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Nelly Țurcan[1], Gheorghe Cuciureanu[2], Rodica Cujba[3], Irina Cojocanu[4], Igor Cojocaru[5]

Readiness Toward the Implementation of Open Science Initiatives In the Republic of Moldova

ABSTRACT: *Open Science paradigm involves transformations throughout the entire cycle of scientific research. Decision-makers play the key role of paradigm change facilitators. Consequently, the promotion of Open Science requires a political commitment.*
Even though Open Science movement emerged at the international level back in 2002, its principles are being implemented quite slowly in the Republic of Moldova.
Thus, the current study aims to analyze the importance and benefits of Open Science policy implementation, the strategic priorities of the Republic of Moldova on Open Science, barriers in transition to Open Science in the Republic of Moldova, and identification of the key actors in development, adoption, and implementation of Open Science policies in the Republic of Moldova.
The study employed a mixed method: survey among members of the scientific community (quantitative data collection) and semi-structured interviews of the key informants in Open Science policies and practices (qualitative data collection).

KEYWORDS: Open Science, Open Access, Open Data, scientific community, Republic of Moldova

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INTRODUCTION

Open Science is the new paradigm of scientific research and involves transformations throughout its entire cycle. These changes can only happen, granted the involvement of all stakeholders and the use of different tools. The role of process facilitator rests mainly with the government and government policies.

Political commitment is needed to promote Open Science and integrate it into government agendas. This requires Open Science policies to be formulated and developed in clear strategies, as well as resources to be allocated for the implementation of the policies (Gema Bueno de la Fuente, 2016). An effective Open Science policy must be supported by adequate financial and human resources (UNESCO, 2022).

At the international level, there are several approved documents that emphasize the importance of public policies for the promotion of Open Science and consequently recommend states to develop and implement these. The relevant policies reinforce the fact that Open Science is becoming a focal point of the political agenda, at both national and international levels, and the pertaining policies and measures for its implementation are increasing in number and efficiency.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) Recommendation on Open Science, approved in November 2021, states that countries should establish or encourage an enabling environment (at institutional, national, regional and international levels) that supports the operationalization of Open Science and the effective implementation of its

1 Prof., PhD. Information Society Development Institute, Moldova State University, Department of Communication and Theory of Information, Chisinau, Republic of Moldova. ORCID: 0000-0001-8475-0770, nelly.turcan@idsi.md

2 Assoc. Prof., PhD. Information Society Development Institute, National Agency for Quality Assurance in Education and Research, Chisinau, Republic of Moldova. ORCID: 0000-0003-2140-0591, gheorghe.cuciureanu@idsi.md

3 PhD. Technical University of Moldova, Information Society Development Institute, Chisinau, Republic of Moldova. ORCID: 0000-0002-7982-6184, rodica.cujba@adm.utm.md

4 PhD student, Moldova State University. ORCID: 0000-0001-5591-422X, irisha.cojocaru@gmail.com

5 PhD. Information Society Development Institute, Chisinau, Republic of Moldova. ORCID: 0000-0002-4318-9240, igor.cojocaru@idsi.md

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practices. The document recommendations refer to developing national policies and effective regulatory framework via a transparent, participatory, multi-stakeholder process, involving dialogue with the scientific community and other Open Science actors, approving relevant policies at different levels, encouraging actors to implement such policies, respecting the diversity of approaches, developing, implementing, and monitoring funding and investment policies and strategies in scientific research, based on the values and principles of Open Science, and so on (UNESCO, 2021).

Open science is a policy priority of the European Commission and the standard operating method for its research and innovation funding programs because it improves the quality, efficiency, and responsiveness of research. When researchers share knowledge and data as early as possible in the research process with all relevant stakeholders, it helps to disseminate the latest knowledge. Also, when partners from academia, industry, government, and citizen groups are invited to participate in research and innovation, creativity and confidence in science grow (European Commission, 2020).

The policies and mechanisms developed and implemented at the European Union (EU) level are diverse, supporting the needs of the various actors involved. The EU has developed an advanced comprehensive framework on Open Science, which addresses the development (including expert groups and advisory platforms), implementation (including projects and infrastructures) and monitoring (including the Open Science monitor and studies) of policies. The EU policy aims at Open Access to all publicly funded research results and access to research data, based on the principle "as open as possible and as closed as necessary" (European Commission, 2020).

Open Science policies should be based on internationally recognized principles, but adapted to local environments. National public policies must take into account not only specific conditions, governance structures, and legal regulations, but also issues related to commercial interests and the need for data protection. Decision-makers are also faced with the challenge of keeping the balance between opening up science and guaranteeing competition in scientific research. UNESCO recommends the alignment of Open Science policies, strategies, and actions from individual institutions to the local and international levels, their development and implementation in collaboration with national science academies, young researchers' associations, as well as the business sector (UNESCO, 2021).

National Open Science policies, developed by the EU Member States according to local specifics, can be classified into major groups: 1) national policies and legislation (e.g., Law 2016-1321 in France or Law 14/ 2011 on science, technology, and innovation in Spain); 2) funder policy (e.g., Deutsche Forschungsgemeinschaft [DFG], Germany's main research funder has adopted Open Access policies); 3) national plan (e.g., the Belgian Code of Ethics or the Dutch National Plan); 4) declaration and concordat (e.g., Greek Declaration, UK Concordat, or Italian Memorandum of Understanding); and 5) acknowledgments and recommendations (e.g., the governmental document mentioning Open Access as a priority direction in Latvia, efforts to form a national strategy in Albania, National Guidelines in Estonia, Data Principles and Guidelines in Norway, the Luxembourg institutional recommendations, or the Swiss White Paper) (Toli et al., 2020).

Thus, the current study aims to analyze the importance and benefits of Open Science policy implementation, the strategic priorities of the Republic of Moldova on Open Science, barriers in transition to Open Science in the Republic of Moldova, and identification of the key actors in development, adoption, and implementation of Open Science policies in the Republic of Moldova.

LITERATURE REVIEW: THE ROLE OF PUBLIC POLICIES FOR OPENNESS OF SCIENCE

The documents developed by different international structures focus on public policies in promoting Open Science and its various aspects, including the documents and reports of the Organization for Economic Cooperation and Development (OECD, 2020, 2022), International Science Council (Boulton, G.S., 2021; ISC, 2021), European University Association (EUA, 2022; EUA, n.d.), and especially those developed by UNESCO (UNESCO, 2021; UNESCO, n.d.). These documents are based on studies and surveys and therefore reflect the opinion of different stakeholders toward Open Science policies. The EUA survey from 2017 to 2018 showed that universities believe the policies promoted in the EU, especially the mandatory policies on Open Access to research publications and the research data management, are significant factors for Open Science advancement (Morais and Borrell-Damian, 2019). The UNESCO Recommendation on Open Science, highlighting the role of public policies in opening up science, was based on a broad consultation process, including all countries and stakeholders, such as the Member States, the scientific community, main international and national scientific organizations, other relevant UN agencies, and citizens and owners of traditional knowledge, all united under a Global Open Science Partnership (UNESCO, n.d.).

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Although most scientific studies do not explicitly address the role of public policies in opening up science, most of them conclude with recommendations for Open Science public policies or analysis of their impact. This fact highlights the importance of a national Open Science policy framework. In developed countries, especially in Europe, governments, upon acknowledging the significance of Open Science, took the lead and played a dominant role in Open Science movement (Gong, 2022). At the national level, several European states have adopted efficient public policies to stimulate Open Science (Maddi et al., 2021). On the other hand, even though the trends toward Open Science are positive, strategies are needed to encourage relevant negotiations within the scientific community and the willingness to experiment scientific communication needed to shape the future criteria of science (Heise and Pearce, 2020).

One of the studies, examining closely the influence of Open Science policies on research processes and outcomes, which involved interviewing UK biologists, showed that understanding the implications of these policies means paying particular attention to the variety of shapes that openness can take at different stages and places of the research cycle. Diverse and sometimes contradictory government policies on Open Access and open data not only encouraged the sharing and dissemination of publications and data, but also impacted on decisions regarding certain intellectual property licenses that define the use, reuse, and sharing rights (Levin et al., 2016).

The importance of an Open Science policy derived from national needs is inferred from the survey results of Colombian researchers, which revealed that 93.75% of respondents believe the country should have an integrated Open Science public policy and its main priorities should be developing strategies and tools to guarantee free access to scientific information in a timely manner (91% fully agree), improving the skills and competence of researchers in using information systems (83% fully agree) and designing effective incentives for the scientific community to get involved in Open Science (Pardo Martínez and Poveda, 2018). The acceptance and need for policies supporting Open Science has also been demonstrated for domain-specific researchers, for example, biomedical scientists from the US National Institutes of Health, regarding the Open Access policy (O'Hanlon et al., 2020).

A study conducted in South Korea highlights the limited progress in Open Science due to the lack of a comprehensive national policy in this area. This situation is caused by insufficient political will, inadequate coordination among national stakeholders, and the lack of a holistic approach at the government level regarding systematic implementation of Open Science; limited number of national and institutional legal instruments that explicitly encourage or enforce Open Science; the lack of reward mechanisms for Open Science practices as part of researchers' assessment; and so on (Shmagun et al., 2022). The significance of national policies is also illustrated by survey results of Australian researchers, indicating that successful transition to Open Science is possible when the responsibility for strengthening transparency and openness lies not just with scientists and researchers, but also with research funding and support agencies, and even those beyond the research and innovation sector (Lacey et al., 2020). The policies of research funding councils are crucial in promoting Open Science in the UK, USA, and Canada. These councils are seen as key actors in Open Science debates and should, therefore, focus their efforts around the demands of various stakeholders, consisting of governments, academic and research communities, and publishers. At the same time, building an effective research infrastructure for Open Science means more clarity in terms of approaches and tools employed by research councils to better understand the direction of policies and institutional frameworks that support Open Science internationally (Lasthiotakis et al., 2015). The need for a policy on Open Science funding also emerges from the survey of Polish researchers, who claim that the principles of Open Science are insufficiently supported by the national funding agency (Ostaszewski, 2014).

Some studies demonstrate the existence of positive correlations between the adopted policies and different components of Open Science, for example, data sharing (Abdullahi et al., 2021; Cook-Deegan et al., 2017; Gewin, 2016). Research methods, processes, settings, and goals are highly contextual, therefore, Open Science policies must account for the diversity of research contexts. Openness is not always justified or useful, and it definitely is not a general policy that applies indiscriminately to all stages of research in various fields. Unfortunately, the diversity and contextual nature of openness are not always considered in broad Open Science policies and recommendations (Levin et al., 2016).

Studies show that national public policies should recognize the specific characteristics of scientific communities and adjust accordingly, depending on case. Efforts to impose a single approach on Open Access may lead to a dead end, definitely not Open Science (Schöpfel et al., 2016). At the same time, there is a discrepancy between Open Science policies and their implementation (Manco, 2022). However, more empirical research is needed to show how Open Science policies, including Open Access and open data policies, have implications for peer review procedures, fostering excellence, and sharing (or not) research data (Levin et al., 2016).

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METHODS

Overview of research design

Research design can be divided in three basic types: exploratory sequential designs, explanatory sequential designs, and convergent designs (Creswell, 2015). The exploratory design begins with qualitative data collection and analysis phase, which builds to the subsequent quantitative phase. The explanatory design begins with quantitative data collection and analysis phase, which serves as input for the qualitative research phase. Convergent design means the simultaneous collection and analysis of quantitative and qualitative data, followed by an integrated analysis.

The current study employs an explanatory design, with mixed sequential methods, to investigate the outlook of the scientific community in the Republic of Moldova on Open Science, as well as the actions needed to create a favorable framework for open research and alignment with the European Open Science practices.

The reason for sequential explanatory design of the mixed method is that often, "quantitative data and their subsequent analysis provide a general understanding," while "qualitative data and their analysis refine and explain those statistical results" (Ivankova et al., 2006). Most of the literature suggests that quantitative methods usually take precedence (Creswell and Plano Clark, 2018; Doyle et al., 2016; Harrison and Reilly, 2011; Jeanty and Hibel, 2014; Stentz et al., 2012; Walker and Baxter, 2019).

In this framework, an initial quantitative investigation (Study 1) informed the subsequent qualitative study (Study 2). Therefore, the qualitative study was based on the results of the quantitative study (Creswell, 2015, p. 37).

The integration of quantitative and qualitative data as a central element of mixed methods has been increasingly highlighted (Brannen, 2005; Hands, 2022; Morgan, 2007; O'Cathain et al., 2007; Santos et al., 2017). Integration is an intentional process by which the researcher brings together quantitative and qualitative approaches in a study (Creswell, 2015, p. 2). Quantitative and qualitative data then become interdependent in addressing common research questions and hypotheses (Bazeley, 2012, p. 816).

Most commonly, the use of a mixed methods design is determined by pragmatic issues: the increasing demand for cost-effective research and the shift from theory-based research to research that meets the requirements of policymakers and practitioners, as well as competition for research funding (Brannen, 2005; O'Cathain et al., 2007).

When qualitative and quantitative methods are integrated in a single study, one method usually takes precedence over the other. In such cases, the purpose of the study, the rationale for using mixed methods, and the ratio of each method determine whether and how the empirical results are to be integrated (Östlund et al., 2011). Mixed methods can also help highlight similarities and differences between certain aspects of a phenomenon (Bernardi et al., 2007). Mixed methods research provides a more balanced perspective, joining the benefits of both methods, as well as compensating the weaknesses resulting from a single method (McKim, 2017).

This robust approach takes advantage of the strengths of both types of research. In Study 1, a survey was conducted on the attitude of the scientific community in the Republic of Moldova regarding Open Science. In Study 2, semi-structured interviews were carried out, gathering in-depth perspective on the beliefs and attitudes of political decision-makers and administrative and management staff of research and university institutions, regarding the adoption of Open Science policies in the Republic of Moldova, as well as the actions needed to create a favorable framework for open research. This allowed for the quantitative measures for the adoption and use of Open Science practices, as well as the exploration of policy actions that could potentially influence the expansion of these practices.

Target population, sample size, and sampling

Study 1

An online survey of scientific actors was conducted to explore the attitude and identify the awareness of Open Science practices of the scientific community in the Republic of Moldova.

The target population of the quantitative study was the scientific community in the Republic of Moldova, including researchers, scientific and teaching staff, administrative and management staff from the Research–Development–Innovation (RDI) area, doctoral students, postdoctoral fellows, librarians, as well as RDI decision-makers. The minimum sample size, needed to assess socioeconomic factors associated with Open Science practice, was estimated using the Krejcie and Morgan calculations (Krejcie and Morgan, 1970).

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Based on these suggestions, a minimum sample size of 389 respondents was estimated. Anticipating a certain nonresponse rate, 685 responses were collected for the online survey. Several types of nonresponse rates are typical for web surveys (Vicente and Reis, 2010, p. 253). Experimental comparisons between web surveys and other types of survey have not identified any changes (Daikeler et al., 2020). The analysis has not identified any concerning differences in survey noncompletion rates, based on the survey type – online or paper based (Denscombe, 2009, p. 289); also, it has not identified any statistically significant difference in the average nonresponse rate in online surveys, compared to other survey methods (Čehovin et al., 2022, p. 15).

Six hundred and eighty-five participants answered at least one question, and therefore were considered for the survey. Of them, 532 (77%) participants who started the survey had filled it in online and provided their informed consent for participation in the study. The remaining 153 (23%) participants did not finish the survey (answering only the sociodemographic items). Out of 532 valid responses, 423 were complete (79.5%), with answers for all survey items. All valid responses have been included in the analysis (Table 1).

Tab. 1: Details on respondents

Variable	Level	Frequency	Percentage
Current position	Administrative and management staff	109	20.49
	Researchers	71	13.35
	Pedagogical staff in higher education institutions	262	49.25
	Academic fellows (doctoral and postdoctoral students)	51	9.59
	Librarians	32	6.02
	Other positions	7	1.32
Total		532	100

Source: Own elaboration based on the survey results

For details on sampling technique, representative sample size, and data collection for this study, see Țurcan et al. (2022).

Study 2

Qualitative approach was applied to achieve the declared objectives of this research. When a concept is quite new or not well addressed, qualitative research is preferred because it provides a deeper understanding and illuminates the attitudes and differences of the interviewees (Creswell and Poth, 2018). Semi-structured interview is the most common method of data collection in qualitative research (Qu and Dumay, 2011).

We used a qualitative approach to study the results gained from the semi-structured interview. Semi-structured interviews are superbly suited for a number of valuable tasks, particularly when more than a few of the open-ended questions require follow-up queries (Adams, 2015), and for gathering information from key informants who have personal experiences, attitudes, perceptions, and beliefs related to the topic of interest (DeJonckheere and Vaughn, 2019). The key premise is that the people chosen for the interview should be in a position to provide rich data on the topic and answer research questions (Morris, 2015, p. 43).

The target population for the qualitative component consisted of the key informants in Open Science policies and practices. A total number of 12 key informants were selected, based on their willingness, their knowledge of and first-hand implication in Open Science Movement, their existing interest and involvement in Open Science discussions and practices, and their availability for the study. Most of these participants come from organizations that develop policies and manage projects related to Open Science.

We carried out semi-structured interviews with universities´ top management staff and project leaders employing Open Science practices, several selected experts, as well as policymakers (see Table 2).

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Tab. 2: Details on interviewees

Participant ID	Group	Title	Institution	Gender	PhD
PM 1	Policymakers	Director	National Agency for Research and Development	F	Yes
PM 2	Policymakers	President	The Academy of Sciences of Moldova	M	Yes
PM 3	Policymakers	President	National Agency for Quality Assurance in Education and Research	M	Yes
PM 4	Policymakers	President	The Court of Accounts of the Republic of Moldova	M	Yes
AMS 5	Administrative and management staff	Vice-Rector	Moldova State University	F	Yes
AMS 6	Administrative and management staff	Rector	Technical University of Moldova	M	Yes
AMS 7	Administrative and management staff	Rector	State Agrarian University of Moldova	M	Yes
AMS 8	Administrative and management staff	Head of Research Department	"Nicolae Testemitanu" State University of Medicine and Pharmacy	M	Yes
AMS 9	Administrative and management staff	Deputy director	Institute of Legal, Political and Sociological Research	M	Yes
-	Policymakers	NA	Ministry of Education and Research		
-	Policymakers	NA	The culture, education, research, youth, sports and media commission of the Parliament		
-	Policymakers	NA	Presidency of the Republic of Moldova		

Source: Own elaboration based on the interview results

The respondents selected for this study are not characteristic of the national research community, but are rather a representative sample of actors who are involved in and can contribute to the implementation of national and institutional policies/strategies on Open Science in the Republic of Moldova. We explicitly chose interviewees, who made public statements and/or participated in projects related to Open Science policies, as well as policymakers in charge of developing Open Science policies.

The purpose of the interview is to consult the political decision-makers, funders, and promoters of Open Science on the actions to be taken by decision-makers at the national and institutional levels to open research in the Republic of Moldova and the opportunities that Open Science offers to research actors throughout this process.

Each interview was about the concept of Open Science, Open Science Policy, and openness of research data, the expected benefits of making Open Science a national strategic priority, and barriers and challenges in the transition to Open Science in the Republic of Moldova.

These interviews helped us understand what are the views of key actors on the need and goals of a national Open Science Policy.

Research instruments

Quantitative data collection took place from October 25, 2021 until December 6, 2021, using specialized software (SurveyMonkey) to develop the questionnaire, collect data, and analyze results. The purpose of the quantitative study was to understand the attitude regarding Open Science practices and adoption of a national policy on Open Science in the Republic of Moldova. The questionnaire

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had five sections with 27 questions. For this article, only the opinions of the scientific community from the Republic of Moldova regarding the Open Science Policy are analyzed and presented.

Qualitative data collection took place from December 2021 until April 2022, applying the interview protocol. Before the study, the respondents were notified and appropriate meeting place and time were agreed upon.

Semi-structured interview questions were sent by e-mail. E-mail communications are emerging as an alternative method for conducting interviews in qualitative research (Dahlin, 2021; Walker and Baxter, 2019). While a mixed mode interviewing strategy should always be considered when possible, semi-structured e-mail interviewing can be a viable alternative to face-to-face interviews, especially when time or financial constraints are barriers to an investigation (Meho, 2006, p. 1293). There are a number of advantages of using an e-mail interview rather than a face-to-face interview (Fritz and Vandermause, 2018; Hamilton and Bowers, 2006; Hawkins, 2018; Hunt and McHale, 2007; Oltmann, 2016): cost, practical alternative to overcome geographic barriers, financial concerns, range of participants, access to participants, time for reflection, saying things that would not be said face-to-face, working with a set of interviews simultaneously, rapport, overcoming interviewer effects.

In particular, the interview protocol addressed the four main dimensions generally linked to Open Science:

1. Changes in terms of Open Science policy for the alignment of the Republic of Moldova with the EU provisions on Horizon Europe Programme and the European Research Area.
2. National and institutional actions required to open the science.
3. Barriers and challenges in implementing/transitioning to Open Science in the Republic of Moldova.
4. The expected benefits of making Open Science a national strategic priority in the Republic of Moldova.

For each of these dimensions, the interview protocol included open-ended questions on the understanding and opinion of the interviewee, the state of the art, and advantages and problems as perceived by the interviewee. Each interview included particular questions related to the interviewee's Open Science practice.

The interview protocol also included an introductory letter, explaining the content, structure, length, and the actual and future use of the collected data, to fully inform every interviewee on the purpose and requirements of the interview.

NVivo software was used to process interview results.

The first phase of the analysis included reading the answers, highlighting relevant fragments according to the research question, and assigning a code to them based on the content of the fragment. The second phase involved a second analysis, based on the interview answers and the results of the previous analysis. For the second phase, an open coding process using NVivo software was used.

RESULTS AND DISCUSSION

Importance of Open Science and the strategic priorities of the Republic of Moldova

One of the important topics discussed in the framework of the quantitative study concerned Open Science policies or strategies. These documents or directives describe the actions that are focused on promotion of Open Science principles and recognition of Open Science practices. Open Science policies or strategies are usually set by research-performing organizations, research funders, governments, or publishers.

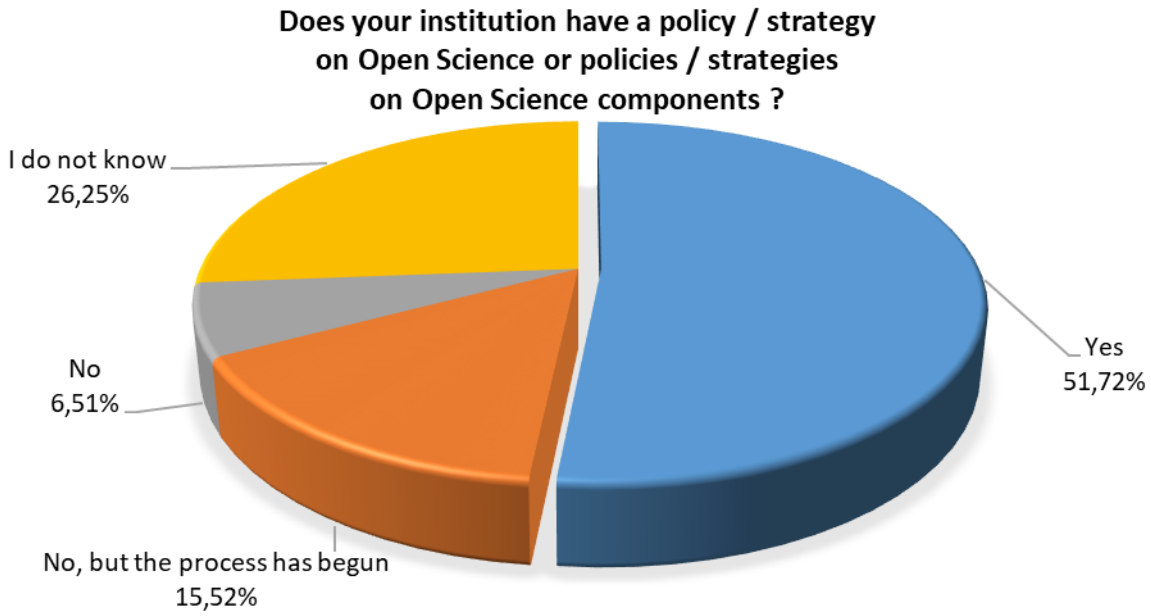
To assess the situation and the opinion of the scientific community and academia on this subject, the respondents were asked whether the institution they are affiliated to has adopted a policy or strategy on Open Science or policies/strategies related to Open Science components. This question collected 522 answers. More than half of the respondents (n = 270; 51.72%) confirmed, and another 15.52% (n = 81) affirmed these documents are under development by the institution. Over a quarter of the respondents (n = 137; 26.25%) were not aware (Figure 1).

Respondents who confirmed were asked to specify the types of Open Science policies at the institutional level. Despite 51.72% (n = 270) of respondents answered "yes" to the previous question, only 254 of them specified the exact type of document and the remaining 16 respondents were unable to provide details.

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Fig. 1: Presence of a policy or strategy on Open Science at the institutional level



Source: Elaborated by authors based on the survey results

The majority of respondents who answered affirmatively (n = 153, 60.24%) specified an Open Access policy adopted at the institution; more than a third of them (n = 90, 35.43%) were convinced that there is a single policy covering all aspects of Open Science at the institutional level. More than a quarter (n = 71, 27.95%) believed there is a Policy on Open Educational Resources at the organizational (especially, the university) level. A proportion of 17.72% (n = 45) of respondents thought there is a Research Data Management Policy adopted by the institution, and 16.93% (n = 43) believed there is an Open Evaluation Policy. The Open e-Infrastructure Policy was mentioned by 10.63% (n = 27) of the respondents (Figure 2).

In fact, at present, the national strategies and policies dedicated to Open Science are not yet developed in the Republic of Moldova. The most relevant national strategic document referring to Open Science was the *National Roadmap for the Integration of the Republic of Moldova into the European Research Area for the years 2019–2021* (Government of the Republic of Moldova, 2018). This document provided one of the specific objectives connected to the Priority of the European Research Area, "Optimal circulation, access, and transfer of knowledge," being mentioned that "for the Republic of Moldova, it is a major priority to contribute to the elaboration of policies for strengthening the link between science and industry and raising the role of research in the public and private sectors in 'Open Innovations' and ensuring Open Access to results and scientific services."

The distribution of responses by organization shows that most institutions have adopted both a policy and strategy covering all aspects of Open Science, as well as separate documents for each aspect, which is not true. This denotes that a significant proportion of the personnel is either not aware of the real situation at the institutional level in terms of promoting and implementing Open Science policies or is not yet familiar with the concept.

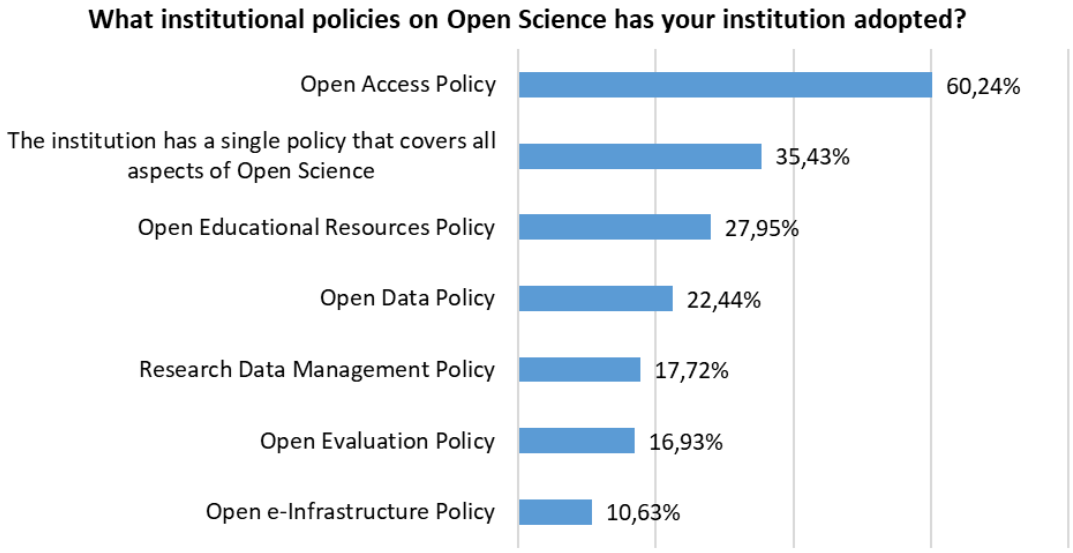
Although, the implementation of several international projects (Țurcan and Cojocaru, 2022) has stimulated research institutions and universities of the Republic of Moldova to adopt institutional Open Access policies and institutional strategies on Open Science, currently, 14 institutional policies on Open Access and only three institutional strategies related to Open Science are approved in the Republic of Moldova.

The Open Science movement in the Republic of Moldova has emerged at the institutional level, the champions being the Information Society Development Institute and university libraries, but it is crucial to gain support and promotion from the national decision-makers. In this context, the respondents were asked to assess the importance of having an Open Science policy or strategy at the national level.

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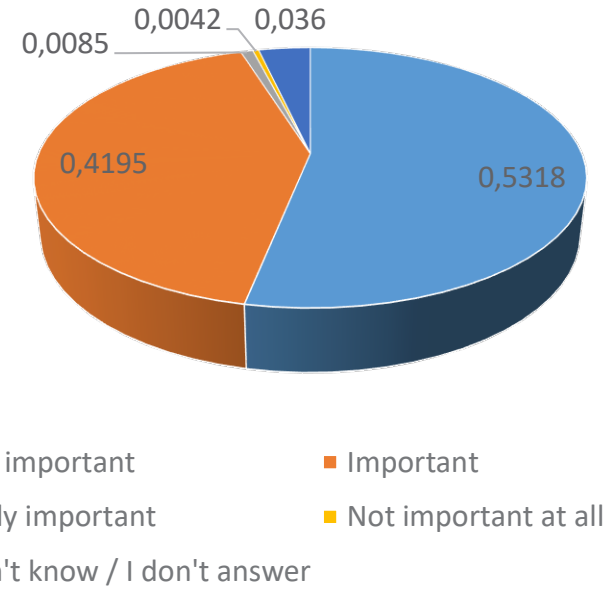
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Fig. 2: Types of institutional policies or strategies on Open Science



Source: Elaborated by authors based on the survey results

Fig. 3: Opinions on the importance of a national policy or strategyon Open Science



Source: Elaborated by authors based on the survey results

Even though a significant proportion of respondents are not yet familiar with the concept, 95.13% (n = 449) of them consider a national Open Science policy or strategy very important (*Very important* and *Important* answers) (Figure 3).

The small standard deviation value speaks of the uniform opinion of the respondents on this matter (Table 3).

The distribution of responses on the importance of a national Open Science policy or strategy per scientific area reveals that respondents from various areas exhibit interest in this subject (Figure 4).

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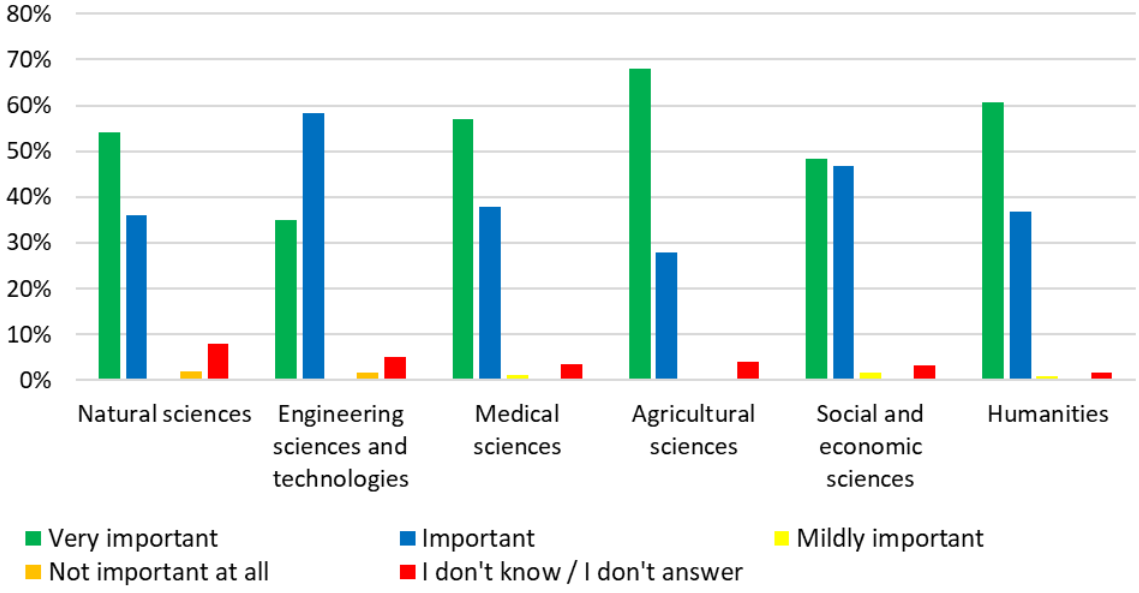
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Tab. 3: The importance of a national policy or strategy on Open Science

Question	Mean score	Standard deviation
In your opinion, how important is it to have a national Open Science policy or strategy?	3.54	0.542

Notes: Four-point scale (1 = not important at all, 4 = very important)
Source: Elaborated by authors based on the survey results

Fig. 4: Opinions on the importance of the existence of a national policy or strategy related to Open Science, distributed by scientific fields



Source: Elaborated by authors based on the survey results

The respondents believed that Open Science is a new model for organizing the research activity, increasing its quality and impact.

Respondents also mentioned the importance of Open Science and Open Science policies. Comments focused on the importance of Open Science include: "*only joint efforts, the availability and exchange of knowledge, information and data at a global level can contribute to achieving the strategic priority objectives of the Republic of Moldova*" (AMS 7); "*adopting the Open Science model would accelerate the development rate of the Republic of Moldova*" (AMS 8); "*it makes research more effective and credible, also by implementing traditions of collaborative interaction inside the scientific community and in society in general*" (PM 2); "*could contribute to increased visibility, relevance and impact of the scientific activity*" (PM 1); "*Open Science adoption could be a decisive factor for the implementation of research results in industry*" (PM 3).

Open Science adoption at the level of a national strategic priority could offer a series of benefits, as well as contribute to efficiency of research in the Republic of Moldova.

All interviewees were asked about the expected benefits of Open Science as a strategic priority for the Republic of Moldova (Table 4).

Experts' opinions were unanimous, supported by the following statements: "*Promoting Open Science at the national level would make researchers more accountable towards research and tax-payers*" (AMS 6); "*Open Science policy can offer many advantages for research, such as faster circulation of scientific ideas or increased collaboration among researchers*" (AMS 9); "*should lead to a closer collaboration between the science and the industry, ensuring continuous development of the Republic of Moldova from an economic, social, etc. point of view*" (PM 4); "*it can increase the relevance and impact of scientific activity by facilitating access to research results and publications, boosting the transfer of knowledge to education and industry, creating opportunities for the reuse of research data, but also for a wider*

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Tab. 4: Expected benefits of making Open Science a national strategic priority

Expected benefits of making Open Science a national strategic priority	PM 1	PM 2	PM 3	PM 4	AMS 5	AMS 6	AMS 7	AMS 8	AMS 9
– Sharing and reusing research data			*		*			*	
– Faster implementation of research results	*	*							*
– Wider involvement of citizens in the decision-making process	*		*						
– Objective and transparent evaluation of research outputs			*		*		*	*	
– Wider access to research results and publications			*				*	*	
– Easier access to high-performance infrastructures			*						
– Faster circulation of scientific ideas							*		*
– Facilitates collaboration among researchers		*		*	*			*	*
– Increasing accountability toward research and citizens		*				*			
– Increasing research quality		*						*	
– Increasing the funders' level of trust	*							*	
– Fraud elimination		*							
– Excludes duplication of expenses					*				
– Greater visibility and promotion of research results					*				

Source: Elaborated by authors based on the interviews analysis

involvement of civil society in the decision-making process" (PM 1); "*the possibility of integration into macro-level interdisciplinary research and the benefits of reusing existing knowledge and data*" (AMS 5). At the same time, "*developing an Open Science legal framework*" (PM 1) was highlighted as a major priority.

Implementing Open Science components

Open Science encompasses various aspects, therefore it was important to establish which of them are better known or considered more valuable by scientific and academic community in the Republic of Moldova.

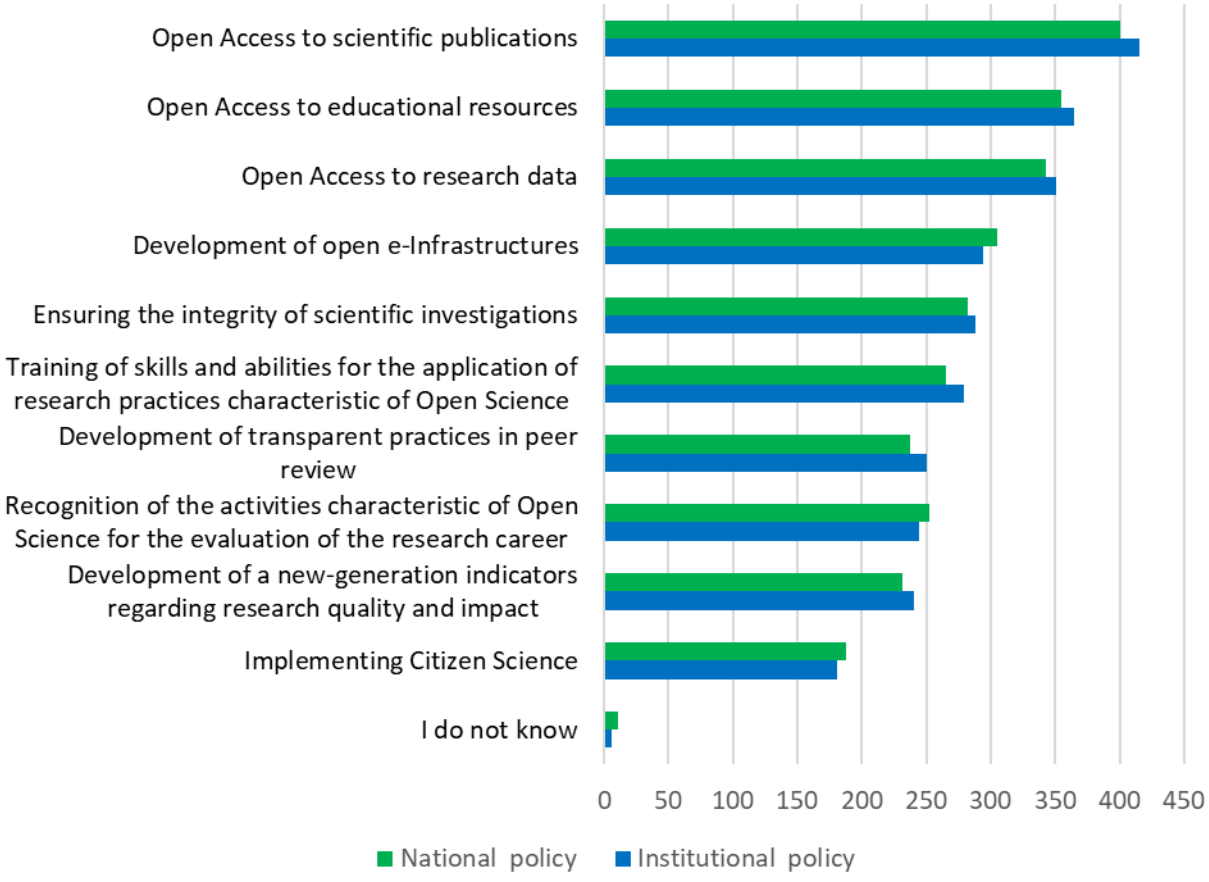
Four hundred and seventy-two respondents provided their input in terms of key aspects to be taken into account when implementing an institutional Open Science policy or strategy (multiple responses possible). The data presented in Figure 5 shows that over 70% of respondents considered Open Access to publications, educational resources, and research data as the most important Open Science practices. Less than half mentioned the importance of Citizen Science (n = 181, 38.35%), even though the lion's share of research in the Republic of Moldova is funded from the public budget.

The analysis and benchmarking regarding the institutional Open Access policies and Open Science strategies (Cheradi et al., 2023) had shown that all 14 institutional policies regulate the self-archiving of publications of scientific and teaching staff in universities and research institutions in institutional repositories with Open Access, as well as stimulate publication in Open Access journals. The institutional Open Access policies declare the storage of all scientific publications developed on the basis of state-funded research projects and grants. However, these policies differ in certain segments, establishing institutional rules for storage, retention, and access to employee publications. The three institutional strategies on Open Science, approved in 2022 within the MINERVA project "Strengthening research management and Open Science capacities of HEIs in Moldova and Armenia" (2018–2022), covered various key components of Open Science. Thus, the Open Science strategies of the Academy of Economic Studies of Moldova, Technical University of Moldova, and State University of Medicine and Pharmacy of Moldova include Open Access, Open Data, Open Evaluation, and Open Science tools. In addition, the strategy of the Technical University of Moldova addresses open education.

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Fig. 5: Key issues to be included in institutional and national Open Science policies or strategies



Source: Elaborated by authors based on the survey results

In terms of key aspects to be accounted for in a national Open Science policy or strategy, the respondents ranked the issues similar to those for an institutional strategy or policy (Figure 5).

The experts shared the same opinion, underlining that all Open Science components are important "*because they contribute to achieving the Open Science goal*" (PM 3), as well as "*they are interconnected and thus bring more value when they are implemented together*" (AMS 5). The expert mentioned the importance of all Open Science components "*although some are not applicable to all research areas*" (PM 2), still some key components were highlighted, depending on the expert's position and affiliation, for example, "*Open Evaluation, Open Education, Research Data Management, Open Access to scientific publications*" (PM 2); "*Open Access to publications, Research Data Management, FAIR Data, Open Education, Open Evaluation, Citizen Science*" (AMS 6); "*Open Access to research publications, Research Data Management, data sharing, setting up repositories, Open Education, Open Evaluation, Citizen Science*" (AMS 7).

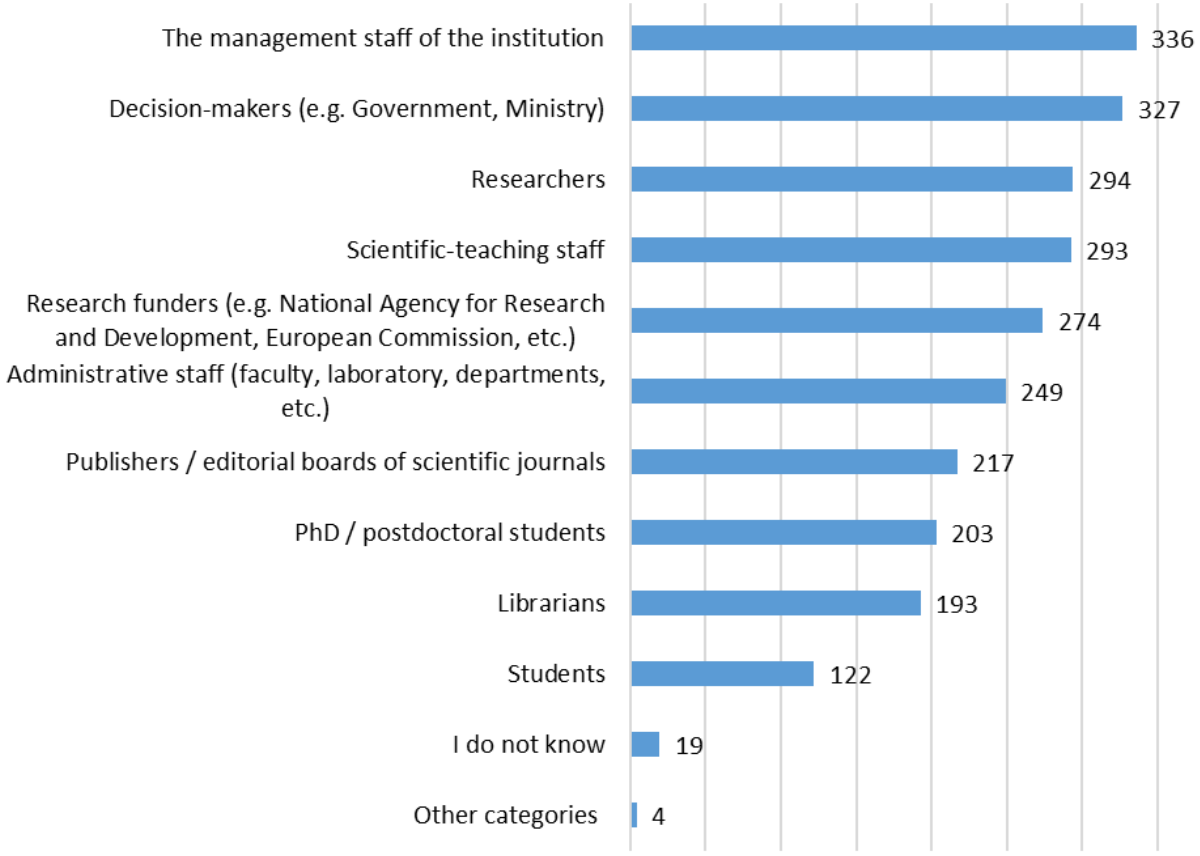
Key actors in Open Science adoption

According to the respondents, different stakeholders involved in the research process should be responsible for adopting an Open Science policy or strategy (Figure 6), but primarily it refers to decision-makers at the institution (n = 335, 71.19%) and country (n = 327, 69.28%) levels; researchers (n = 294, 62.29%), and the academia (n = 293, 62.08%) were ranked third and fourth, respectively. This opinion is also validated by the answer to another question, where 90.46% of respondents agreed and fully agreed that a national

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Fig. 6: Actors who should apply an Open Science policy or strategy



Source: Elaborated by authors based on the survey results

strategy to support Open Science should be developed by the state. On the other hand, libraries, which are Open Access pioneers in the Republic of Moldova, are positioned at the end, being selected by only 40.89% of the respondents (n = 193).

In terms of developing and adopting national and institutional Open Science policies, political decision-makers, as well as the administrative and management staff of universities and research institutions should be held accountable. The experts highlighted: "*The policy/policies, as well as the related action plans, should be developed with the involvement of such parties as: Ministry of Education and Research (MER) – the policymaker in education and research; the founding ministries of research and innovation organizations; the Ministry of the Economy, the Ministry of Infrastructure and Regional Development, the Ministry of the Environment – major beneficiaries of the research results, in addition to the founding ministries; the Ministry of Finance – could potentially evaluate if research results are efficiently implemented in economy and the social sector, could assess the potential benefits of Open Science policy adoption, National Agency for Research and Development, National Agency for Quality Assurance in Education and Research, Academy of Sciences of Moldova, the Council of Rectors, the Council of research organisations' directors; professional associations, NGOs representing the business sector, etc. – as potential beneficiaries of knowledge transfer from the research sector to industry*" (PM 1). In particular, it is necessary to attract for Open Science policy development "*representatives of the business sector, civil society to ensure a greater impact on the development of the Republic of Moldova*" (PM 4), and it is necessary to establish "*a national working group under the authority of MER, that will develop policies and action plans, concerned with implementation of all Open Science components*" (AMS 5).

Based on the provisions of the *Code on science and innovation of the Republic of Moldova* (259/2004) and subsequent government decisions, the Ministry of Education and Research is the entity responsible for the development policies in the research sector, which "*should be based on the involvement of the entire scientific community, as these regulations target every researcher*" (PM 2); however, "*high-*

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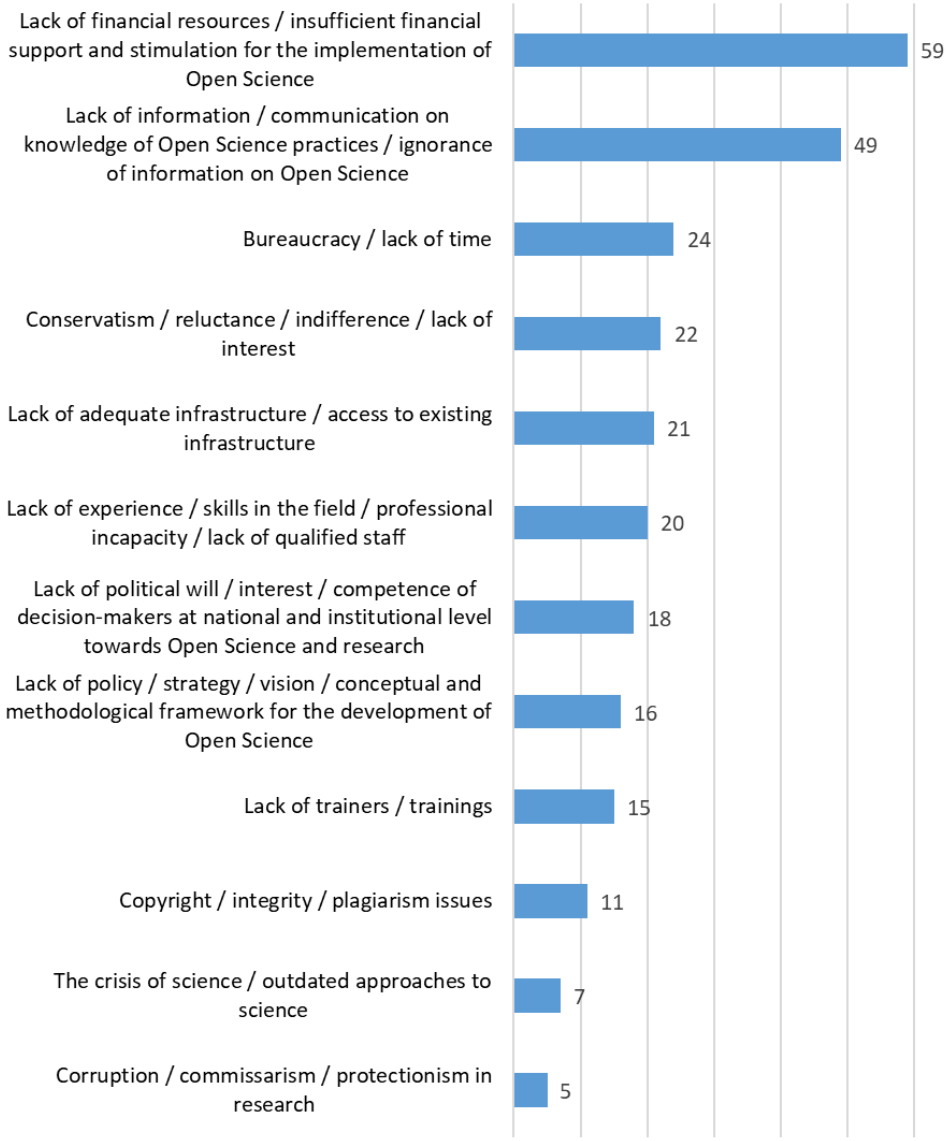
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level political support is mandatory, because these activities require laws to be adopted, funds to be allocated, personnel in various institutions, in order to ensure the feasibility and continuity of processes, including at the implementation level" (AMS 5).

Barriers to Open Science transition

Even though the Open Science movement emerged at the international level about 20 years ago (Budapest Initiative for Open Access, 2002), Open Science principles are being implemented in the Republic of Moldova quite slowly. Aiming to determine the causes of this phenomenon, the respondents were asked to identify the obstacles to Open Science practices (open-ended question). The answers were grouped according to their meaning, and the most frequent reasons (mentioned by five and more respondents) are presented in Figure 7. The figure shows that lack of funding is perceived as the most significant impediment to implementation of Open Science

Fig. 7: Opinion on obstacles to the development of Open Science practices in research institutions and in the Republic of Moldova



Source: Elaborated by authors based on the survey results

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practices. The respondents consider it is imperative for both governments and institutions to fund and adopt better practices aimed at embedding Open Science in the research cycle.

All interviewees were asked about the perceived barriers to implementation of Open Science practices in the Republic of Moldova (Table 5).

Tab. 5: Barriers to Open Science transition in the Republic of Moldova

Barriers to Open Science transition in the Republic of Moldova	PM 1	PM 2	PM 3	PM 4	AMS 5	AMS 6	AMS 7	AMS 8	AMS 9
– Issues with providing access to publications and data			*						*
– Low quality of research results				*			*		
– Lack of skilled and competent staff for practicing Open Science	*			*	*		*	*	*
– Unawareness of the benefits and opportunities of Open Science	*		*		*		*	*	
– Lack of open scientific culture		*							
– Insufficient funding for adoption of Open Science practices	*	*		*	*		*		*
– Lack of interoperability			*	*					
– Lack of incentives and rewards		*	*						
– Lack of adequate infrastructure		*		*				*	*
– Lack of regulations/legislation supporting Open Science practices	*	*	*	*	*	*	*	*	*
– Lack of transparency				*					
– Doubts regarding the ethical use of research results			*				*		

Source: Elaborated by authors based on the interview analysis

Interviews have revealed at the moment, it is not possible to effectively implement all Open Science components in Moldova, and "*the resistance to change and fear that research results will be plagiarized and IP rights will be infringed*" (AMS 6) is perceived as a major problem by many experts. Some of the most frequent financial, legislative, and logistical obstacles mentioned by experts are access to research results, infrastructure, research quality, skills and awareness, interoperability, integration, incentives and rewards, transparency, and others. Some expert opinions regarding the barriers and challenges in transition to Open Science in the Republic of Moldova at the national and institutional levels refer to "*low quality of scientific results, [...] scarcity or lack of competent human resources*" (AMS 7); "*the majority are not aware of the importance of Open Science for the social-economic development of the Republic of Moldova. The worst is that this was not and is not understood by any Government*" (PM 1); "*researchers' unwillingness to share their ideas*" (PM 4); "*lack of a national interest for this initiative*" (AMS 5); "*researchers' reluctance to share research results [...] insufficient knowledge of the benefits of Open Science*" (AMS 8); "*insufficiency of skilled personnel in Open Science practices*" (AMS 9); "*no efforts made to set up scientific and technological platforms for common use*" (PM 2). The experts also pointed out that the biggest barriers to Open Science adoption are the following: "*the existing regulatory framework doesn't provide enough levers to promote the principles of Open Science*" (PM 3); "*long-term investments in digital infrastructures are missing*" (PM 4); "*research is insufficiently integrated with the educational and business sectors*" (PM 3).

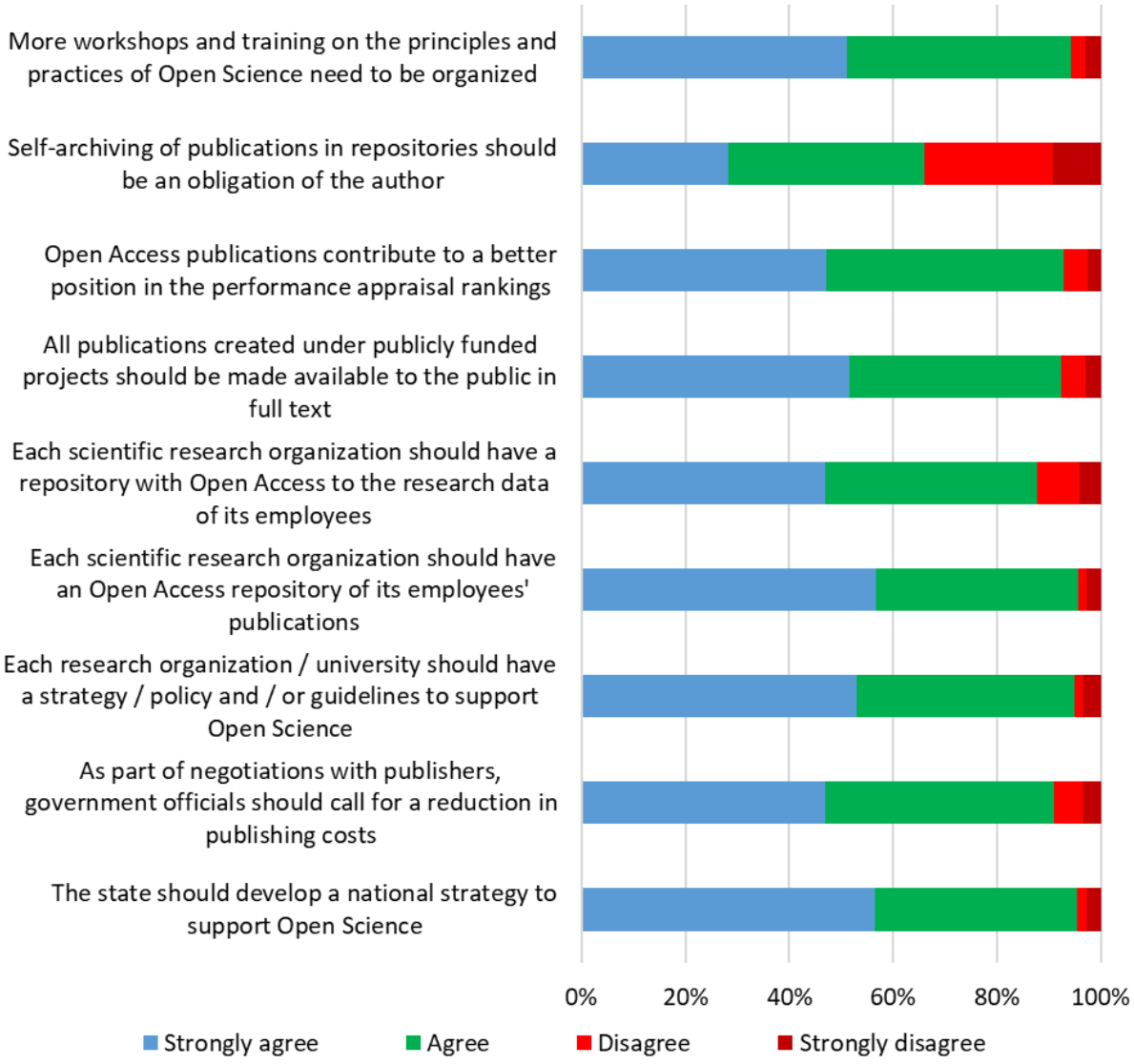
Respondents were asked to what extent they agreed with the transfer of responsibilities regarding Open Science implementation. The answers are presented in Figure 8.

The data show that more than 80% of respondents agreed in general with most of the statements, except for the obligation to self-archive publications in repositories, which was supported by 57% of the respondents.

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Fig. 8: Opinions on the transfer of responsibility for Open Science implementation



Source: Elaborated by authors based on the survey results

The standard deviations presented in Table 6 show that the most varied responses were generated by the statement regarding the self-archiving of own publications (0.94), compared to the values of the standard deviations for the remaining statements, ranging from 0.67 to 0.79.

As shown, it seems the scientific community and academia in the Republic of Moldova is ready to hand over the responsibilities regarding Open Science adoption to other stakeholders, but is less ready to accept more responsibilities at the individual level.

Another finding of our study referred to the expectation that the researchers have from for state institutions, such as the government, the Ministry of Education and Research, and the National Agency for Research and Development, to set an example in adopting Open Science principles, especially in terms of accessibility of research data and scientific publications, resulting from publicly funded research. The existing Open Access publishing system of publicly funded research results comprises 57 Open Access accredited scientific journals (IDSI, 2022), the provisions of the contract on public funding of research projects (Government of the Republic of Moldova, 2019), as well as access to publications from national, institutional, and thematic repositories

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Tab. 6: Opinions on the transfer of responsibility for Open Science implementation

Statement	Mean score	Standard deviation
The state should develop a national strategy supporting Open Science	3.49	0.672
As part of negotiations with publishers, government officials should call for a reduction in publishing costs	3.34	0.742
Each research organization/university should have a strategy/policy and/or guidelines supporting Open Science	3.44	0.701
Each research organization should have an Open Access repository of its employees' publications	3.49	0.674
Each research organization should have an Open Access repository of research data of its employees	3.30	0.789
All publications produced in the framework of publicly funded projects should be accessible as full text	3.41	0.722
Open Access publications contribute to a better positioning in performance evaluation rankings	3.37	0.692
Self-archiving of publications in repositories should be an obligation of the author	2.85	0.940
More workshops and trainings on the principles and practices of Open Science are needed	3.42	0.692

Notes: Four-point scale (1 = strongly disagree, 4 = strongly agree)
Source: Elaborated by authors based on the survey results

(IDSI, n.d.). Unfortunately, this existing system at the national level is not concerned with Open Access to research data or a national or institutional data repository, as part of research infrastructure. The experts acknowledged this situation could be improved significantly: "*the availability of national repositories for scientific results and publications would facilitate access to research data [...], would support the identification of trends in the sector, the calculation of certain scientometric estimates, evaluations of research organizations and research and teaching staff, rankings aimed at displaying and boosting research performance*" (PM 3); "*a single repository with publications of researchers from the Republic of Moldova is needed*" (PM 1); "*Republic of Moldova should have a single online national platform providing access to all research outputs produced in the country*" (AMS 8). At the same time, some experts believe, "*it is neither rational nor economically efficient to develop several repositories*" (PM 1); "*I would rather advocate for Moldova to join a European or international repository, developed with the use of blockchain-like technologies and complying to FAIR principles*" (PM 2); "*the opportunities to contribute to European and international Open Science movement are currently numerous and open to groups, institutions, even the whole country*" (AMS 5).

The interviewees also noted the need of raising awareness and involving all members of the academic community in the implementation of Open Science practices, especially national level decision-makers, to develop the regulatory framework to support the transition toward Open Science. Certain practices are adopted at the institutional level, aimed at developing strategies, action plans on Open Science, funding Open Access publishing, setting up institutional repositories, organizing events promoting Open Science, trainings for researchers, teaching staff and students on Open Science skills, implementing open education components, and so on. However, more concerted efforts are needed, such as "*embed Open Science principles in calls for project proposals and during project implementation*" (PM 1); "*support research projects, which provide for employ transparent research practices and publish results in Open Access*" (PM 2); "*use open and participatory evaluation procedures*" (PM 3); "*collaborate closely with the civil society*" (AMS 9); "*Open Science requires the co-participation of government bodies and institutions in the entire research process*" (AMS 5).

LIMITATIONS OF THE STUDY

Although the paper presents relevant information on the perceptions by the scientific community of the Republic of Moldova about the Open Science movement and its preparation for the implementation of Open Science practices, the study also has some limitations.

Given the field of study, it is important to recognize the unequal distribution of respondents from various research institutions and universities, as well as different research fields, which could influence the results. Unlike the respondents from the universities,

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the share of which was 79.89% (n = 425), the respondents from the research institutions were much more passive in participating in the survey (16.54%, n = 88). There was also a gap in the representation of some research areas. For example, of all respondents who represented science disciplines, only 53 (9.96%) were from natural sciences and 27 (5.08%) were from agricultural sciences. Also, compared to statistical data (50% of researchers are women), a higher share of women (68.61%) participated in the study.

Since the sample is mainly composed of researchers of advanced career level (85.52% of respondents were over 35 years old), the conclusions cannot be generalized to researchers at the beginning of their career (up to 24 years old), the share of which is only 1.32%.

These limitations suggest that further research could be carried out on the differences in attitudes toward Open Science and its components between different groups of stakeholders from different research fields (agricultural sciences, medicine, humanities, etc.), as well as with different levels of experience (young researchers, administrative staff, librarians, etc.). Further research could help identify the most relevant information, training, and incentive actions for the application of Open Science practices.

The main limitation of qualitative research is represented by the difficulty of collecting and obtaining enough data to be representative not only from the decision-makers responsible for the elaboration and approval of national policies in the field of science (e.g., the Ministry of Education and Research, the relevant committee of the Parliament of the Republic of Moldova), but also from the administrative and managerial staff of some institutions, who have experience in developing policies and strategies, as well as in implementing Open Science practices at the institutional level.

Although this article mentions the benefits of e-mail interviewing, using this method for data collection also has some challenges and potential drawbacks. One limitation of an e-mail interview is that preparing written responses takes longer than an oral interview. Also, responses to the interview conducted by e-mail limit the full understanding of the participant's experience and impose certain constraints on individuals.

Despite these limitations, our paper offers important new perspectives on the practices of implementing Open Science initiatives in the Republic of Moldova.

CONCLUSIONS

Our study revealed that members of the scientific community believe a regulatory framework must be developed at the national and institutional levels to support the transition to and implementation of Open Science principles. Political decision-makers and the top management of universities and research institutions must shoulder most of the responsibility for the development and approval of national and institutional policies on Open Science. Unfortunately, the decision-makers are not open for discussing and sharing opinions on their position in terms of Open Science and the national policies regarding the transition toward Open Science in the Republic of Moldova.

The data gathered during the study also demonstrate that most of the respondents are not aware of the real situation in their organizations, in terms of Open Science regulations at the institutional level.

At the same time, the data show that most of the respondents generally agree with most of the statements regarding the transfer of responsibilities related to implementation of Open Science, but they are less prepared to self-archive their own publications in repositories.

Both the opinions expressed by the representatives of the scientific community, as well by the interviewed experts from the Republic of Moldova confirm Open Science implementation as a national strategic priority could bring a series of benefits for the Republic of Moldova and contribute to research efficiency. *Open Access, access to educational resources*, and *open research data* were highlighted by researchers and academia as the top three most important Open Science components to be considered when developing a national or institutional policy or strategy. The interviewed key actors and decision-makers alike noted the importance of all Open Science components, ranking *Open Evaluation, Open Education,* and *Research Data Management* as top priorities.

The respondents focused not only on the need for awareness raising and involvement of decision-makers in the development of regulatory framework, but also on incentivizing members of the scientific community to implement Open Science practices.

At the national and institutional levels, solutions are being sought for the adoption of Open Science practices and knowledge transfer models that support Open Access to publications and research data. Discussions and debates regarding the benefits and importance of Open Science should result in major political decisions, focused primarily on the modification and updating of the legislative framework on Open Science in the field of research and innovation.

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