affect the contribution of Government and Industry actors in creating an effective research ecosystem. Also, Romania faces a shortage of researchers, due to both the Romanian educational system and the low attractiveness of the research environment.

In Romania, there are not enough innovative start-ups to create a mature entrepreneurial ecosystem. According to EU Startup Monitor, few start-ups survive more than 5 years due to lack of support services, financing difficulties, high bureaucracy, unpredictable legislative framework, weak corporate governance, uncertain business models and insufficient skills. The lack of effective financial incentives and support from intermediary bodies makes public-private interaction poorly developed and often ad hoc. Few innovative enterprises collaborate with universities and fewer with national research, development and innovation institutes. Investments in R&D and Innovation activities by Romanian enterprises, especially small and medium ones, are significantly lower than the European average, limiting technology transfer. According to a study made by Prospective Institute in 2022, just over half of business organizations are not involved in partnerships or RDI projects with partners from different levels (national, regional, local). The same is true of support organizations. Things are different, however, in the case of organizations of research, where most respondents indicated involvement in such partnerships and/or projects (Prospective Institute, 2022).

The R&D ecosystem in Romania suffers from insufficient collaboration between actors from various sectors due to the lack of a culture of cooperation, mutual trust and effective support mechanisms, factors that prevent its development.

CONCLUSIONS

The R&D system in Romania is poorly attractive for researchers, due to underfunding and the low prestige of universities and institutes, which limits the attraction and retention of high-performing researchers, both from the country and from abroad. Funding tools for young researchers have been reduced, causing them to migrate outside the country or to other better-paid economic sectors. It is necessary to implement institutional funding programs to support high-performing young researchers, especially in research organizations of excellence. The R&D management in Romania faces significant challenges mainly due to inadequate financial instruments to stimulate R&D activities. Additionally, the system suffers from low transparency, excessive bureaucracy, and instability due to frequent changes in secondary legislation and the institutional framework. Romania's R&D ecosystem is further weakened by the Brain Drain Phenomenon (BDP), leading to a shortage of skilled human resources, which negatively impacts the performance and efficiency of the system. To align with the innovative policies of the European Union, the strategic and functional framework of open science in Romania must include the development of researchers' skills, the adoption of new research evaluation metrics and the involvement of citizens in science. Mapping centers of excellence, through partnerships between research organizations, focus resources on advanced research agendas connected to societal challenges and smart specializations, Romania needs to actively participate in addressing global challenges through research, aligning itself with European missions and partnerships.

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