

Romanian Research Infrastructures: Classification, Relevant Key Aspects and Concrete Managerial Needs

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Abstract

Research and innovation infrastructures are facilities that provide resources and services to the research community to conduct research and stimulate innovation. Science, technology, and innovation are essential components of the national development plan and have been recognized as a driver of socio-economic progress in Romania. Finding novel and innovative solutions to socio-economic challenges that we are currently facing requires a better understanding of the concrete managerial needs within the Romanian research infrastructures. This study aimed to identify the infrastructures in Romania that carry out research and innovation activities in priority domains and analyze the managerial needs perceived by people belonging to different research infrastructures to identify the key aspects capable of bringing value to these organizations.

Keywords: Research; Infrastructures; Management; Non-reimbursable resources; Innovation

Introduction

Research and innovation infrastructures are facilities that provide resources and services to the research community in order to conduct research and stimulate innovation. These entities may be located in a single place, distributed, or virtual, and, aside from research, they can be used for other purposes such as education or government services. These facilities, resources, and services, including major scientific research equipment, resources, databases, computing systems, and communication networks, are usually used by the scientific community, industry, or entrepreneurs to solve global challenges. Moreover, research and innovation infrastructures contribute to sustainable economic development and societal growth through technology transfer to the private sector [1,2]. Furthermore, research and innovation have a crucial role in supporting Europe's Recovery from the COVID-19 crisis [3].

Science, technology, and innovation are important components of the national development plan and have been recognized as a driver of socio-economic progress in Europe and Romania. Regardless of whether funded and functioning on a regional, national, or EU level, research and innovation

infrastructures are at the center of the knowledge pyramid of research, education, and innovation, hence playing a critical role in the evolution and dissemination of knowledge and technology [4].

European and national science, technology, and innovation strategies aim to advance scientific excellence within a country to find novel and innovative solutions to socio-economic challenges. As a result, such strategies must be consistent with international trends, policies, and objectives, such as the Sustainable Development Goals (SDGs) and the European Science, Technology, and Innovation Goals (STIGs) [5]. The Commission develops, assesses, and integrates strategies and methods to ensure that Europe has world-class, long-term research infrastructures [6]. The Commission guarantees that these research infrastructures are open and accessible to all researchers and academic staff in Europe and far beyond by collaborating with EU countries participating in the Horizon program. Coordination and cooperation among different research facilities are essential to enhance the output and impact of research carried out. A cross-sectorial or large-scale approach when addressing multidisciplinary scientific problems may prevent the duplication of efforts and fragmentation of research [7–11].

In recent decades, the research infrastructure sector in Europe has flourished and the definition of research infrastructure is expanding. Several framework programs have extended the definition of individual infrastructure for research and demonstrated the benefits of cooperation and collaboration between national centers [4,12].

The national roadmap regarding the research infrastructures in Romania for the period 2017-2025 aimed at creating a list of priority research infrastructures for national support, based on policy documents in the field (the National Strategy for Research, Development and Innovation), on European commitments and international participation of Romania (e.g., participation in pan-European research infrastructures included in the ESFRI Roadmap, etc.), on a prospective substantiation of needs, and on a process of identifying areas of specialization and future development that may have an economic and regional impact [12–15].

The Engage in the Romanian Research Infrastructures System (ERRIS) platform was created in 2015 to support the coordinators of public/private research infrastructures and those who want to benefit from the services offered by these infrastructures, stimulating collaboration and participation in national networks and international profile of the scientific community in Romania [16]. Developed as a social network, the ERRIS platform is a "facebook of things" in which research infrastructures are "actors", having the opportunity to make their services known in a broader and more diverse market. The realization of this platform also responds to the actions necessary for the internationalization of the national system of research, development and innovation, following the National Strategy for Research, Development and Innovation 2014-2020 [17].

From its launch in June 2015 until August 2019, 1,720 research infrastructures with generally public profiles were registered in ERRIS, 8,720 research services and 220 technological services being listed, as well as 23,676 pieces of equipment. Another 482 infrastructures did not have a public account on ERRIS, either because the respective account administrator did not make the account public or because the account did not meet a set of mandatory conditions established by the ERRIS team [18].

In 2016, the National Program for the research and innovation conditioned the participation in the competitions launched by the Ministry of Education and Research to finance the research, by registering in ERRIS the research infrastructures of the applicants. Thereby, the registration rate on the platform was constant during the competition periods. Considering similar initiatives at the European level, the long-term ambition is to internationalize the ERRIS platform, encouraging reciprocal regional cooperation between research groups [18].

This study aimed to identify the infrastructure in Romania that carry out research and innovation activities in priority domains and analyze the managerial needs perceived by people belonging to different research infrastructure to identify the key aspects capable of bringing value to these organizations.

Material and Method

Selection and Description of Participants

The analysis regarding the existing pool of research infrastructures in Romania was taken in terms of presence in the ERRIS platform. In the analysis of the stock of research infrastructures in terms of the presence in ERRIS, only the visible research infrastructures that had associated at least one research equipment, at least one service was taken into account and were financed through SOP non-reimbursable funds in the last 10 years. A series of indicators were assessed, such as the degree of completeness of the data in the ERRIS platform; type of financing (public, private, public-private organizations), number of equipment pieces per research infrastructure, domains/subdomains associated with research infrastructures, the geographical distribution of research infrastructures and equipment. The classification and priority domains in which the research infrastructures offer research services was also assessed.

Methods

The research regarding the existing needs at the managerial level within the infrastructures was carried out through the evaluation questionnaire-type instrumentation on one hundred volunteers belonging to different research infrastructures, both private and public.

Apart from the general questions regarding the professional position and years of experience of the respondents, the size of the research infrastructure and the value of the assets, participants were asked 3 questions about the results of the research activity, to assess the institutional performance, in a possible subsequent correlation with the size, funds and number of researchers, in the activity of operating the questionnaire. The addressed questions referred to the last three years in regards of number of ISI articles resulting from research activity, the number of patents registered, the number of new products / services launched by the organization. The respondents had the opportunity to illustrate both the "pros" and "cons" reasoning for the decision of a young person to be included in the infrastructure managed by each of the surveyed organizations, listing three reasons for each of the two categories (Table 1).

Table 1. Reasons for pursuing a career in a research infrastructure

PROs	CONs
Attractiveness of the research and development sector	Unattractive salary level
State of the art technologies and equipment	Multiple responsibilities
Competitive environment	Very demanding work environment
Possibilities of promotion	Stress; Busy work schedule
Attractive work environment	Lack of financial stability
Freedom	Lack of coherence and inconsistency regarding national research policies, lack of funding
Flexibility	Lack of communication regarding the strategies and planning of development process steps
Non-formalism	Tight deadlines
Motivation atmosphere	Extremely cumbersome carrer promotion
Performance education	Unattractive urbal environment
International visibility; Prestige	Colleagues' abuse due to the direct boss's favoritism
Young, energetic team	Promotion of non-values
Above average salary	Syncope in the supply of reagents and consumables, insufficient infrastructure
Safety	Bureaucracy; inefficient relationship with the administrative departments
Curiosity, Passion, Motivation	
Job possibilities	

At the end of the questionnaire, respondents were asked to identify a number five elements capable of bringing value to the belonging organization, the respondents' answers were merged into 4 large study topics, management, market approach, public policies, respectively resources.

A series of statistical analyses of the ERRIS database were developed as part of the study of the current stock of research infrastructures in terms of their existence in the ERRIS platform, taking into account the reports downloaded in the first trimester of 2021. The information was gathered by accessing the ERRIS platform, <https://eeris.eu>.

Results and Discussion

According to the database, there were 2010 research infrastructures registered in the ERRIS, of which 1,650 had a public profile, and listed both services and equipment. Almost 90% of the infrastructures included in the study were public. The largest number of research equipment and services is associated with public-funded research infrastructures (20,678 equipment and 8,641 services), compared to the private organizations, to which are associated 1,830 equipment and 623 services.

In order to be able to properly assess the needs of the national infrastructures and to be able to support them through clusters, we conducted a questionnaire-based evaluation of both private and public infrastructure. Research on existing managerial infrastructure needs has been conducted upon completion of the evaluation questionnaire-type instrumentation, and the profile of the respondents is presented in Figure 1.

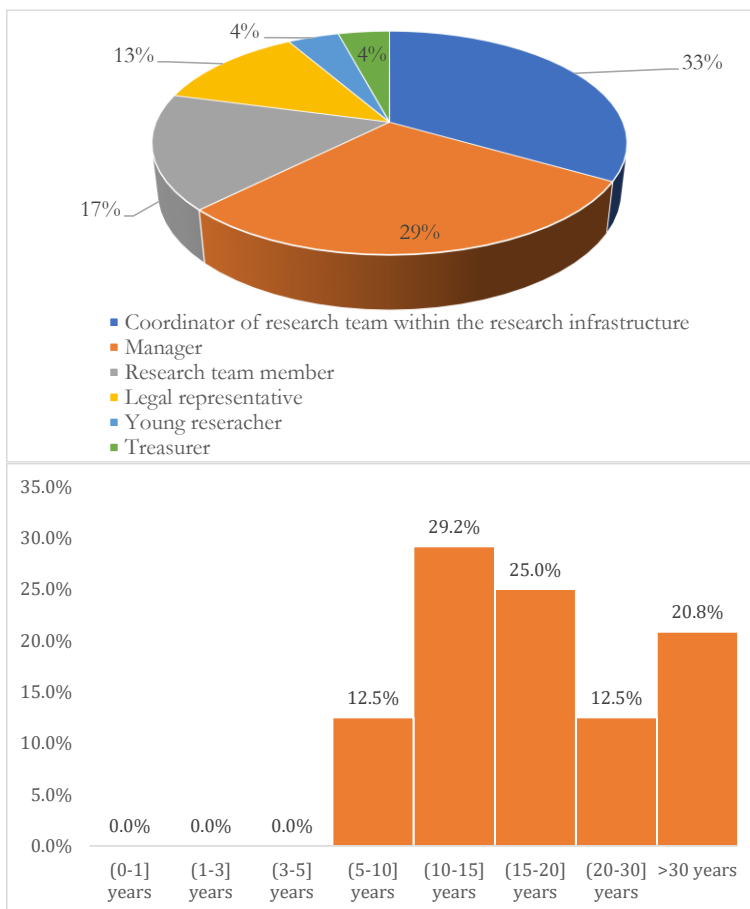


Figure 1. Professional position and years of experience of the respondents

Over 75% of respondents have more than 10 decades of experience in the organization and hold a top management position. The fewest respondents are young researchers or have less than one year of experience in the organization. Most of the respondents were declared as being in a leadership position and almost a third in a management position. The structural analysis of the group was a necessary step to give validity to the answers and prove that they are provided by people with an overview of the activities, difficulties, and strategy of the organization they represent.

Approximately one-third of the respondents occupied, by subjective assessment, a position in which they coordinated the staff that generated knowledge or were part of the research team that generates knowledge at the request of management, occupying when an executive position in the organization that they represented when completing the present questionnaire (Figure 2).

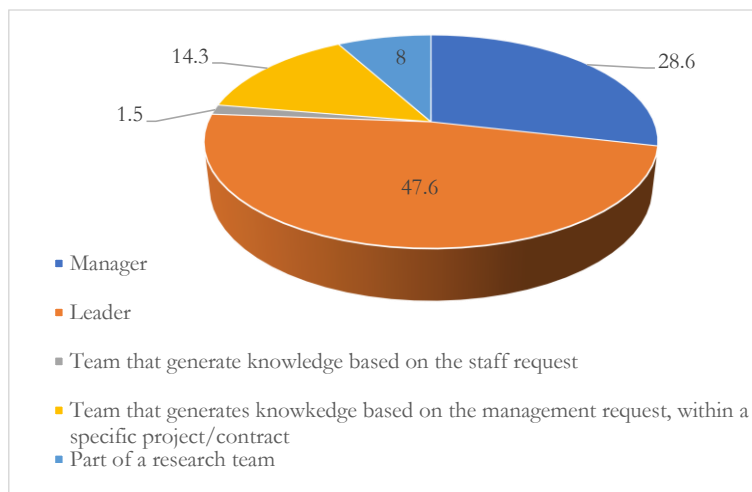


Figure 2. The respondent's perception about his / her relationship in relation to the belonging organization

Regarding the organization hosting the infrastructure, 67% of respondents declared that they belong to a public institution, 52% having Health as the major field of activity. The second most representative category was the privately funded institutions, with activity in the field of materials (Figure 3). In terms of areas of activity, the percentages were equal between the fields of ICT, bioeconomy, environment, food, and nuclear physics (Figure 4).

Over 66% of respondents identify public funds as the primary source of income, while funds of private origin are identified in a proportion of only 28.8%. Moreover, over 35% of the respondents do not know the real percentage of private funds used, while 20% of those who identify them, appreciate their share at over 75%. Disregarding the challenges confronting Romania's research and innovation system, the prioritization of public funds allotment, and neglecting effective incentives for increasing private sector contribution to RDI funding will keep Romania labeled as a "modest innovator," ranking it among the least in the EU in terms of performance indicators [19]. According to a study conducted by Romanian policy makers should encourage R&D investment and foster an atmosphere conducive to growing returns [20]. In contrast, within the EU, the corporate sector continues to be the primary source of funding for R&D operations, Northern and Western European nations having the greatest R&D spending, which is also characterized by a high proportion of business-financed R&D. Despite having smaller R&D shares, the higher education and government sectors have been more resilient to economic fluctuations [21].

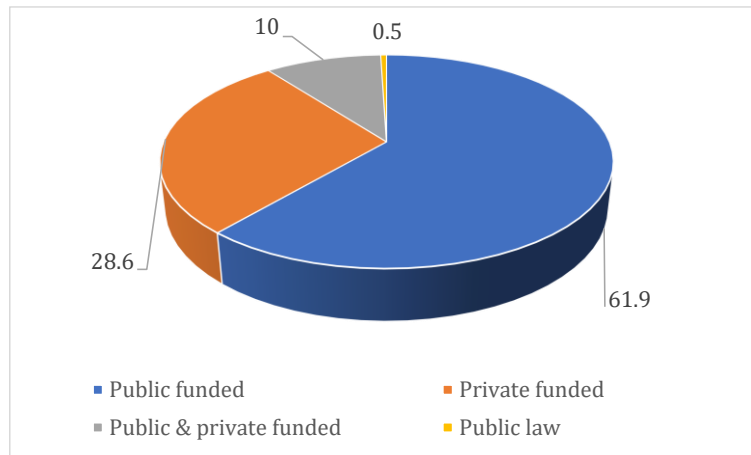


Figure 3. Type of organization in which the respondents activate

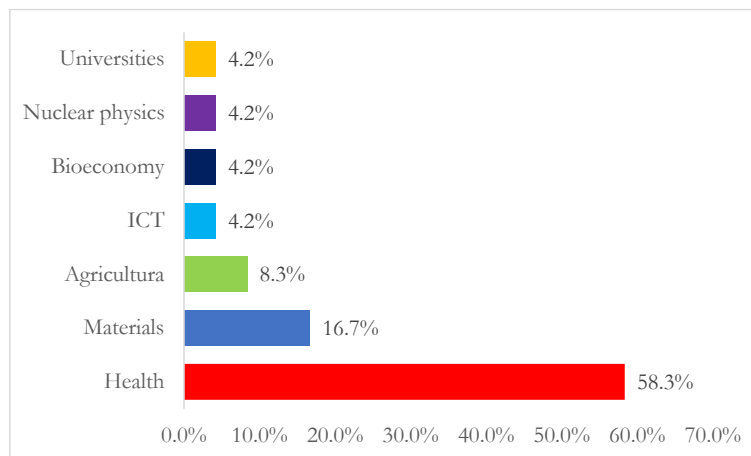


Figure 4. Type of major domains in which the infrastructures offer research services

The size of the interviewed research and development infrastructures, regardless of the nature of the funds (public, private, or public-private), was estimated by assessing the value of infrastructure assets (Figure 5). Surprisingly, most respondents (28%) stated that they did not have this information. The following percentage was 19%, corresponding to infrastructure with assets between 1-5 million euros and 5-10 million euros, respectively. This analysis was performed for further integration into the Romanian innovative entrepreneurship, start-up and scale-up ecosystem overview.

Apart from analyzing the infrastructures from the financial point of view, the fields of activity and the source of funds, the structure of the human resource was also analyzed. This analysis was carried out due to the fact that one of the problems identified in the previous studies both in terms of entrepreneurial capacity and the possibility of technology transfer was the specialized human resources.

From the perspective of the human resource, the data collected show that 33.3% of the research infrastructures taken into study have a small number of researchers as employees (10- 50 employees) and 33.3% very small (0-9 people). The majority of the analyzed infrastructures (Figure 6).

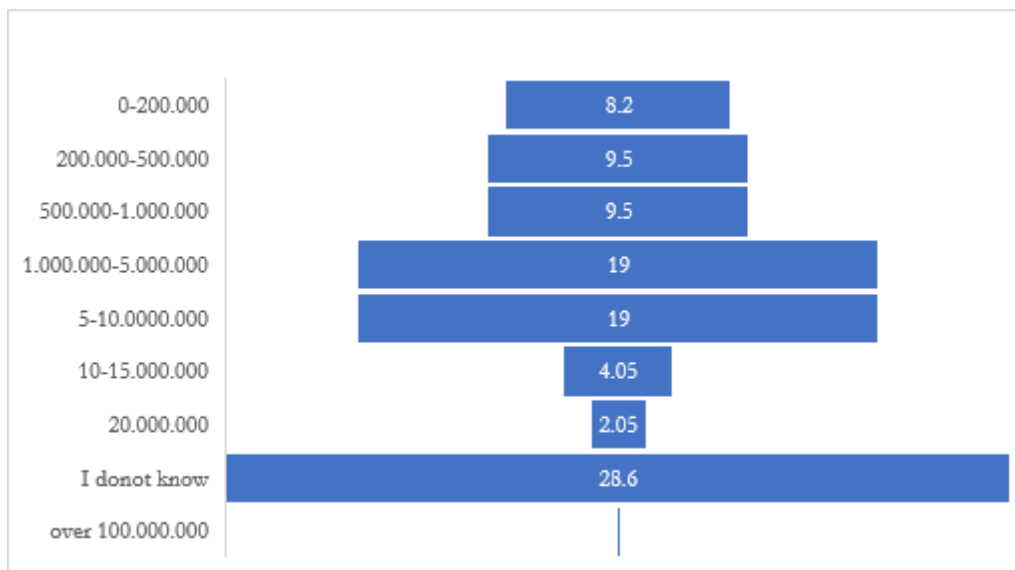


Figure 5. Value dimension of the research infrastructure assets

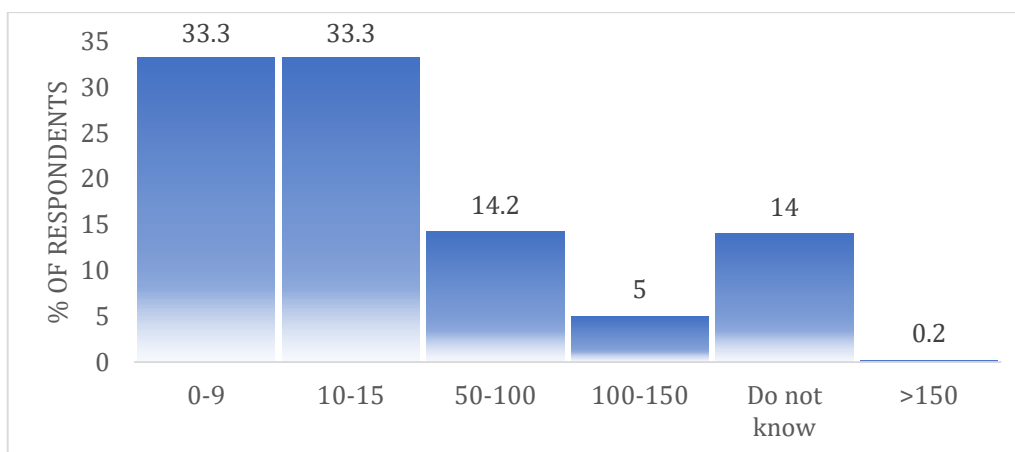


Figure 6. Number of research staff in the analyzed research infrastructures

The performance of each research infrastructure was assessed, in line with the national evaluation criteria such as ARACIS and the reported total number of patents filed by the institution, publish ISI indexed articles. Some of these indicators are included in the Methodology for evaluating the innovation activity of research and development institutes in Romania, published in 2020 [22]. One third of the respondents declared they do not know the number of patents registered in the last 3 years by the entity, neither the number of articles with ISI impact factor published. Over 25% of the respondents stated that they do not know the organization's innovative products / services. About three-quarters of respondents were unable to answer to the question regarding the values of patent exploitation in the last 10 years, although a large of the respondents were managers in the institution and have more than 10 years of experience in that infrastructure. In a study conducted by Băcescu-Cărbunaru and Condruz-Bacescu in 2014, it was concluded that Romania has a low degree of innovation and research culture, both in the corporate sector and in universities. In contrast to industrialized nations, significant technical deficits encourage technology import to the disadvantage of innovation engagement with the international environment (23). At the same time, the questionnaire addressed the issue related to the load work assigned to the staff. In addition to the lack of information, overload at the organizational level was present, 33% of employees being loaded above the optimal level.

Regarding the time required for respondents to formulate documented responses regarded prior information, following consultation with relevant departments within the relevant organizations, it was found that over 70% of respondents need a minimum of a few days to have a documented response in real-time (Figure 7).

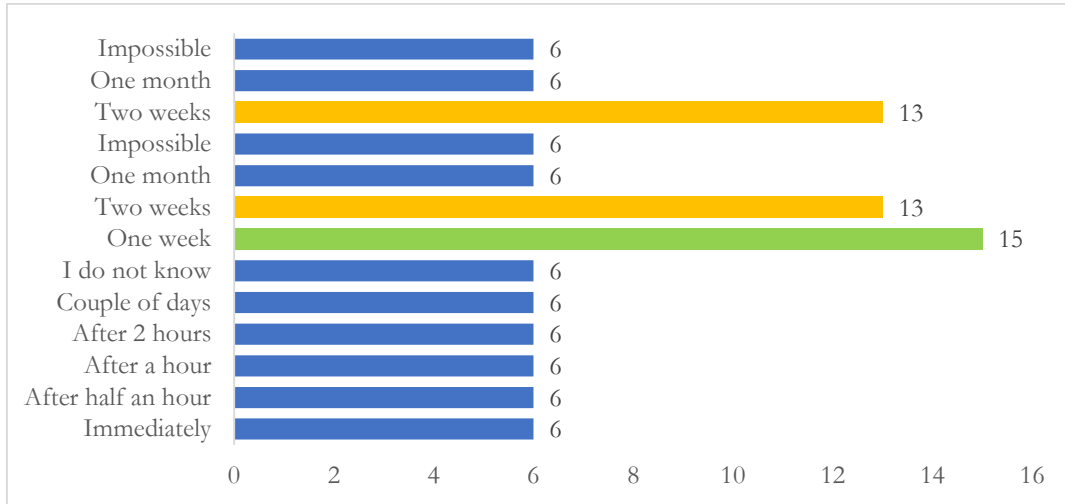


Figure 7. Time required for respondents to formulate documented responses

From the perspective of gender distribution at the infrastructure level, the answers given by the participants indicate that in 25% of the infrastructure the women represent 80% of the employees (Figure 8).

The approaches followed in the questionnaire also aimed at revealing the time dedicated to the study of the literature and strategic planning. The results indicate that at the level of the entire respondent spectrum, there is an increased exponential interest, the activities in the field representing concerns carried out regularly.

The respondents concluded that the main criteria for pursuing a career in research infrastructure are the attractiveness of the field together with the access to state-of-the-art equipment and technologies and the working environment that is intended to be competitive but at the same time flexible (Figure 9).

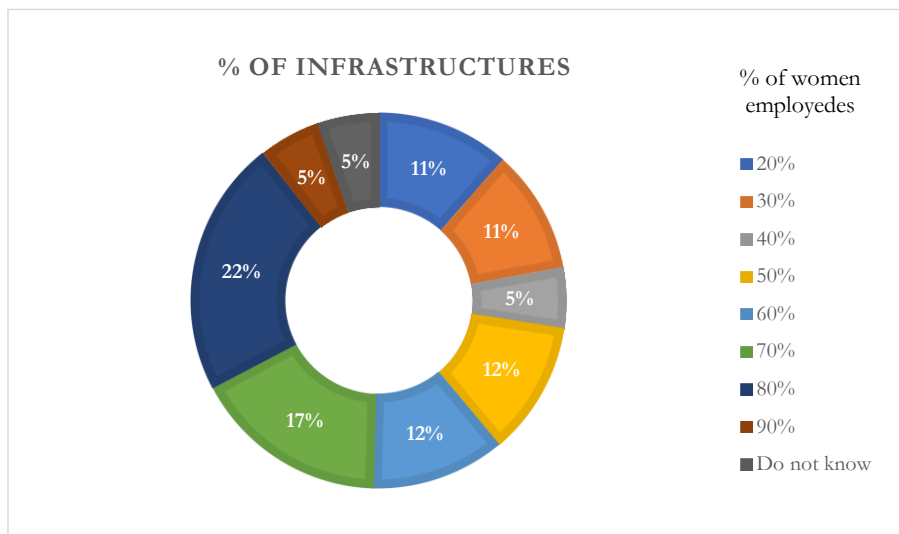


Figure 8. Gender distribution in the analyzed research infrastructures

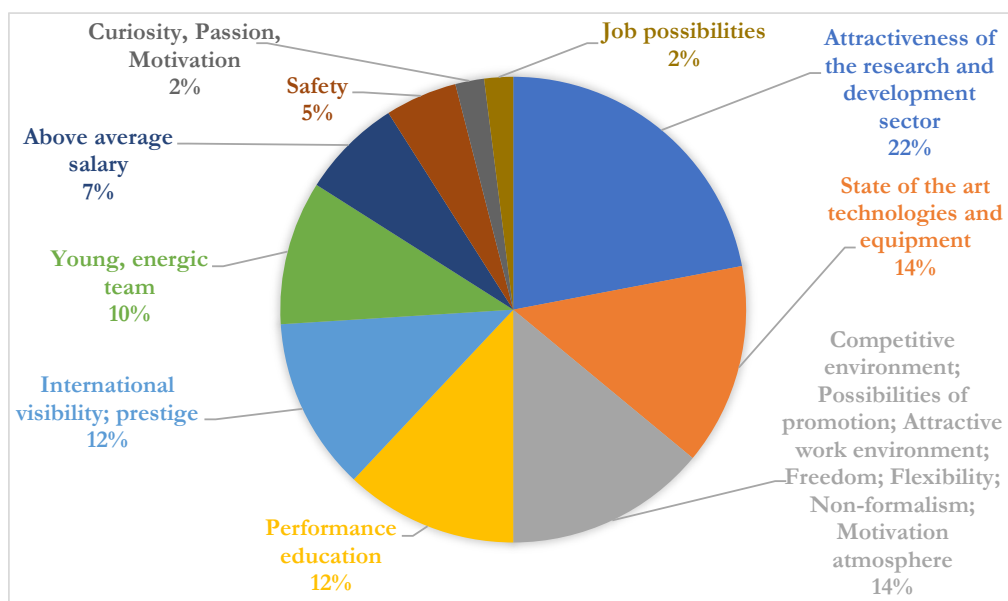


Figure 9. PRO arguments identified by the respondents for pursuing a career in a research infrastructure

As arguments against pursuing a career in research infrastructure, the first identified is the unattractive salary level. These multiple responsibilities, together with the lack of coherence and inconsistency of national research policies and a stressful work environment, may prevent young people from considering working in these infrastructures.

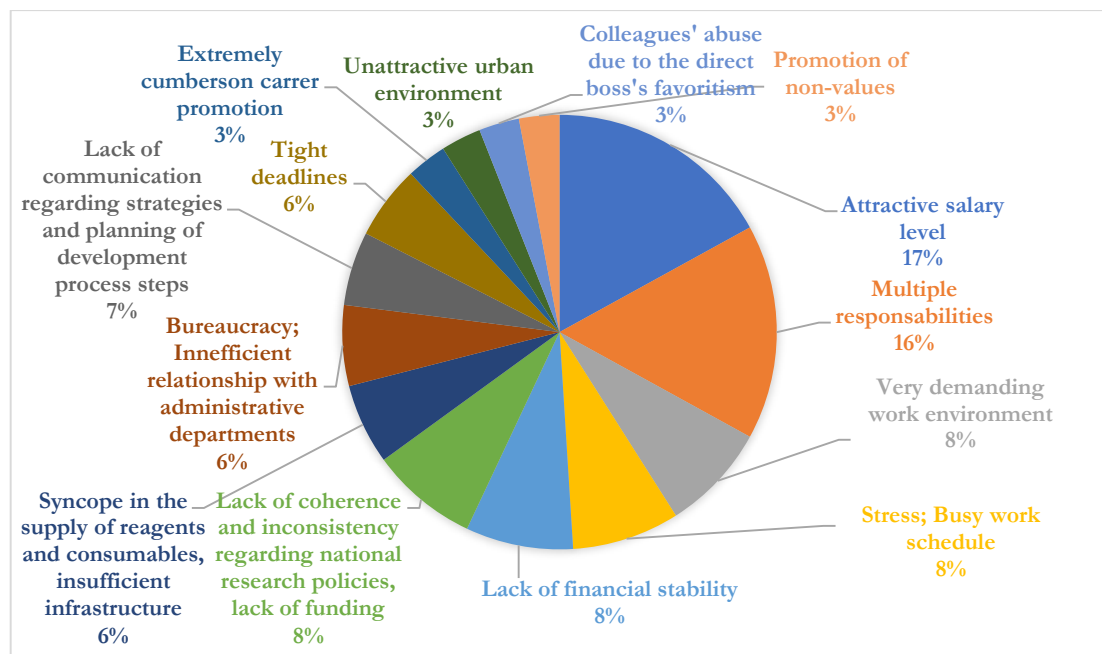


Figure 10. CON arguments identified by the respondents for pursuing a career in a research infrastructure

The elements capable of bringing value to the belonging organization, identified by respondents', were merged into four large study topics, including management, market, public polies and resources,

to be addressed in further studies from the perspective of quality improvement for the management of modern sustainable research-development-innovation infrastructures (Table 2).

Table 2. Elements identified by respondents' as being capable of bringing value to the belonging organization

MANAGEMENT
<ul style="list-style-type: none">• Clearer procedures;• Reduction of bureaucracy,• Better scheduling of tasks and time• Adherence to a clear program• Organizational culture• Dedicated / specialized management;• Flair, vision• Issuing system procedures and observing them by each employee;• Meetings scheduled at the beginning and end of the week; clear and precise Determination of the responsibilities of each employee;• Possibility of direct promotion independent of management;• Visibility;• Transparency of projects and strategy; collective thinking and not individual thinking,• Optimized organization pyramid;
MARKET
<ul style="list-style-type: none">• Identifying at national level the real need for new knowledge, technologies, products and services;• Collaborations with researchers from other fields of research;• Inclusion in international research consortia;• Marketing for research;• Supporting technology transfer through specific programs;• Participation in international projects,• Collaborations with universities,• Collaborations with the private environment• An active presence at international trade fairs• Developing a marketing department• Rapid adaptation to market demand
PUBLIC POLICIES
<ul style="list-style-type: none">• Professionalism of the authorities,• Coherent national research policies• Ensuring continuity in research activity;• Stability

Table 2. (continuation) Elements identified by respondents' as being capable of bringing value to the belonging organization

RESOURCES	
Financial Resources	<ul style="list-style-type: none"> • Investment funds, • Funding of long-term research programs / projects, • Predictable funding (regular national competitions, in areas of smart specialization); • Basic financing • Providing support funding for human resources
Human Resources	<ul style="list-style-type: none"> • Additional staff • Providing support funding for human resources (a researcher is trained in 7-10 years), • Maximum involvement of employees in the daily work carried out; New employees with experience > 5 years, • Competent researchers for key fields; • Adequate financial motivation of the staff in the position they hold; • Regular selection of staff involved and recruitment of new people who may develop the organization. • Quality of the staff, the knowledge of the norms of professional deontology • Greater consistency of the feeling of duty at work • Loyalty to the institution • Responsibility and attention of the institution towards the work of each employee • Qualified human resources and young people with the desire to improve; • Changes in the management staff; • Dismissal of non-values • Promotion of staff personnel eager to raise their professional level • Courses
Material Resources	<ul style="list-style-type: none"> • material resource (small equipment wears out in 2-5 years); • centralized maintenance of equipment at the level of the institution; • state-of-the-art equipment

Conclusions

As the Europe 2020 strategy is implemented over the next decade, research infrastructures will play an important role in stimulating innovation, meeting new societal challenges, and driving openness, excellence and collaboration. The research infrastructures are dedicated to providing the scientific community with world-class facilities. The more complete and complex they are, the more competition is to use them - and thus, an international assessment system must be developed to ensure that the best projects and researchers have proper access in research infrastructures. The Romanian entrepreneurship environment is in its early stages. While the country has a lot of potential, its transition dynamics onto a more innovative economy and digital society are weak. The most significant impediments to its development are the lack of confidence, predictability, and openness, inadequate cooperation among government policymakers, and access to financing.

List of abbreviations

- ERRIS- European Research Infrastructures System, the booking gate for research infrastructures, research & technological services

- ARACIS - Romanian Agency for Quality Assurance in Higher Education
- EUROPE 2020- is the EU's ten-year strategy for smart, sustainable and inclusive growth.

Conflict of Interest

The authors declare that they have no conflict of interest.

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References

1. Palei T. Assessing the Impact of Infrastructure on Economic Growth and Global Competitiveness. *Procedia Economics and Finance*. 2015;23:168-175. doi: 10.1016/S2212-5671(15)00322-6
2. Maradana RP, Pradhan RP, Dash S, Gaurav K, Jayakumar M, Chatterjee D. Does innovation promote economic growth? Evidence from European countries. *Journal of Innovation and Entrepreneurship*. 2017;6(1):1-23.
3. Arjona Román, Samson Ramona. The role of research and innovation in support of Europe's Recovery from the COVID-19 crisis. R&I Paper Series Policy Brief. Luxembourg: Publications Office of the European Union, 2020.
4. Ewart C, Fletcher P, Bollinger I, Sgard F, Morris J. Optimising the Operation and Use of National Research Infrastructures [Internet]. 2020 [cited 2021 Jan 12]. Available from: <https://www.scienceurope.org/media/cbchuqj/se-oecd-policy-paper-optimising-the-operation-and-use-of-national-research-infrastructures-aug-2020.pdf>
5. OECD Science T and IPP. Strengthening the effectiveness and sustainability of international researchinfrastructures [Internet]. 2017 [cited 2021 Mar 11]. Available from: doi:10.1787/fa11a0e0-en
6. European Charter for Access to Research Infrastructures: Principles and Guidelines for Access and Related Services, European Commission, Brussels. 2016 [cited 2021 Mar 11] Available from: <https://op.europa.eu/en/publication-detail/-/publication/78e87306-48bc-11e6-9c64-01aa75ed71a1/>
7. Dixon BE, Whipple EC, Lajiness JM, Murray MD. Utilizing an integrated infrastructure for outcomes research: a systematic review. *Health Information & Libraries Journal*. 2016;33(1): 7-32. doi: 10.1111/hir.12127.
8. Strategic Priorities, Funding and Pan-European Co-operation for Research Infrastructures in Europe. [Internet]. 2016 [cited 2021 Mar 12]. Available from: <https://www.scienceurope.org/our-resources/strategic-priorities-funding-and-pan-european-co-operation-for-research-infrastructures-in-europe>
9. Cross-border Collaboration and Portfolio Management of Research Infrastructures, Science Europe, Brussel [Internet]. 2017 [cited 2021 Mar 12]. Available from: , <https://www.scienceurope.org/our-resources/cross-border-collaboration-and-portfolio-management-of-research-infrastructures/>.
10. Crewe TL, Kendal D, Campbell HA. Motivations and fears driving participation in collaborative research infrastructure for animal tracking. *PLOS ONE*. 2020;15(11):e0241964. doi: 10.1371/journal.pone.024196.
11. Oxford JT, Cornell KA, Romero JJ, Smith DB, Yarnell TL, Wood RM, et al. Center of Biomedical Research Excellence in Matrix Biology: Building Research Infrastructure, Supporting Young

- Researchers, and Fostering Collaboration. *International Journal of Molecular Sciences*. 2020;21(6):2141. doi: 10.3390/ijms21062141.
12. Reference framework for assessing the scientific and socio-economic impact of research infrastructures [Internet]. 2019 [cited 2021 Feb 13]. Available from: https://www.oecd-ilibrary.org/science-and-technology/reference-framework-for-assessing-the-scientific-and-socio-economic-impact-of-research-infrastructures_3ffee43b-en
 13. Vulturescu V. Research Infrastructures in Romania. Impact of Public Funding in Scientific Outputs. *Review of General Management*. 2015;22(2):90–103.
 14. Chioncel MF, del Rio JC. RIO Country Report 2017:Romania. [cited 2021 Jan 12]; Available from: https://rio.jrc.ec.europa.eu/sites/default/files/riowatch_country_report/RIO_CR_RO_2017_PUBSY_IDF.pdf
 15. Rusu RD. Romania's Research and Innovation Area: The Beginning of a Swot Analysis. *Review of Economic & Business Studies*. 2019;12(2):191-205.
 16. Digital platforms for facilitating access to research infrastructures. [Internet] 2017. [cited 2021 Feb 13]. Available from: <https://community.oecd.org/docs/DOC-156267>
 17. National Strategy for Research, Development and Innovation 2014–2020 [Internet]. Ministry of Education and Research; [cited 2021 Mar 17]. Available from: www.edu.ro/sites/default/files/_fișiere/Minister/2016/strategii/strategia-cdi-2020_-proiect-hg.pdf
 18. UEFISCDI. Raport UEFISCDI privind infrastructurile de cercetare la nivel national-generat din platforma ERRIS. 2017 [cited 2021 Apr 12]; Available from: www.poc.research.gov.ro/uploads/despre-oicercetare/documente-de-programare/exante/erris-raport-pt-cric.pdf
 19. Sandu S, Anghel I. New Challenges for R&D and Innovation in Romania. *Annales Universitatis Apulensis Series Oeconomica*. 2012;2(14):618-627.
 20. Sandu S. Main Issues of R&D Financing in Romania. *Romanian Journal of Economics*. 2010;30(1):127–145.
 21. Europe 2020 indicators - R&D and innovation- EUROSTAT. [Internet] 2017. [cited 2021 Mar 17]. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Europe_2020_indicators_-_R%26D_and_innovation&oldid=335438
 22. Methodology for evaluating the innovation activity of research and development institutes in Romania [Internet]. 2020 [cited 2021 Apr 12]. Available from: <http://www.incd2020.ro/sites/default/files/Methodol%20eval%20activ%20inovare%20INCD-uri.pdf>
 23. Băcescu-Cărbunaru A, Condruz-Bacescu M. Scientific Research Management in Romania. *Revista de Management Comparat Internațional*. 2014;15(1):125-139.