EUROPEAN UNIVERSITY ASSOCIATION

From principles to practices: Open Science at Europe's universities

2020-2021 EUA Open Science Survey results

Rita Morais, Bregt Saenen, Federica Garbuglia, Stephane Berghmans and Vinciane Gaillard

July 2021

European University Association asbl

Avenue de l'Yser 24
1040 Brussels
Belgium
+32 (0) 2 230 55 44

Rue du Rhône 114
Case postale 3174
1211 Geneva 3, Switzerland
+41 22 552 02 96

www.eua.eu · info@eua.eu

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Preface

Open Access to scientific publications and research data has been making progress over the past twenty years. Driven by the scientific community, it has evolved from a "nice to have" to a "must have". As a movement, Open Access to research outputs aims to transform research methods and offer alternatives to the monopolies of international publishers and their increasingly unsustainable financial demands.

Beyond the early years of activism, universities, later joined by consortia, became strongly involved in actions aimed at accelerating the transition to Open Science. This includes the creation of open repositories or networks of repositories at the institutional, national and European levels; the creation of community-based not-for-profit publishing platforms; the immediate Open Access to any publication resulting from projects funded by certain institutions (cOAlition S initiative); the development of methods and instruments facilitating the deposit of and access to research data while respecting the FAIR principles (European EOSC project); the evolution of research evaluation methods (DORA).

On its part, for nearly fifteen years, EUA has been engaged in promoting an open vision of science and positioning itself as an independent organisation that looks beyond specific political contexts. Notably, since 2014, EUA has conducted several complementary actions, including:

- analysing and understanding the multiple obstacles that hinder the development of Open Science, such as the different perspectives in the scientific communities, the challenges in sharing „FAIR" data, the impact of relying on publications for research evaluation and career management, and legislative and regulatory challenges;
- organising workshops and webinars on different overarching themes, such as the evolution of publication models and research and career assessment;
- participating in dedicated European projects.

In this context, one of the major EUA activities on Open Science is the periodic Open Science survey, focusing on strategies and actions carried out by Europe's universities. This latest edition, the sixth in the series, is a close-up look at the state of development of Open Science in the 272 institutions that agreed to respond. Combined with the five previous publications, it provides a comprehensive picture of the challenges and achievements in Open Science at Europe's universities (more than 700 institutions have participated in at least one of the six surveys).

The results are numerous and are of interest to institutional leaders and managers, researchers, librarians, as well as national and European policy makers. They shed light on both the evolution of Open Science strategies and the maturity of their implementation, as well as on emerging topics such as the role of Open Science in evaluation methods, human resource management and the opening up of science to society. In conclusion, these comprehensive results make it possible to propose a set of recommendations addressed to different groups of stakeholders.

This work was led by an ad hoc group composed of members of the EUA Expert Group on Science 2.0 and Open Science, with the active support of the Director of the Research and Innovation Unit, Stephane Berghmans and the Deputy Director, Vinciane Gaillard.

My special thanks go to Rita Morais, EUA Adviser for Research and Innovation, who, for the sixth time, was the main driving force behind the concept of the survey, the processing of the results and the production of this report.

Finally, I would like to thank all the survey participants from higher education and research institutions for their commitment to this comprehensive and rich questionnaire, as well as for the quality of their answers.

I have no doubt that this survey will become a major tool for the entire higher education and research community, at the national, European and international levels.

Professor Jean-Pierre Finance
Chair of the EUA Expert Group on Science 2.0 and Open Science

Acknowledgements

The authors would like to thank all the universities and higher education institutions that participated in the 2020-2021 EUA Open Science Survey. The authors would also like to acknowledge the important role of the members of the EUA Science 2.0/Open Science Expert Group for their contribution to the EUA Open Science Survey and this report. Special thanks are extended to Professor Jean-Pierre Finance, Chair of the Expert Group, for his ongoing support for the development of this report.

Finally, the authors would like to thank our colleagues at the EUA Secretariat who provided input and helped design and edit this report. Special thanks go to Inès Mezher, Jessica Carter, Lenka Kuzelova and our former colleague Lennart Stoy. Special thanks are also extended to Clare Gaunt for editing this report.

Dr Rita Morais
Research and Innovation Adviser

Dr Bregt Saenen
Policy Analyst

Ms Federica Garbuglia
Policy and Project Officer

Dr Stephane Berghmans
Director, Research & Innovation Unit

Dr Vinciane Gaillard
Deputy-Director, Research & Innovation Unit

Executive summary

This report presents the outcomes of the 2020-2021 EUA Open Science Survey and provides evidence-based recommendations for institutions, researchers, research funders and policymakers on the transition towards Open Science.

The 2020-2021 EUA Open Science Survey focused on the level of development of Open Science in Europe's universities, addressing the role of Open Science in institutions' strategic priorities and its implementation in institutional practices. In addition, the survey transversally addressed both the established (Open Access, research data) and emerging (e.g. citizen science, open education) fields of Open Science.

This survey was open to all interested European higher academic institutions from October 2020 until January 2021, having gathered a total of 272 valid responses from institutions in 36 European countries. Most of the sample are comprehensive institutions (64%), followed by specialist (e.g. medical sciences, music, art schools) and technical universities, which both represent 13% of the sample. The full anonymised dataset of the survey is available in the Open Access repository Zenodo.

KEY RESULTS:

- **Open Science principles:** over half (59%) of the surveyed institutions rated Open Science's strategic importance as very high or high. Open Access to research publications was considered to be highly important for 90% of institutions, but only 60% considered its implementation level to be high. However, the gap between importance and implementation is much wider in data-related areas (RDM, FAIR and data sharing): high importance at between 55-70% of the institutions surveyed, with high levels of implementation at 15-25%.
- **Open Science policies**: 54% of institutions have an Open Science policy and 37% are developing one. Only 9% of surveyed institutions lack an Open Science policy or are not planning to draft one.
- **Monitoring Open Access to research publications:** 80% of institutions monitored the number of publications in their repository and 70% monitored articles published by their researchers in Open Access journals. In addition, almost 60% reported monitoring the cost of publications by their researchers in Open Access journals.
- **Infrastructure for Open Access to research publications:** 90% of the institutions surveyed have their own repository, participate in a shared repository or both. For journal hosting or publishing platforms this figure reaches 66%, and levels out at 57% for monograph hosting/publishing. In addition, 66% of those surveyed reported that their institution has participated in or supported non-commercial Open Access publishing.

- **Data-related skills:** over 50% of the surveyed institutions reported that research data skills were only partially available. Moreover, all of the institutions that indicated the absence or partial availability of data skills, considered that more of these skills are needed at institutional level.
- **Emerging areas of Open Science:** Approximately 50% of the respondents know of citizen science and open education activities at their institutions.
- **Open Science in academic assessment:** In 34% of institutions, none of the Open Science elements examined by the survey were included in academic assessments. Amongst the institutions that included Open Science activities in their academic assessments, 77% took into consideration article deposition in a repository.

The following **recommendations** are proposed:

- **Create the conditions to mainstream Open Science.** If Open Science is to become the standard way of producing and sharing scientific knowledge, the continued involvement of all stakeholders is crucial. The active involvement of institutional leaders, in addition to national and European guidelines and regulatory frameworks, is also instrumental to creating a favourable context for the transition to Open Science.
- **Continue to invest in embedding Open Science in institutional policies and practices.** Institutions should continue to develop internal Open Science policies that are aligned with national and European policies (whenever possible). They need to continue to create incentives and opportunities for researchers and staff to increase their involvement in both established (e.g. Open Access to research publications, RDM and FAIR data) and emerging areas of Open Science (e.g. citizen science, open education). Institutions should also expand training in the key skills needed for the transition towards Open Science (e.g. data skills) for researchers and staff.
- **Fully integrate Open Science in reward and incentive practices.** For Open Science to become the norm, it must become an integral part of academic assessments. Research funders and institutions play a key role in making this transition possible, by increasingly incorporating Open Science contributions in assessment and restructuring current award and recognition systems.

Glossary

Academic assessment: every method used to evaluate the quality and impact of academic activities. Assessment outcomes are typically, but not necessarily, used in career progression, academic unit performance evaluation and funding allocation processes within the institution (EUA Open Science and Access Survey 2019).

Citizen science: citizen science is a broad EU policy covering Open Science activities in which citizens participate in the scientific research process as: observers, funders, in identifying images or analysing data, or by themselves providing data.

European Open Science Cloud (EOSC): the European data portal for hosting, sharing and re-using scientific data and results, supported by high-capacity cloud solutions with super-computing capabilities. EOSC is intended to function as a federated, globally accessible environment, where researchers, innovators, companies and the general public can publish, find and reuse each other's data and tools for research, innovation and educational purposes under well-defined and trusted conditions.

FAIR (Findable, Accessible, Interoperable, Re-usable): "The FAIR Data Principles are a set of guiding principles in order to make data findable, accessible, interoperable and reusable" (Wilkinson et al., 2016). "These principles provide guidance for scientific data management and stewardship and are relevant to all stakeholders in the current digital ecosystem. They directly address data producers and data publishers to promote maximum use of research data" (Liber, 2017). Horizon Europe requires the projects it funds to make their research data FAIR. In 2018, the European Commission Expert Group on FAIR Data published a comprehensive report: Turning FAIR into Reality.

Open education: a system that often uses digital technologies. Open education aims to widen educational access and participation to include everyone by removing barriers and making learning accessible, abundant, and customisable for all. It offers multiple ways of teaching and learning, building and sharing knowledge. It also provides a variety of routes to formal and non-formal education, and connects the two. The European Commission's in-house Joint Research Centre report provides more information.

Open Science: an approach to science based on cooperative work and ways of disseminating knowledge, that improves accessibility to and the re-usability of research outputs through digital technologies and collaborative tools.

Research Data Management: a "set of practices to handle information collected and created during research. [...] These practices involve, but are not limited to, data management planning, documentation, organization, storage, dissemination and preservation" (Higman et al., 2019).

Introduction

1

"When looking to the future, we envision universities without walls; these are universities that are open and engaged in society while retaining their core values. [...] Open Science, making research accessible to all, will be the default way of producing knowledge."

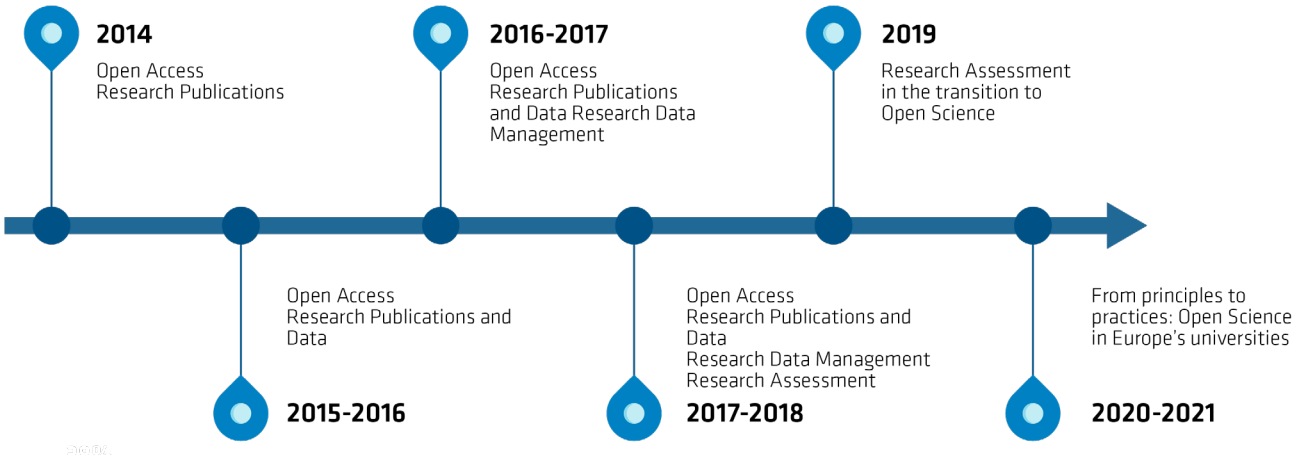
European University Association, Universities without walls. A vision for 2030 (February 2021)

Open Science is based on the principle of the openness and transparency of the whole research cycle, fostering sharing and collaboration as much and as early as possible. Open and transparent practices accelerate the research process at an unprecedented speed, as demonstrated by the scientific breakthroughs related to the Covid-19 pandemic. Research openness and transparency also reinforce core academic values, such as research integrity, cooperation and knowledge sharing. Open Science is key to increasing public trust in science and to sparking interest and fostering participation in research activities.

The transition to Open Science entails systemic, cultural and technical reforms. Universities in Europe are key actors – they explore and test new ideas and processes, and implement reforms. They also have the power to instil a culture of openness and transparency as they train the next generation of citizens, particularly scholars. In sum, universities are in the best position to collectively advance Open Science in Europe and globally. But this cannot be done in isolation. Supportive policies to build capacity and infrastructure, enabling framework conditions and appropriate funding are key prerequisites for success.

As the voice of Europe's universities, EUA has actively supported institutions in the transition to Open Science since 2007. While the Association initially focused almost exclusively on Open Access to research publications, in 2017, it started to embrace a more comprehensive approach: including Open Access to research data, followed by research assessment in the transition to Open Science in 2018. The evolving focus of previous EUA surveys on Open Science is reflected in their titles: they were originally referred to as Open Access surveys (see Figure 1). The first edition addressed the development and implementation of institutional policies on Open Access to research publications. The second survey included additional questions on Open Access to research data. The third survey broadened the scope to research data management. In the fourth edition, EUA started to explore the crucial issue of research assessment. The fifth survey explored this further by taking a different approach: gathering and sharing a comprehensive overview of the current state of research assessment at universities in Europe.

Figure 1 – The evolution of EUA Open Science surveys



This sixth edition of the EUA Open Science Survey addresses Open Science in many, if not all of its dimensions. Open Science continues to be high on political agendas at national, EU and global levels. It has seen many recent favourable developments, such as its inclusion as one of the 14 key actions in the European Commission Communication on "A new ERA for Research and Innovation", and the creation of the European Open Science Cloud (EOSC) Association. Supporting the transition to Open Science means addressing diverse elements: from Open Access to research outputs, to science outreach, communication and citizen science, from FAIR research data management and open repositories to open research protocols and open education, etc.

This survey takes an institutional perspective in order to collect information on the strategic importance and implementation of more established (e.g. Open Access) and emerging (e.g. citizen science, open education) areas of Open Science. It aims to question any gap between principles and practices.

The survey therefore analyses European higher education institutions' willingness and readiness to embrace the systemic, cultural and technical reforms required to make Open Science the new normal. In short, the EUA 2020-2021 Open Science Survey aims to:

- Investigate whether there is a gap between the strategic importance given to Open Science and its implementation on the ground.
- Identify any areas of Open Science with a bigger gap.
- Improve understanding of the opportunities, challenges and hurdles for institutions.

More generally, the report provides evidence of Europe's universities experience of Open Science, supports evidence-based capacity building at EUA members, and strengthens universities' voice in European policy making.

The report is structured into eight sections. This first section presents the survey context and the report. Section 2 presents the data collection and analysis methodologies, and examines the sample characteristics. Section 3 looks broadly at both the strategic importance of Open Science and the extent to which it is implemented at universities. It also addresses the existence of Open Science policies, the drivers and hurdles to Open Science encountered by universities, as well as the availability of skills at institutional level. Section 4 focuses specifically on Open Access to research publications, covering a broad spectrum of topics related to policies, monitoring mechanisms, engagement, infrastructure and funding. Sections 5 and 6 address identical topics, but focus on the areas of research data and emerging Open Science, respectively. Section 7 presents the survey outcomes regarding the role of Open Science in academic assessment. Finally, the key survey findings, conclusions and recommendations are presented in section 8.

Methodology and participants

2

The 2020-2021 EUA Open Science Survey transversally addressed both the established (Open Access, research data) and emerging (e.g. citizen science, open education) fields of Open Science.

The survey included 52 questions and was divided into six parts, starting with strategic orientation (principles), and progressing to institutional practices:

- Part 1: General information about the institution and its profile
- Part 2: Strategic orientation towards Open Science
- Part 3: Policies and monitoring mechanisms
- Part 4: Infrastructure and support services
- Part 5: Institution-level Open Science practices
- Part 6: General views of Open Science at institutional level

Like previous EUA Open Science surveys, the 2020-2021 edition included both closed and open-ended questions.

This survey was open to all interested European higher academic institutions, including EUA and non-EUA members, via the Qualtrics software platform from 26 October 2020 until 15 January 2021. Survey invitations were sent through several communications channels: emails to EUA members and partners, National Rectors' Conferences and on social media. Institutions were asked to provide a single response.

The results included in this report are based on 272 valid responses from institutions in 36 European countries. Of the total 272 responses, 226 are from EUA members, and 46 were from non-member institutions. The full anonymised dataset of the survey is available in the Open Access repository Zenodo.

The number of respondents has remained relatively stable over the past two survey editions, as shown in Table 1. Although the EUA Open Science Survey has focused on different aspects of Open Science since its inception (e.g. 2014-2018 focused on Open Access, 2019 focused on research assessment), the number of respondents increased in the first years and has since remained relatively stable. A total of 736 different institutions have completed the EUA Open Science Survey since its first edition in 2014.

In terms of continuity, a total of 76 universities answered both the 2020-2021 and 2019 survey waves. While the 2020-2021 survey focused on different areas of Open Science, the 2019 edition focused exclusively on research assessment in the transition to Open Science. A comparison of 2020-2021 participation with the 2017-2018 survey (which focused on Open Access and research data) finds that a total of 119 institutions took part in both waves. Moreover, 49 institutions participated in all of the last three survey waves, i.e., 2020-2021, 2019, 2017-2018.

Table 1 – Evolution of the number of respondents to the EUA Open Science survey

EUA Open Science Survey		
	Number of institutions	**Number of countries**
2014	106	30
2015-16	169	33
2016-17	338	39
2017-18	321	36
2019	260	32
2020-21	272	36

The geographical distribution of survey respondents is shown in Figure 2 and in Table 2. These show four countries with over 21 responses, 11 countries with between six and 10 responses and 19 countries with between one and five responses.

Figure 2 – Number of respondents per country

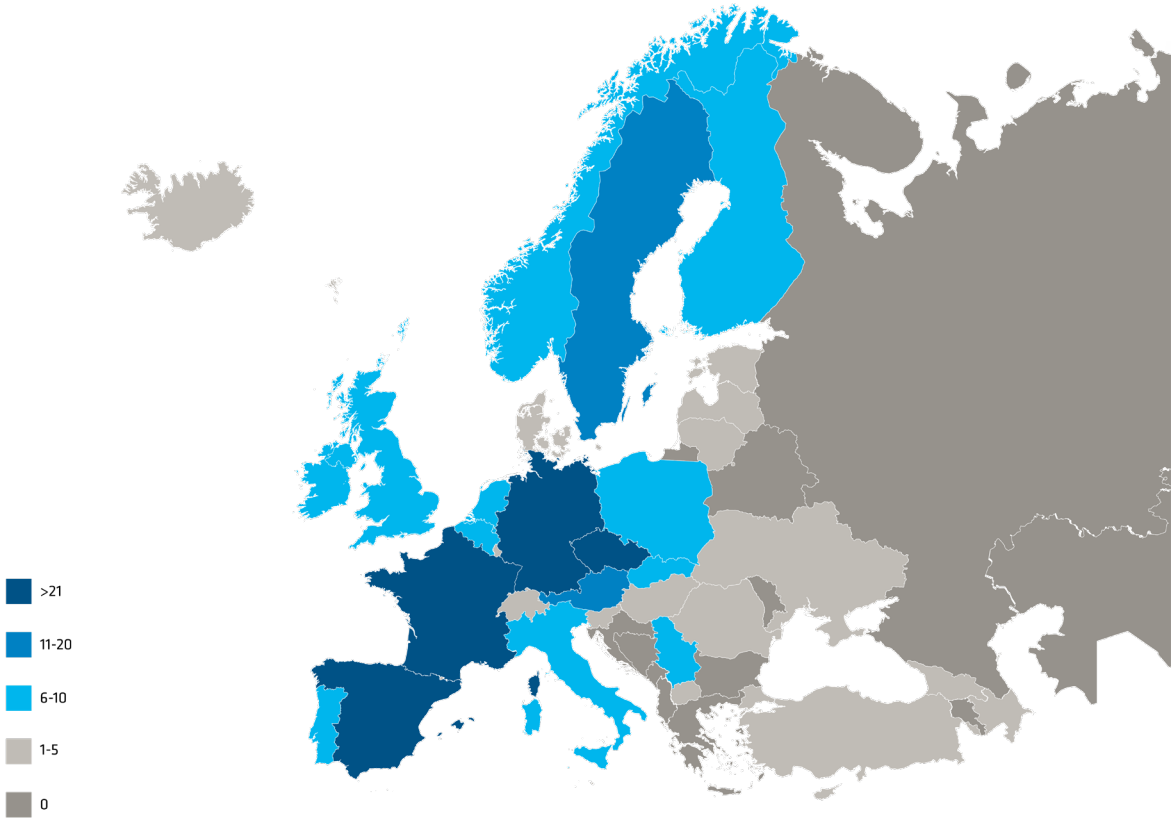


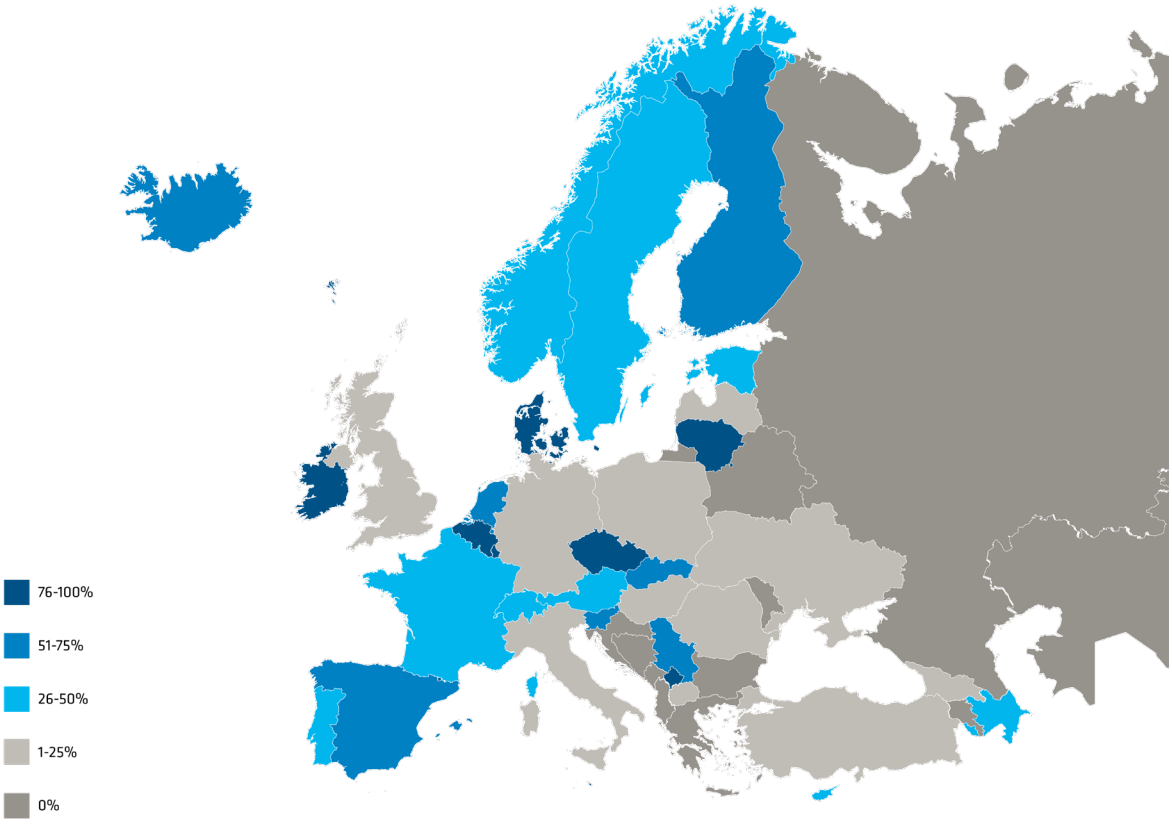
Table 2 – Number of respondents per country

Country	Number of valid responses
Andorra	1
Austria	14
Azerbaijan	1
Belgium	9
Cyprus	2
Czech Republic	25
Denmark	5
Estonia	1
Finland	9
France	29
Georgia	1
Germany	25
Hungary	5
Iceland	2
Ireland	7
Italy	9
Latvia	1
Lithuania	2
Luxembourg	1
Malta	1
Netherlands	10
North Macedonia	1
Norway	9
Poland	6
Portugal	10
Republic of Kosovo	2
Romania	3
Serbia	10
Slovakia	9
Slovenia	3
Spain	33
Sweden	11
Switzerland	5
Turkey	2
Ukraine	2
United Kingdom	6
Total	**272**

Figure 3 presents the number of valid responses from EUA members as a percentage of the individual full and associate EUA members[1] per country. The responses cover between 1-25% of EUA individual full/associate members in 11 countries (Germany, Georgia, Hungary, Italy, Latvia, North Macedonia, Poland, Romania, Turkey, the United Kingdom, and Ukraine), between 26-50% in nine countries (Austria, Azerbaijan, Cyprus, Estonia, France, Norway, Portugal, Sweden and Switzerland), between 51-75% in seven countries (Finland, Iceland, the Netherlands, Serbia, Slovakia, Slovenia and Spain) and between 76-100% in nine countries (Andorra, Belgium, the Czech Republic, Denmark, Ireland, Lithuania, Luxembourg, Malta, and the Republic of Kosovo).

1 Individual full and associate EUA members are typically universities, while other categories include national rectors' conferences or other bodies active in higher education or research. The figures were calculated using the EUA member directory retrieved on 1 March 2021 from: https://eua.eu/about/member-directory.html

Figure 3 – The percentage of respondents who are EUA members per country

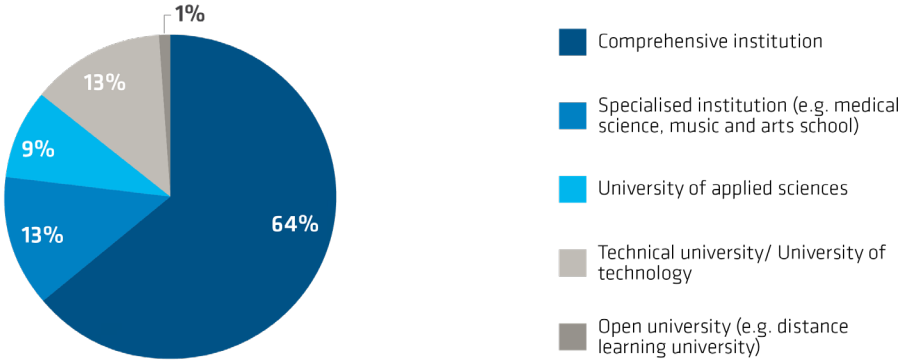


The staff who completed the survey occupy a variety of positions, but most (32%) are university leaders (rectors, vice-rectors, deans), research support staff (21%), research support office managers (19%) and senior library staff (14%). The remaining occupy library positions (6%), are rector/vice-rector's office consultants (5%) or academic researchers (3%).

Most of the sample are comprehensive institutions (64%), followed by specialist (e.g. medical sciences, music, art schools) and technical universities, which both represent 13% of the sample (Figure 4). Universities of applied sciences (for example, colleges or professional education institutions that do not award doctorates, or do so in only a few disciplines) represent 9% of the sample and distance learning universities only 1%.

Figure 4 – Profile of the institutions surveyed

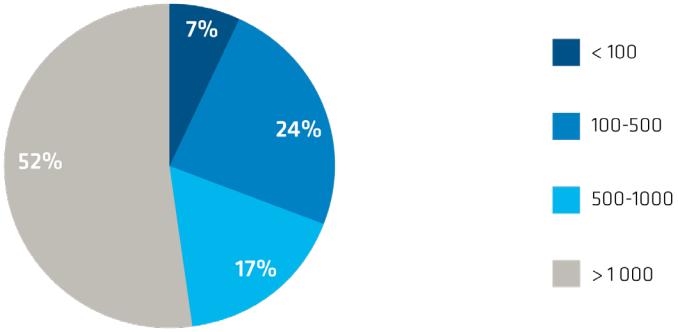
Number of respondents: 270/272.



Moreover, 80% of the surveyed institutions indicated being focused on both research and education, while 11% indicated being mainly research-intensive and 9% primarily education oriented. Figure 5 shows the number of researchers (full time equivalent) working at the responding institutions. Over 50% of institutions have more than 1000 researchers, while almost a quarter have between 100-500 researchers.

Figure 5 – Number of researchers (in FTE) at the institutions surveyed

Number of respondents: 271/272



It is important to note that although the survey achieved broad coverage (both in terms of the number of participating institutions and the countries covered), the results reported below cannot be used to extrapolate conclusions on the status of Open Science at other institutions due to the nature of the data (convenience sample[2]).

2 Convenience sampling is a form of non-probability sampling in which participants are selected because of their accessibility or proximity to the researcher. All EUA members were invited to take part in the EUA Open Access Survey and other dissemination channels were used to advertise the survey (as indicated in section 2). The sample comprises those institutions that volunteered to participate in the survey.

Open Science at institutional level: from principles to practices 3

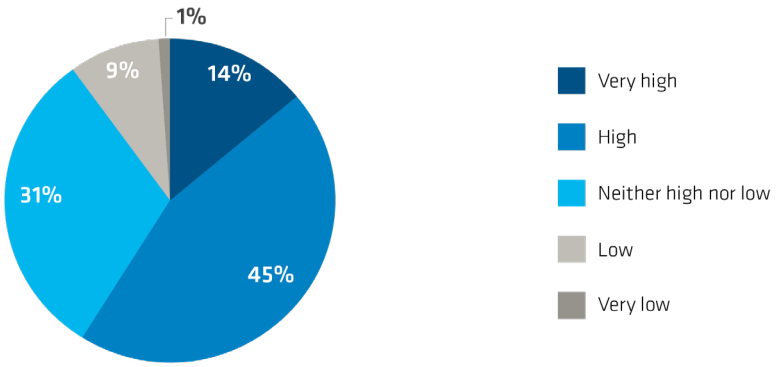
This section provides a broad snapshot of the strategic importance given to Open Science in general, and of some of its specific areas (e.g. Open Access, research data) at institutional level; and how this cascades down to institutional practices (e.g. existence of specific policies and implementation levels). This section also addresses the drivers and hurdles institutions encounter in their transition to Open Science.

3.1. THE STRATEGIC IMPORTANCE OF OPEN SCIENCE AT INSTITUTIONAL LEVEL

Universities were asked about the importance given to Open Science in their strategic priority areas. Almost six out of ten institutions reported that Open Science was given high or very high importance, while 31% noted that Open Science was of moderate strategic importance (Figure 6).

Figure 6 – Level of importance of Open Science in terms of the institution's strategic priority areas

Number of respondents: 272/272.



To further explore how Open Science is viewed and organised at institutional level, universities were asked about the importance and implementation of different Open Science areas. Figure 7 provides an overview of these results, showing that the level of importance is generally always higher than the level of implementation in all areas. More specifically, Open Access (OA) to research publications and science outreach and communication[3] achieved the highest levels of importance and implementation. Areas related to research data (research data management, FAIR data, data sharing) are regarded as moderately to highly important, but their implementation clearly lags behind. Areas such as citizen science, open evaluation, open education, open research protocols and open software/code are seen as less important, which is reflected in their implementation.

3 It is important to note that science outreach and communication is not considered an emerging area per se, as universities have been engaged in these activities for a long time. This is illustrated by the high levels of its importance and implementation reported (which are on a par with Open Access to research publications). In the context of this report, science outreach and communication is therefore considered an emerging area of universities' work on Open Science. Indeed, the emerging areas of Open Science considered (e.g. science outreach and communication, open education, citizen science) are all relatively recent aspects of a more holistic approach that goes beyond established areas of Open Science (e.g. Open Access to research publications, FAIR data).

Figure 7 – Level of importance and implementation of Open Science areas

Number of respondents: 265-270/272

Note: scores represent mean values. Higher values indicate a higher level of importance or implementation.

Figure 8 shows the distribution of responses regarding both the importance and implementation levels of selected aspects of Open Science. Open Access to research publications is considered highly important by about 90% of the respondent institutions, but this figure drops to slightly over 60% when it comes to implementation. Science outreach and communication is seen as the second most important area by 80% of institutions, while its implementation is rated as high or very high by 55%. This difference is even more striking in Open Science areas related to data: Research Data Management (RDM), FAIR data and data sharing. Between 55-70% of institutions consider these areas highly important, but implementation is only high or very high at 15-25% of the respondent institutions. Citizen science, although considered important by almost 40% of respondents, is only implemented at high and very high levels in about 20% of these institutions.

Figure 8 – Distribution of the importance and implementation of selected areas of Open Science
Number of respondents: 266-270/272.

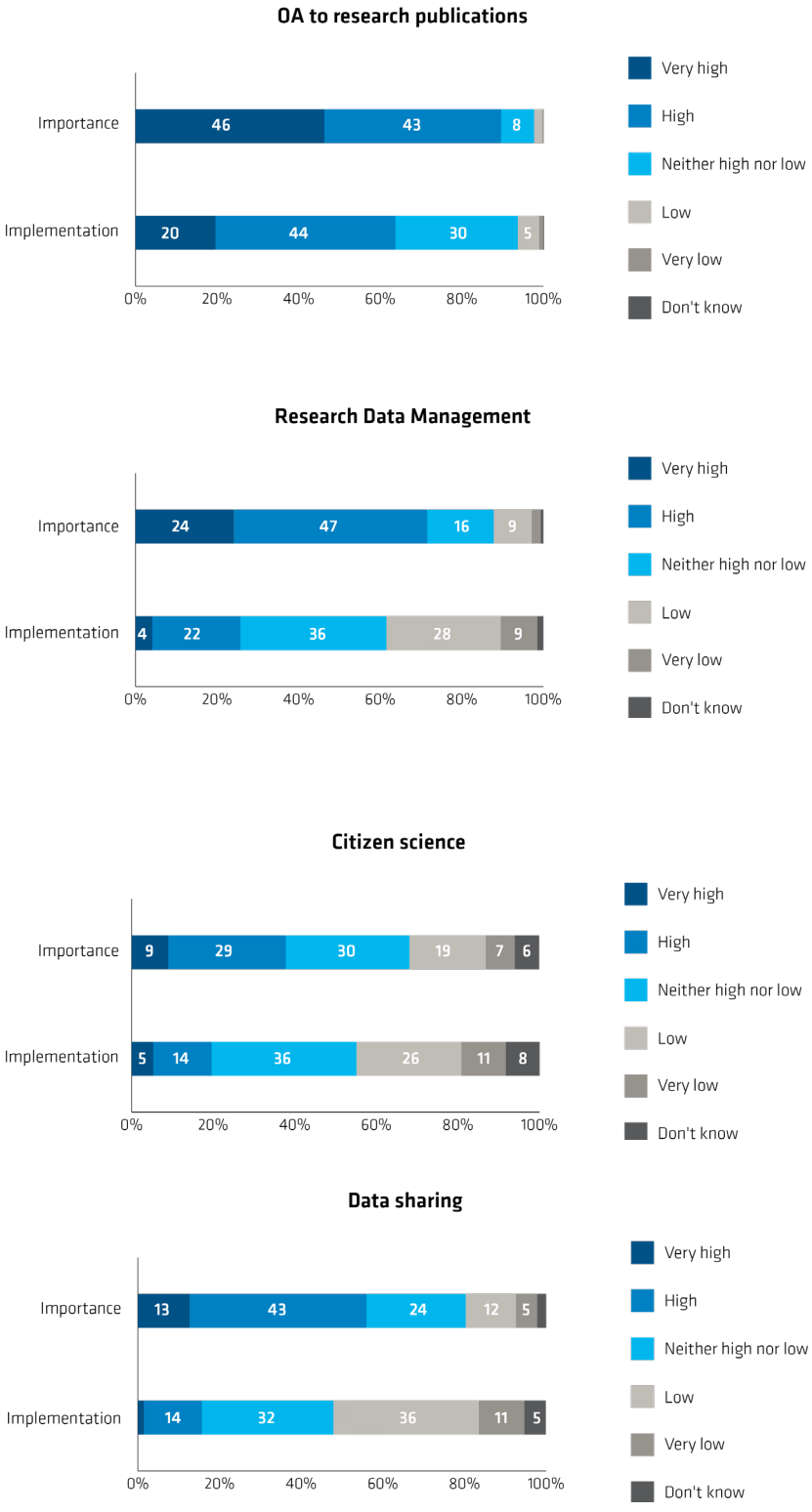
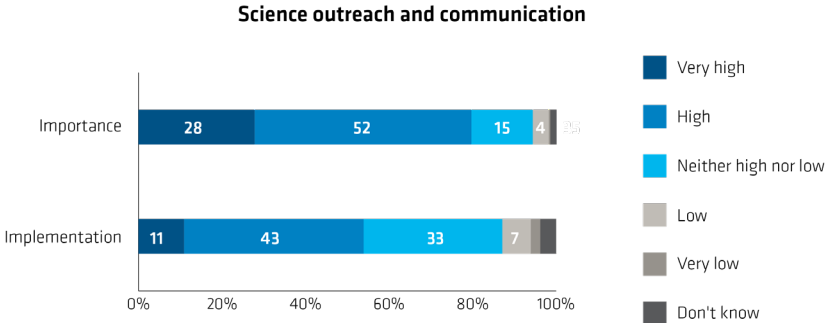


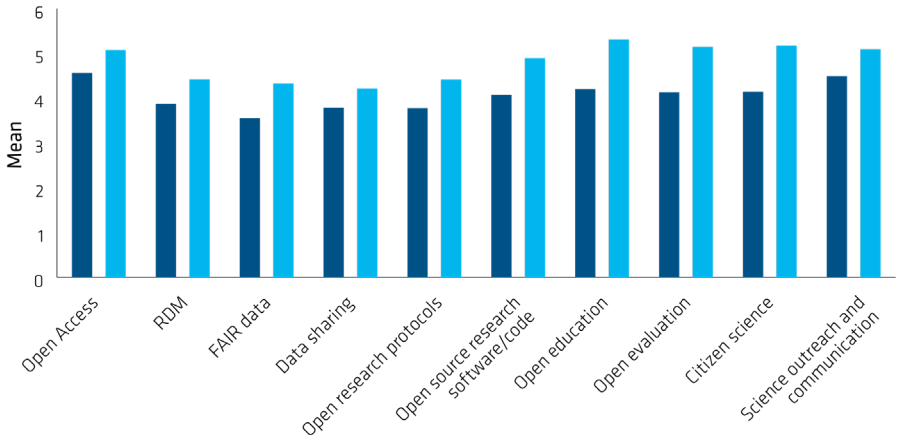
Figure 8 – Distribution of the importance and implementation of selected areas of Open Science (continuation)



The analysis also showed that the implementation of different Open Science areas varies as a function of their importance, even when only considering institutions that rated them important or very important. This is illustrated in Figure 9. Implementation of the vast majority of the Open Science areas considered was significantly higher[4] at institutions that rated them very important, compared with those that rated them important. This difference was only marginal[5] for open research protocols, but the trend was identical.

Figure 9 – Implementation of Open Science areas by level of importance (high vs. very high)

Number of respondents: importance level high= 117; importance level very high= 125.



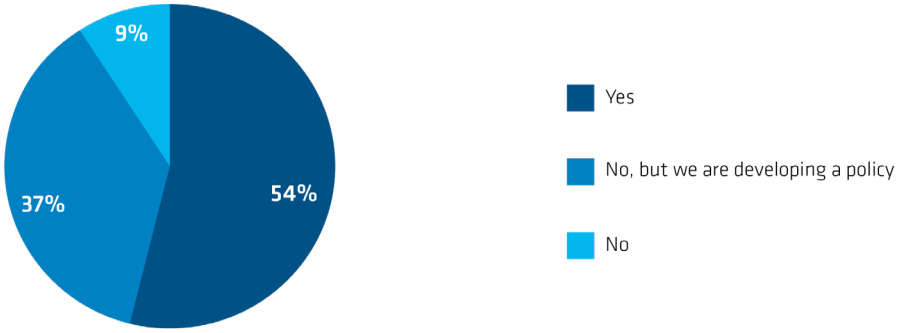
4 OA $t(240)= -4.9$, $p<0.001$; RDM $t(190)= -3.7$, $p<0.001$; FAIR data $t(158)= -4.4$, $p<0.001$; data sharing $t(147)= -2.3$, $p<0.001$; open source research software/code $t(108)= -3.0$, $p<0.05$; open education $t(115)= -6.7$, $p<0.001$; open evaluation $t(80)= -4.1$, $p<0.001$; citizen science $t(97)= -4.3$, $p<0.001$; science outreach and communication $t(209)= -5.1$, $p<0.001$.

5 Open research protocols $t(19.32)= -1.8$, $p=0.089$.

3.2. INSTITUTIONAL OPEN SCIENCE POLICIES: IMPLEMENTATION AND MONITORING

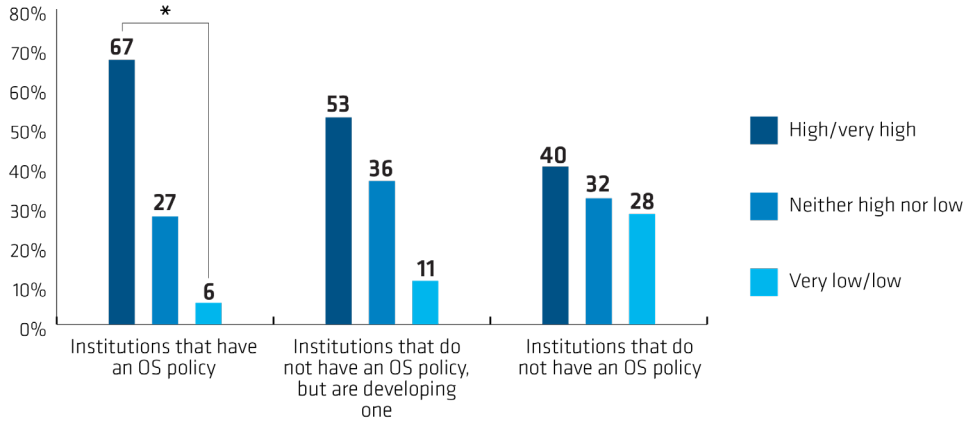
As shown in Figure 10, five out of ten of the surveyed institutions have an Open Science policy, while 37% are in the process of developing one.

Figure 10 – Existence of an institutional Open Science policy
Number of respondents: 271/272.



More detailed analysis revealed that an institutional Open Science policy is significantly related to the importance given to Open Science in the institution's strategic priorities[6] (Figure 11). Although most institutions tend to place high importance on Open Science irrespective of the existence of a policy, institutions that have a policy are much more likely to perceive Open Science as highly important (67%) than of having low importance (5%).

Figure 11 – Relationship between the strategic importance of Open Science and the existence of an institutional Open Science policy
Number of respondents: 270/272.

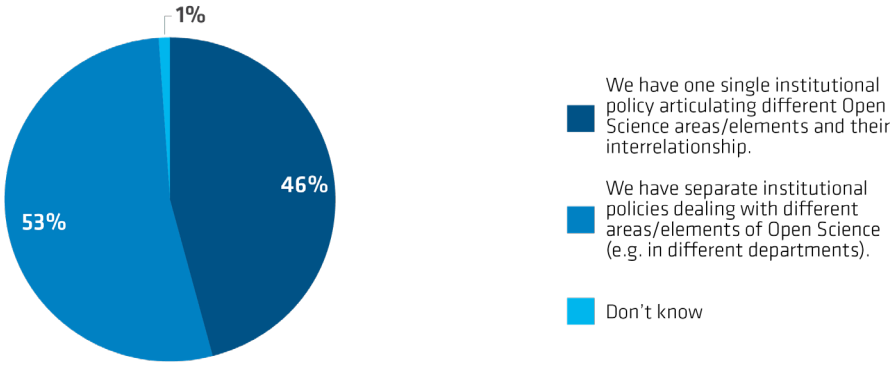


*Note: * indicates that percentages between bars are statistically significant.*

Among institutions with an established policy (see Figure 12), 52% have separate institutional policies dealing with different aspects of Open Science (e.g. Open Access, research data), while 46% have a single, unified policy that focuses on different areas of Open Science and their relationships.

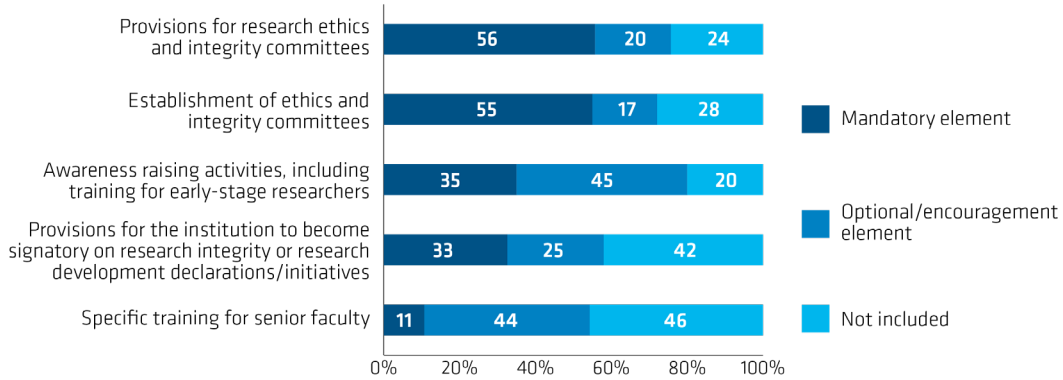
6 A chi-square test of independence was performed: $\chi^2(4, N= 270)= 16.97$, $p= <.05$, $V= .18$.

Figure 12 – Type of institutional Open Science policy
Number of respondents: 141/146.



The specific elements of institutional Open Science policies with a focus on Open Access to research publications, data and emerging Open Science will be presented in subsequent dedicated sections 4, 5 and 6. This section will only examine policy elements related to Open Science awareness, research integrity and ethics, as these are transversal elements applicable to all Open Science areas. As illustrated in Figure 13, awareness-raising activities are the most common element included in Open Science policies, and are either mandatory or encouraged at 80% of institutions with an Open Science policy. The establishment of research ethics and integrity committees and their respective provisions are included at slightly over 70% of institutions; these two elements are also home to most mandatory policies, which exist in about 55% of cases. Senior faculty training is the least frequent transversal element in Open Science policies: it is only mandatory at 10% of the institutions and encouraged at 45% of the institutions with an Open Science policy.

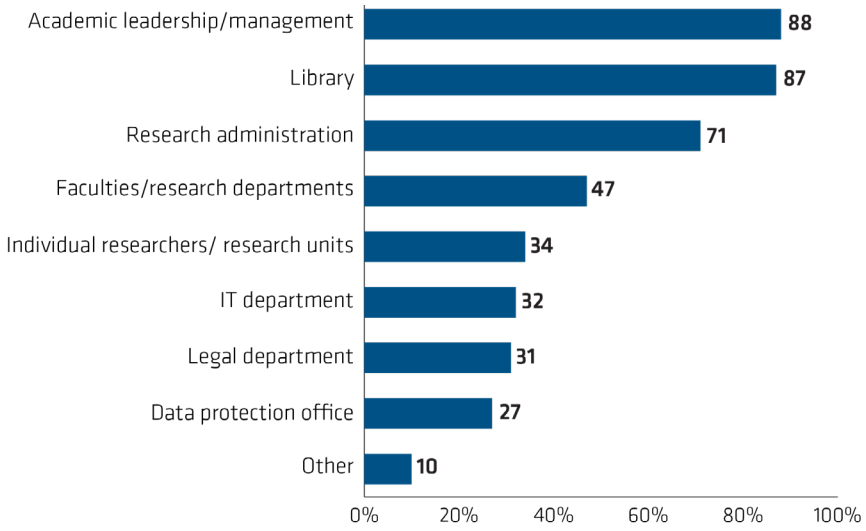
Figure 13 - Open Science policy elements related to awareness, integrity and ethics
Number of respondents: 138-142/146.



Note: This question only applied to institutions that indicated having an Open Science policy.

Academic leadership and management, and library staff are most often involved in developing and drafting Open Science policies: at over 80% of the surveyed institutions, followed by research administration at 60% (Figure 14). Other more specialist departments (such as legal or IT) are only involved at about three out of ten institutions.

Figure 14 - Institutional groups involved in the development and drafting of Open Science policies
Number of respondents: 146/146. Multiple-choice question.

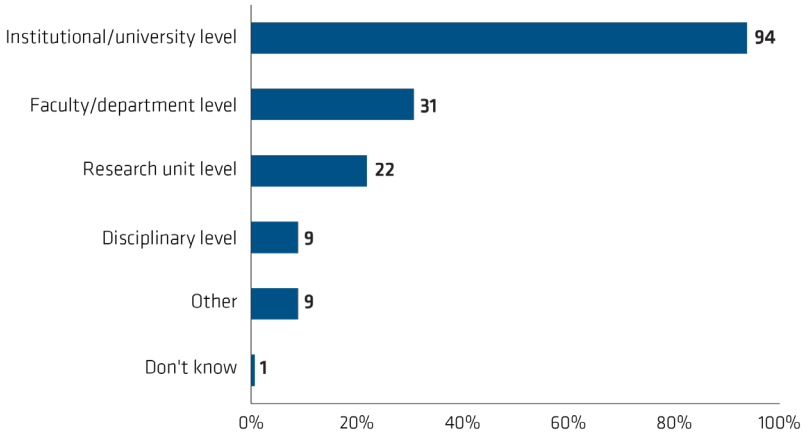


Note: This question only applied to institutions that indicated having an Open Science policy.

In terms of policy implementation, Figure 15 reveals that the vast majority of institutions (94%) implement Open Science policies at institutional level, followed by faculty/department (31%) or research unit level (22%) implementation, which is some way behind.

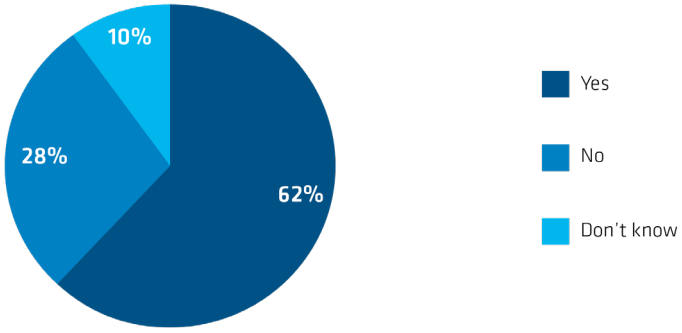
Importantly, the Open Science policy is subject to periodical review and monitoring at about six out of ten institutions, although not at a quarter of respondents, as illustrated in Figure 16.

Figure 15 – Level of implementation of Open Science policies
Number of respondents: 146/146. Multiple-choice question.



Note: This question only applied to institutions that indicated having an Open Science policy.

Figure 16 – Existence of institutional Open Science policy review and monitoring
Number of respondents: 145/146.



Note: This question only applied to institutions that indicated having an Open Science policy.

3.3. DRIVERS AND HURDLES IN THE TRANSITION TO OPEN SCIENCE

Institutions were asked to identify the three most relevant drivers and hurdles in their transition to Open Science. Their answers are presented in Figures 17 and 18. In terms of drivers, external factors seem primarily responsible for the transition to Open Science, namely national policies/guidelines, research funder requirements and EU policies, which were selected by over 50% of the institutions surveyed. Initiatives stemming from institutional actors, such as leadership, research and administration seem to have been mostly responsible for driving the transition to Open Science at 14-35% of institutions.

Regarding the hurdles universities face in the transition to Open Science, the lack of incentives, legal and financial concerns were identified as the most relevant factors hindering progress in this area. Different disciplinary practices and limited awareness of the benefits of Open Science were also rated as important barriers by over 25% of the institutions surveyed. Misconceptions about Open Science and internal institutional factors, such as a lack of coordination between institutional actors and a lack of support structures, were only identified as relevant by around 10% of the respondents.

Figure 17 –Drivers of the institutional transition to Open Science
Number of respondents: 270/272. Multiple-choice question.

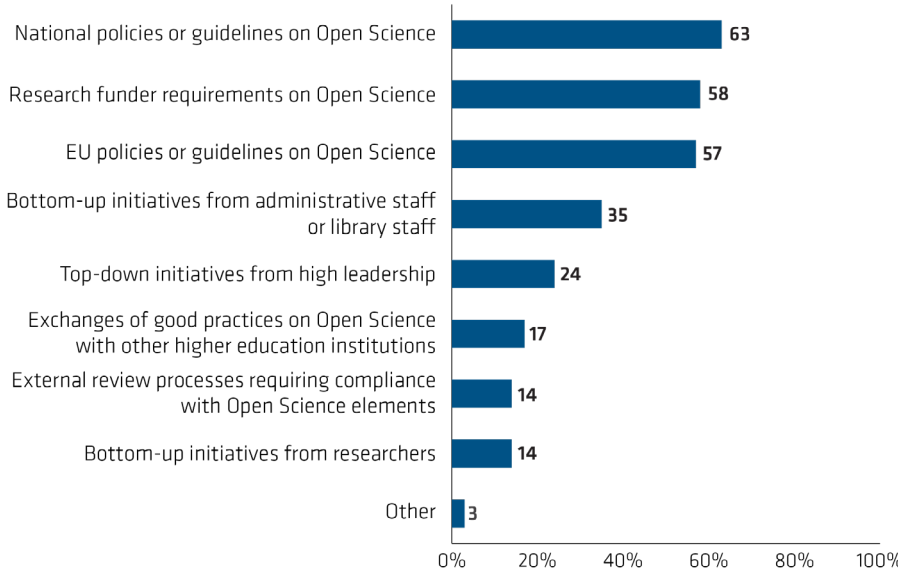
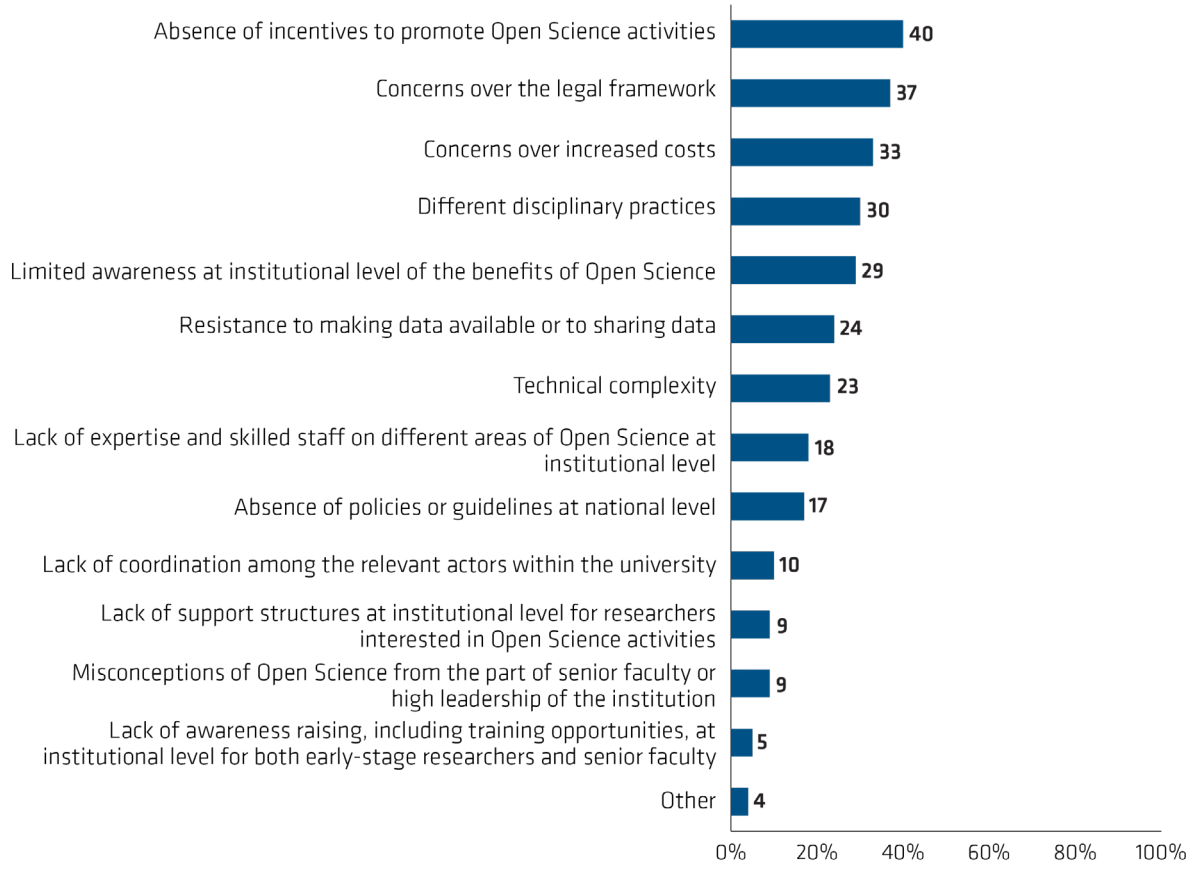


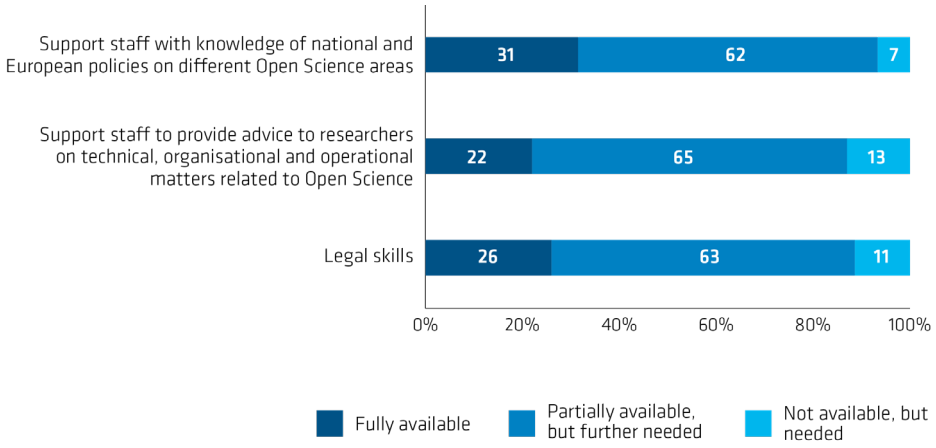
Figure 18 – Hurdles to the institutional transition to Open Science
Number of respondents: 267/272. Multiple-choice question.



3.4. AVAILABILITY OF OPEN SCIENCE SKILLS

In terms of the general skills needed at institutional level for the transition to Open Science, most respondents indicated the limited availability of staff with legal skills and a knowledge of national and European Open Science policies, as well as those capable of providing technical and operational advice. These skills were simply not available at around 10% of the respondent institutions (Figure 19).

Figure 19 –Availability of the skills needed to further Open Science
Number of respondents: 254/272.



3.5. OPEN SCIENCE AT INSTITUTIONAL LEVEL

Survey respondents were asked to indicate how far Open Science and its respective fields are currently implemented at institutional level. Four levels accompanied by practical examples were put forward[7] to help respondents position their institution:

- Level 1: the specific area is not yet part of the institution's priorities, policies or practices.
- Level 2: the specific area is part of the institution's priorities, policies or practices, but its use is still sporadic or ad-hoc.
- Level 3: the specific area is an important part of the institution's priorities, policies or practices, and its use across the institution is gaining traction.
- Level 4: the specific area is fully embedded in the institution's strategic priorities, policies, practices, structures and workflows.

As illustrated in Figure 20, less than 10% of respondents considered that Open Science generally was either fully embedded or totally absent from the institution's priorities and practices (levels 4 and 1). Most placed their institution at level 3 (45%) or level 2 (43%). In terms of the specific areas of Open Science, Open Access to research publications was by far the area most developed/embedded in universities strategies and practices, with over 80% of institutions placing themselves at levels 3 and

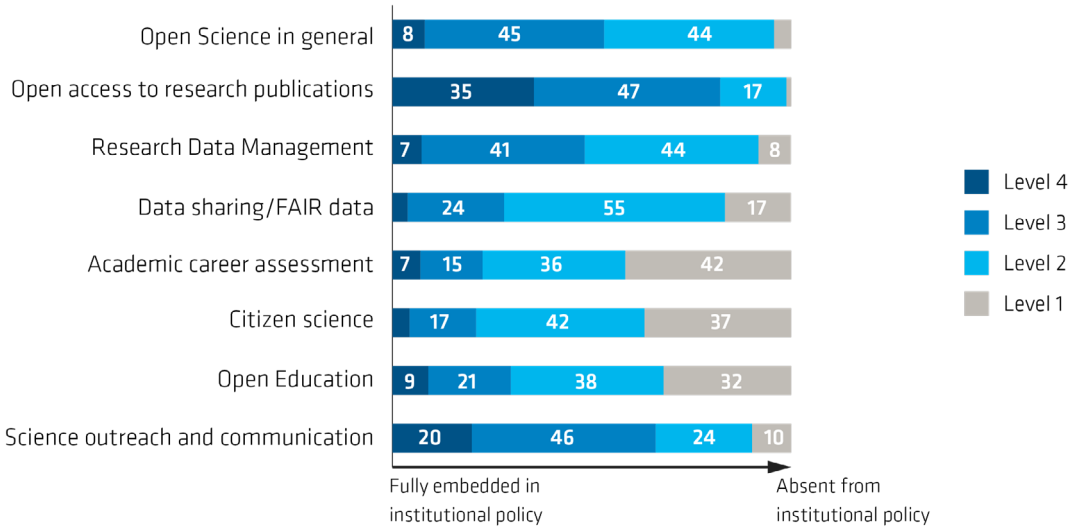
7 The four levels were described in full as follows:
Level 1: This area is not yet part of our institution's priorities, policies or practices.
Level 2: This area is part of our institution's priorities, policies or practices, but its use is still sporadic or ad-hoc. This may be reflected in low awareness of it across the institution, or occasional use (e.g. only in some departments/faculties, only by a small group of researchers/faculty/staff); or low levels of commitment from most stakeholders; or unallocated or inexistent awareness raising, implementation or monitoring resources; or a combination of all three.
Level 3:This area is an important part of our institution's priorities, policies or practices, and is gaining traction across the institution. This may be reflected in good awareness across the institution; or initiatives in several departments/faculties or by a sizable number of researchers/faculty/staff; or the existence of basic monitoring mechanisms and review processes; or in the limited availability of dedicated technical and human resources; or in medium to high levels of commitment from most stakeholders; or a combination of these.
Level 4: This area is fully embedded in our institution's strategic priorities, policies, practices, structures and workflows. This may be reflected in an articulated set of policies covering this area including complementarities with other policies; or streamlined activities across most departments/faculties and by most researchers/faculty/staff/students at all levels; or regular and comprehensive monitoring and review processes; or the allocation of sufficient technical and human resources to this area; or very high levels of commitment from senior leadership, management, support staff and researchers (senior and early career); or a combination of these.

4. Almost 50% indicated that research data management was either an important part of institutions' priorities and practices or was fully embedded (levels 3 and 4). However, data sharing/FAIR data seem to have achieved lower levels of consideration and implementation, as over 70% of the respondents placed themselves at levels 1 and 2. Additionally, between 45-65% of institutions considered science outreach and communication important in strategy and implementation (levels 3 and 4).

At the opposite end of the spectrum, Open Science elements were not part of institutions' academic career assessment priorities, policies and practices for slightly over 40% of the respondents. The scenario was similar for citizen science and open education, where between 70-80% of institutions placed themselves at levels 1 or 2.

Further analysis of the relationship between the levels of strategic importance ascribed to Open Science and perceptions of its institutional integration revealed a positive relationship.[8] Indeed, institutions that give Open Science high or very high strategic importance tend to display higher levels of Open Science integration at institutional level.

Figure 20 –Views of Open Science at institutional level
Number of respondents: 256-260/272.



8 Using the Spearman rank order correlation: $r_s(258) = 0.483$, $p<0.001$.

Open Access to research publications

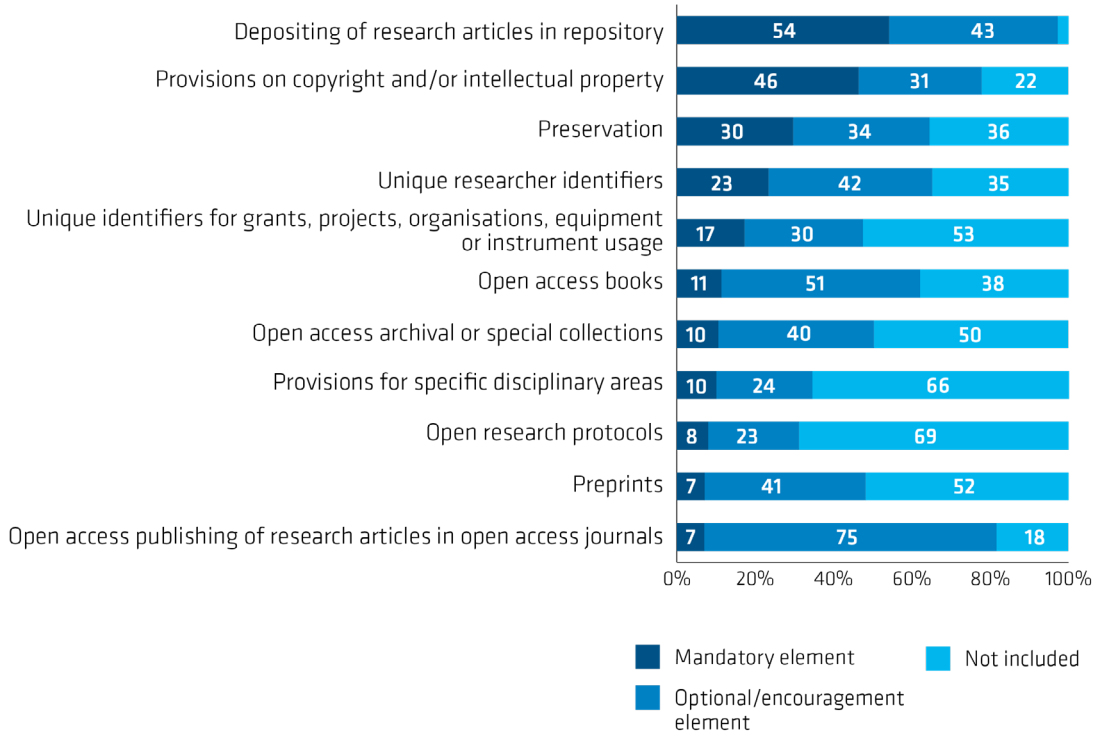
4

This section focuses specifically on Open Access to research publications. It starts with a general overview of how institutional Open Science policies deal with Open Access and its related monitoring activities, and goes on to address more practical aspects of Open Access implementation at Europe's universities. It addresses views on: institutional engagement and Open Access practices, related infrastructure and funding sources. It also presents institutions' views of recent developments in scholarly communication, namely Plan S.

4.1. OPEN ACCESS POLICY ELEMENTS

As noted in Section 3, 54% of the respondents indicated having an Open Science policy. At these institutions, this policy included the specific Open Access elements presented in Figure 21. The most frequent action mandated or encouraged in Open Science policies was depositing research articles in a repository, which was reported in virtually 100% of cases. Publishing articles in Open Access journals was primarily encouraged at 75% of the institutions. Copyright and intellectual property provisions were included in almost 80% of respondent's institutional policies. Preservation, unique researcher identifiers, Open Access books and Open Access archival or special collections were also included in institutional policies, and either mandated or encouraged at at least 50% of the institutions. Provisions for specific disciplines and open research protocols were the areas the least included in institutional policies, at only 30-35% of respondents.

Figure 21 –Open Science policy elements covering Open Access to research publications
Number of respondents: 138-142/146



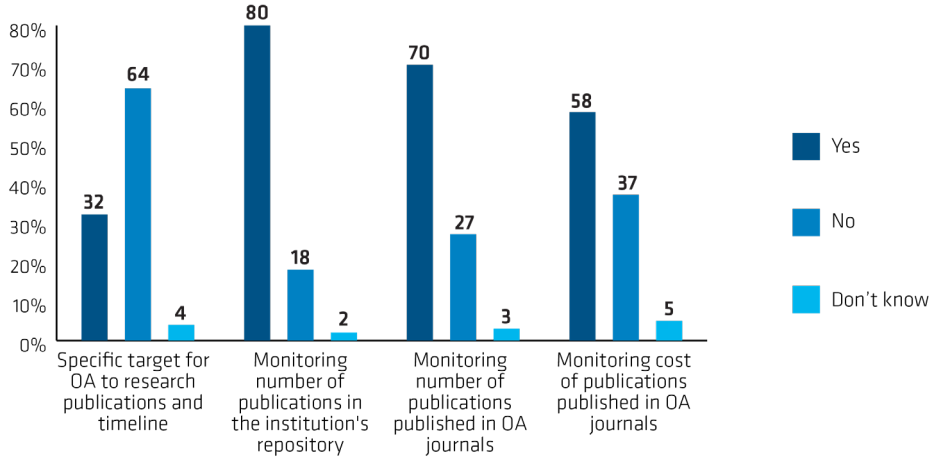
Note: This question only applied to institutions that indicated having an Open Science policy.

4.2. OPEN ACCESS TARGETS AND MONITORING MECHANISMS

The survey included questions about the existence of specific institutional targets and monitoring for Open Access mechanisms, as shown in Figure 22. While 64% indicated not having established specific Open Access targets or timelines, most had monitoring mechanisms in place. Some 80% of respondents noted monitoring the number of Open Access articles in their repository and 70% monitored articles published in Open Access journals. And almost 60% indicated monitoring the costs of Open Access journal publications.

These results suggest that while monitoring the use of repositories, Open Access publications and related costs are relatively well established at most of the institutions surveyed, these indicators are not always used to establish or inform specific Open Access targets at the institutional strategy level.

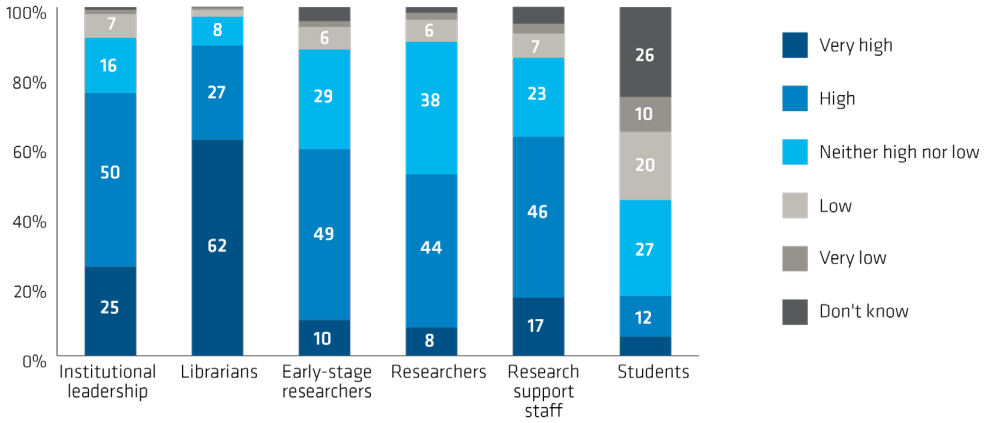
Figure 22 –Existence of Open Access targets and monitoring mechanisms at institutional level
Number of respondents: 268-269/272.



4.3. LEVEL OF ENGAGEMENT IN OPEN ACCESS

Institutions were asked about their perceptions of different groups' engagement in Open Access to research publications (Figure 23). Librarians and institutional leaders were perceived as highly or very highly engaged in these activities at respectively 89% and 75% of institutions. Researchers and early-stage researchers were seen as highly involved in Open Access activities by 52% and 59% of institutions, respectively. Perceptions of student engagement seemed more heterogeneous; with 26% of institutions indicating this was not known. This is probably due to the respondents' positions (see section 2), as most are members of the high-level management team, which is relatively detached from the student population.

Figure 23 – Level of engagement and practice of Open Access to research publications
Number of respondents: 240-251/272.



4.4. INFRASTRUCTURE AND RESEARCH SUPPORT

In terms of institutional level infrastructure, Figure 24 shows that 90% of the surveyed institutions have their own repository, take part in a shared repository or both. But when it comes to journal hosting or publishing platforms, this figure drops to 66%, while only 57% have their own platform for monograph hosting/publishing, participate in a shared platform or both.

Figure 24 – Institution-level Open Access to research publication infrastructure
Number of respondents: 271/272

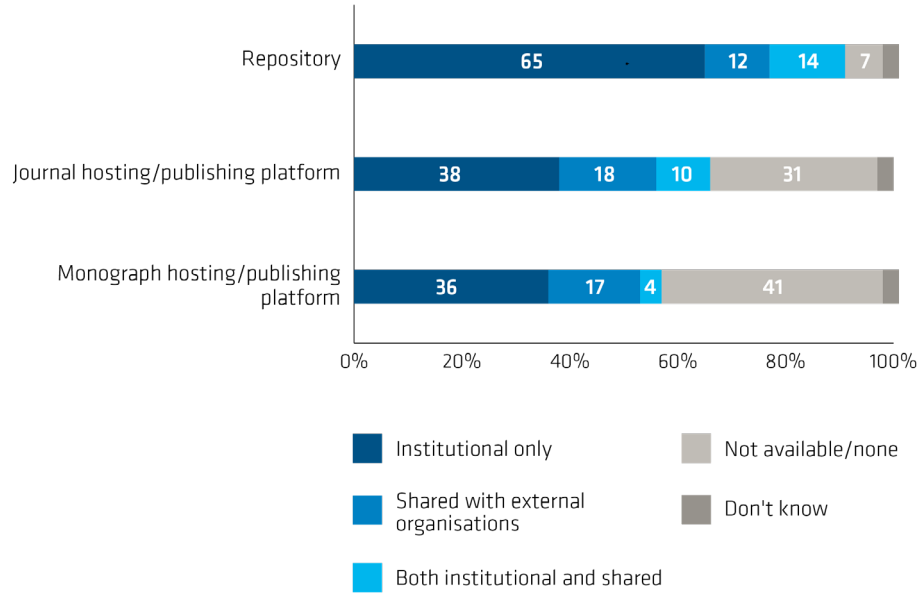
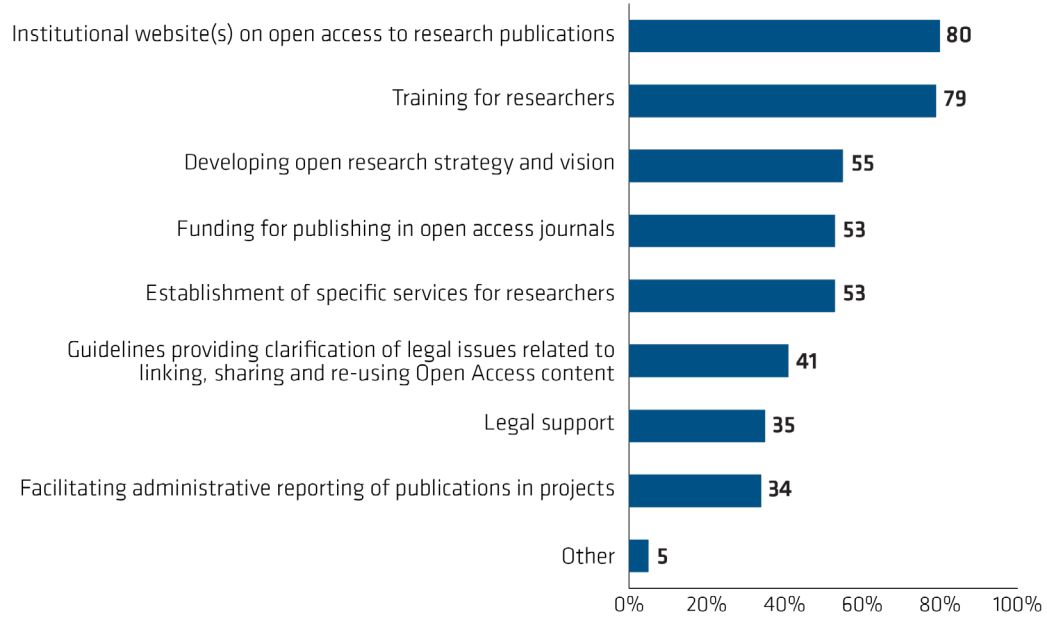


Figure 25 reveals that approximately 80% of the surveyed institutions have a dedicated Open Access website and provide researchers with Open Access training. In addition, over half of the respondents help researchers develop an Open Access research strategy, provide funding for Open Access publishing or have established dedicated services for their researchers.

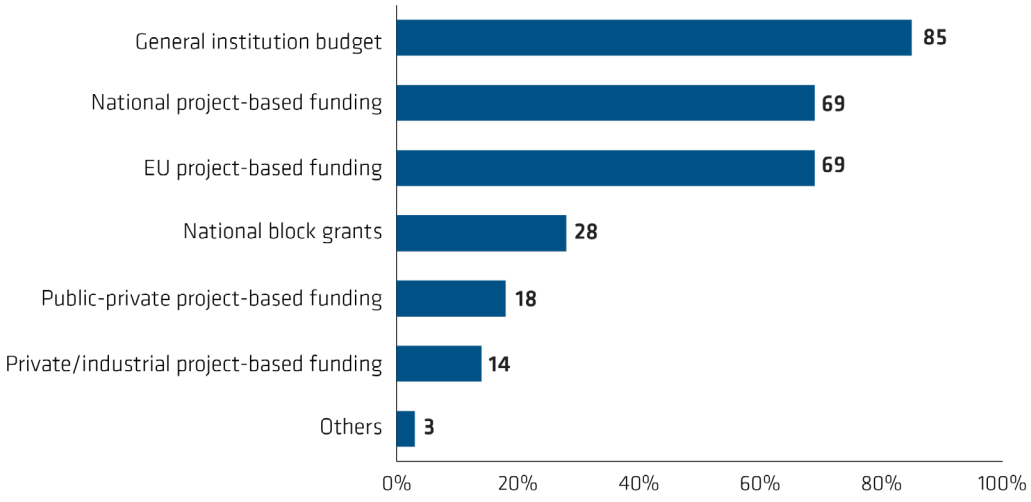
Figure 25 – Open Access support provided by the institution to researchers
Number of respondents: 268/272. Multiple-choice question.



4.5. FUNDING

When it comes to institutional funding for Open Access to research publications (Figure 26), 85% of the respondents draw on the general institutional budget and almost 70% use both national and European project-based funding. National block grants and funding from private or public-private partnerships are only used by 14-28% of the institutions surveyed.

Figure 26 – Funding sources for Open Access to research publications
Number of respondents: 253/272. Multiple-choice question.



4.6. SCHOLARLY COMMUNICATION

The survey included questions on institutions' involvement in recent scholarly communication developments, as shown in Figure 27. Most respondents (66%) reported that their institution participated or supported non-commercial Open Access publishing.

Questions about preparations for the implementation of Plan S produced a more heterogeneous response pattern. Indeed, 41% indicated that preparations are underway, but 38% noted that they are not engaged in such a process. A closer examination of the response patterns in countries whose main research funders have adopted Plan S against response patterns in those that have not (Figure 28) clarifies that in countries where the main research funders have adopted Plan S[9] a significant[10] majority of institutions (68%) are indeed preparing for its implementation and only 17% are not. Conversely, in countries where the main research funders have not yet adopted Plan S, only 24% are preparing for its implementation, whereas 51% of institutions are not.

Figure 27 – Recent developments in scholarly communication
Number of respondents: 269-270/272.

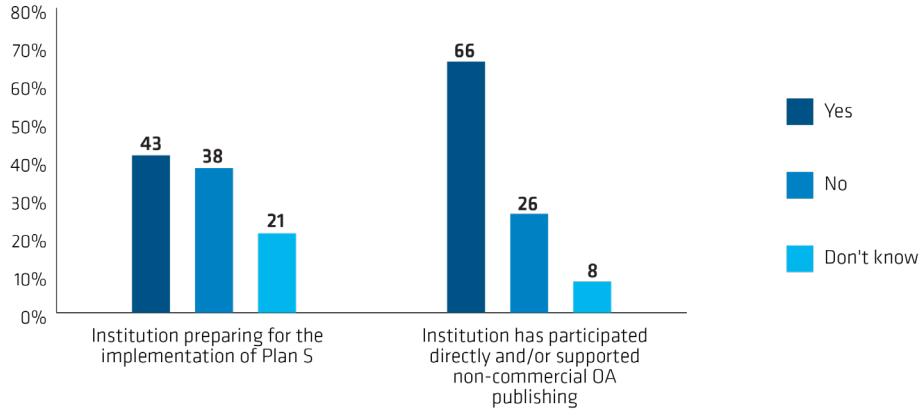
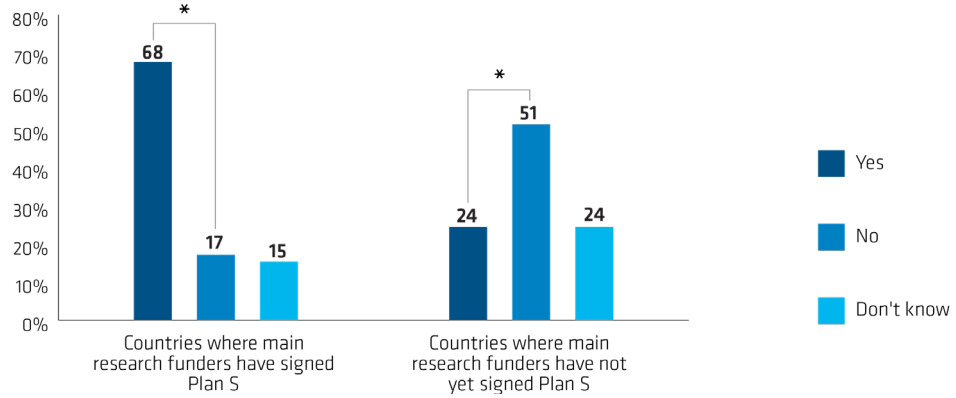


Figure 28 – Preparations for the implementation of Plan S
Number of respondents: 269/272.



*Note: * indicates the percentages between bars are statistically significant.*

9 Countries where the main research funders have adopted Plan S include: Austria, Finland, France, Ireland, Luxembourg, the Netherlands, Norway, Poland, Slovenia, Sweden and the UK. The European Commission has also adopted and funds Plan S. Italy was not defined as a country where the main research funder(s) have adopted Plan S, as only a specialist physics research institute has done so. Portugal's main research funder announced its adoption of Plan S in late January 2021, after the survey was closed. Portugal was therefore not included in the group of countries whose main research funders had adopted Plan S for the purposes of this analysis.

10 A chi-square test of independence was performed: $\chi^2(2, N= 269)= 40.27$, $p= <0.001$, $V= 0.38$.

Research data

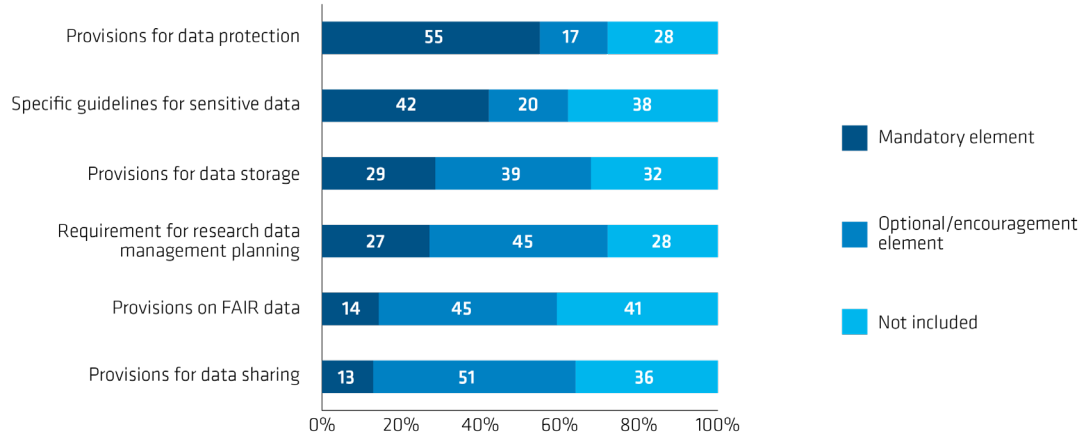
5

This section focuses on institutions' specific views and experiences regarding Open Science and research data. The chapter starts by setting out institutions' policies on data and the engagement of different groups in research data activities, before exploring more practical aspects: the existence of specialist data services, skills availability, infrastructure and funding. A final sub-section presents institutions' plans for the European Open Science Cloud.

5.1. DATA-RELATED POLICY ELEMENTS

Some 54% of the institutions surveyed reported having an Open Science policy (see section 3). Over 50% of these institutions' policies included all the data-related elements presented in Figure 29, (either making them compulsory or making them optional/an incentive). Data protection provisions and specific guidelines on sensitive data were the most common obligations: at 42-55% of institutions. Data sharing, FAIR data and research data management plans were most often included as optional or as incentives in institutional policies at 39-45% of the respondent institutions.

Figure 29 – Open Science policy elements on research data
Number of respondents: 138-142/146.

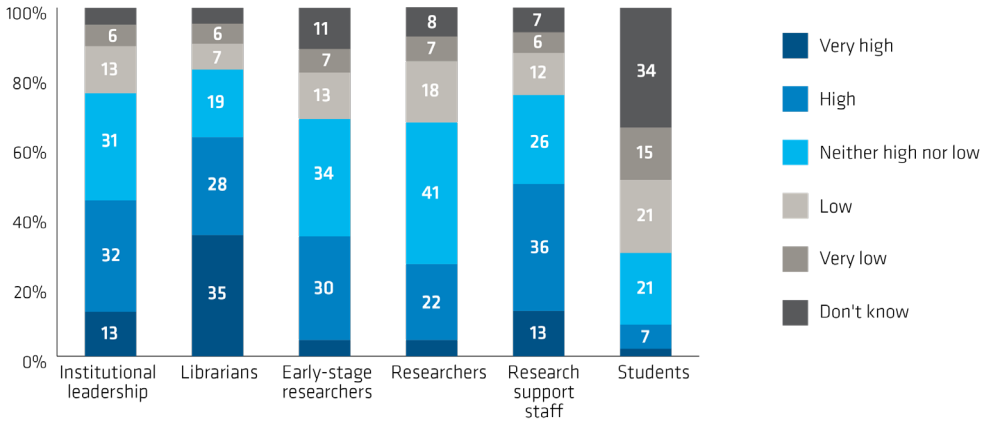


Note: This question only applied to institutions that reported having an Open Science policy.

5.2. LEVEL OF ENGAGEMENT WITH DATA SHARING AND FAIR DATA

Institutions were asked about their perceptions of different groups' engagement in FAIR data and data sharing (Figure 30). Librarians were perceived as most involved at 63% of institutions (ranked in the high and very high categories), followed by research support staff (49%) and institutional leadership (45%). Researchers' and early-stage researchers' engagement was only considered high or very high by 34% and 26% of respondents, respectively. Institutions' perceptions of student commitment were more mixed. A high proportion indicated not knowing their level of engagement (34%). As noted in the previous section, this was probably due to the respondents' positions and their lack of contact with the student body.

Figure 30 – Levels of engagement with and implementation of data sharing/FAIR data
Number of respondents: 233-244/272.



5.3. SPECIALIST SERVICES

Universities were also asked about the existence of specialist research data services and support staff. As shown in Figure 31, 51% of those surveyed indicated having dedicated research data support services, while 43% noted their absence. In addition, 36% indicated the existence of dedicated research data support staff at central and library levels, and 18% at departmental level. However, 32% noted that these specialist support staff were not available, as shown in Figure 32.

Figure 31 – Existence of dedicated research data support services at institutional level
Number of respondents: 269/272.

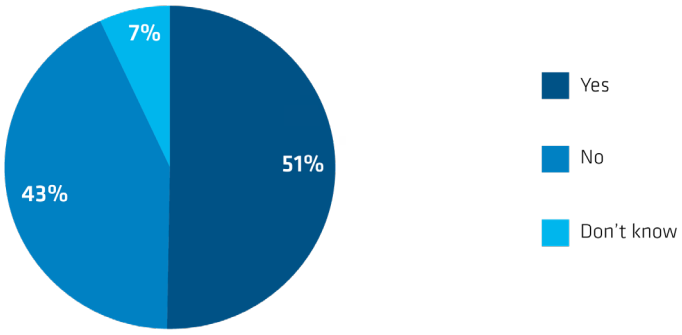
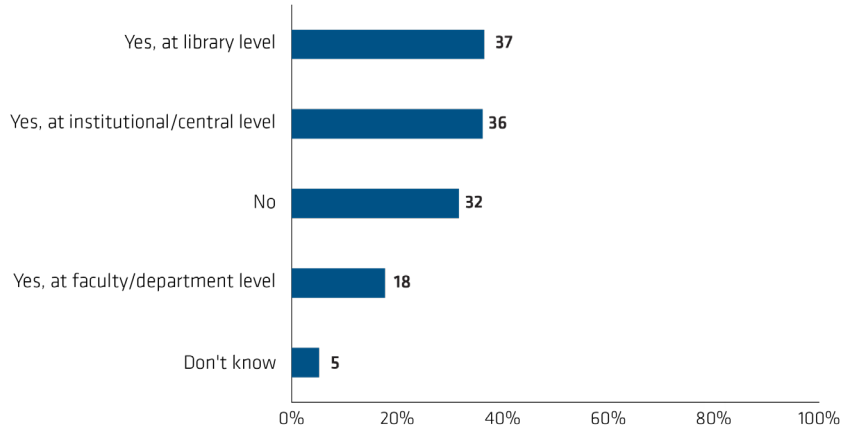


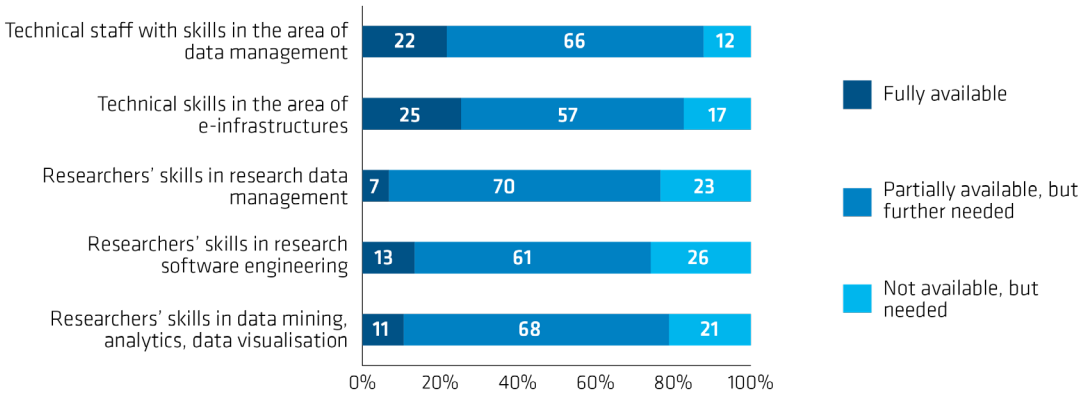
Figure 32 – Existence of specific research data support staff at institutional level
Number of respondents: 271/272. Multiple-choice question.



5.4. AVAILABILITY OF RESEARCH DATA SKILLS

Over 50% of the respondents noted that the data-related skills identified in Figure 33 were only partially available at institutional level. Researchers' data management and data mining/visualisation skills were reported as partly available or missing by approximately 70% of the institutions. Most respondents also included these areas in the categories where they noted a complete skills absence: at 23% and 21% respectively, along with research software engineering (26%). The highest proportions of full skills availability were reported for: e-infrastructure and data management specialists (25% and 22%, respectively).

Figure 33 – Availability of research data skills at the institution
Number of respondents: 217-254/272.



5.5. RESEARCH DATA INFRASTRUCTURE AND SUPPORT

Some 82% of respondents indicated the existence of some kind of institutional data storage, while 78% reported having access to a data repository (internal, external, shared or a combination of all three). These figures dropped slightly to 70% when it came to the existence of Data Management Plan (DMP) tools.

In terms of research data support (Figure 35), most institutions provide training for their researchers (75%) and a dedicated website including relevant information on research data management (62%). Other types of support, namely an open research strategy, FAIR principles compliance and FAIR publishing via recommended repositories are only available at between 35-47% of the institutions surveyed. Dedicated funding for FAIR principle implementation is only available at less than 10% of the respondent institutions.

Figure 34 – Institutional research data infrastructure
Number of respondents: 270/272.

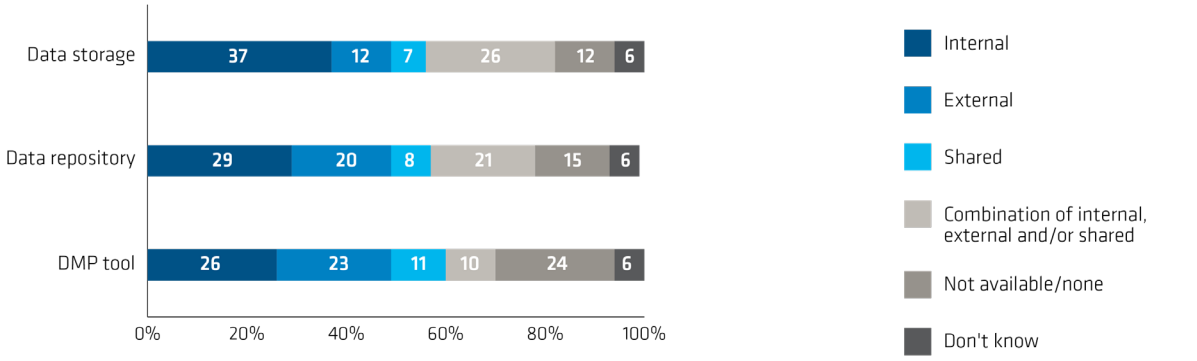
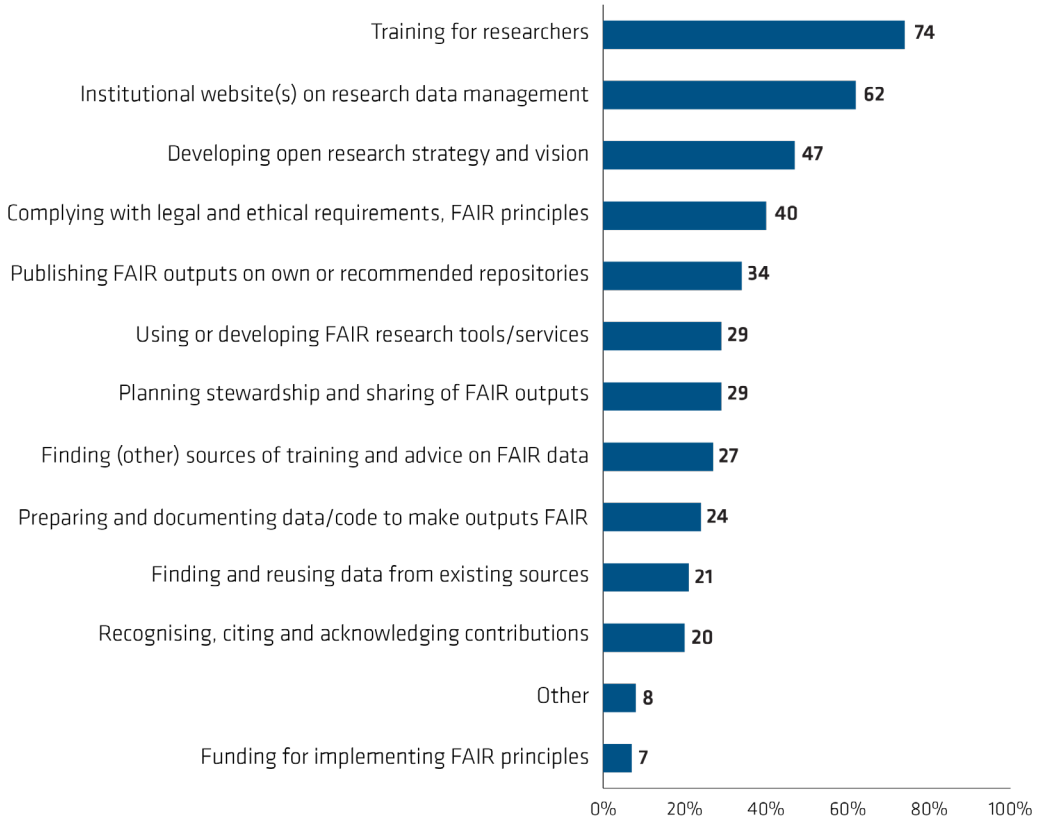


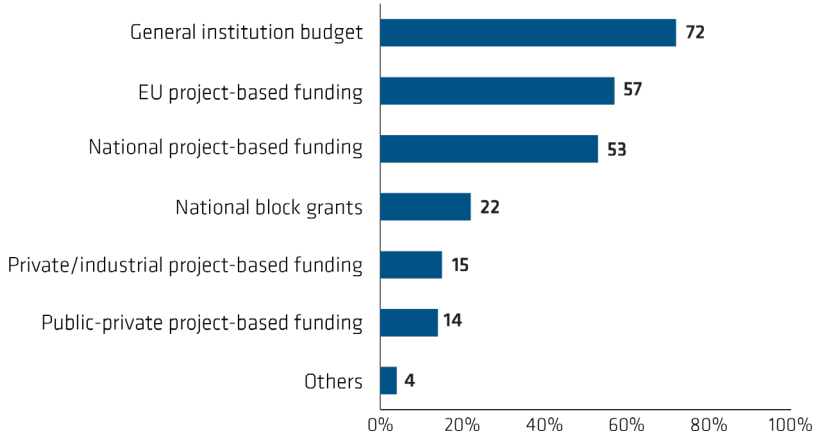
Figure 35 – Institutional support for research data management, FAIR data and data sharing provided to researchers
Number of respondents: 255/272. Multiple-choice question.



5.6. FUNDING

Similarly to Open Access (see section 4), the general budget and both national and EU funding were the most common sources of funding for research data management, used by 53-72% of the institutions surveyed. Private or public-private research data funding was only available at 14-15% of institutions (Figure 36).

Figure 36 – Sources of research data management funding
Number of respondents: 211/272. Multiple-choice question.



5.7. EUROPEAN OPEN SCIENCE CLOUD

The survey included questions on perceptions and plans regarding the European Open Science Cloud (EOSC). As shown in Figure 37, seven out of ten surveyed institutions agree with the potential benefits of EOSC. However, on answering this survey, only 24% were planning to link their infrastructure to EOSC services and only 19% were planning to become a member of the EOSC Association (Figure 38). Most institutions were either still deciding or did not yet know how they were going to proceed. It is also relevant to note that among the surveyed universities, 23 institutions are already members of EOSC. Amongst the total of the EUA membership, so far, 42 institutions have joined EOSC.

Additional analysis explored whether countries with a national data policy responded differently to countries currently lacking a national data policy when it came to the EOSC questions[11]. However, the results indicated no differences.

11 Countries were classified as having a national data policy (CY, CZ, ES, FR, FI, IE, LT, NL, SI, SK, CH, NO, RS, UK) or not having such a policy, based on the study "An analysis of Open Science policies in Europe, v6", published by Sparc Europe in August 2020.

Figure 37 – Agreement with the potential benefits of EOSC
Number of respondents: 272/272.

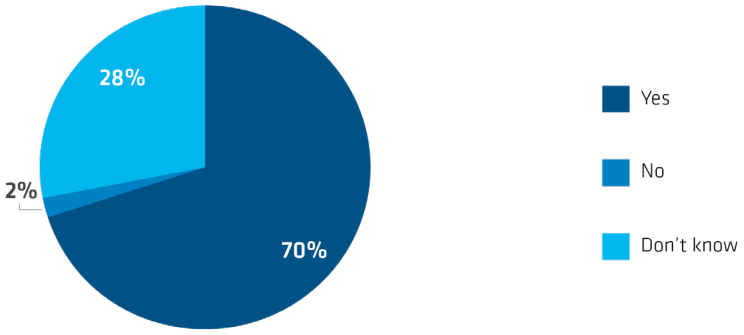
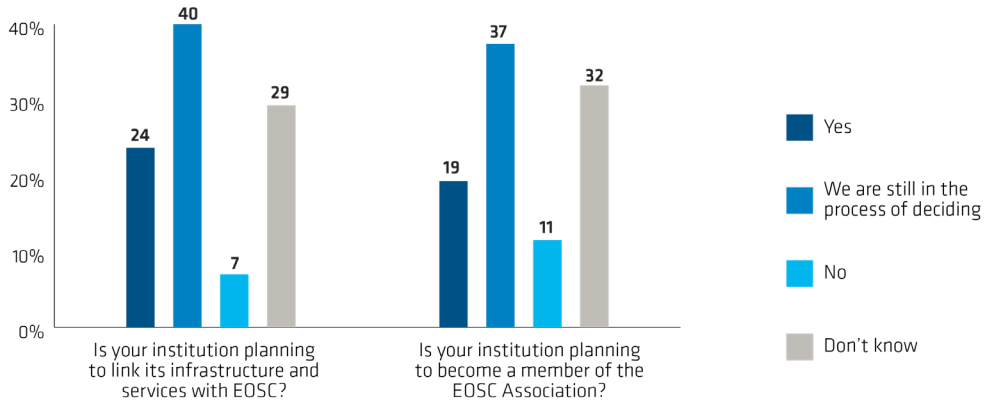


Figure 38 – Future involvement in EOSC
Number of respondents: 270/272.



Emerging areas of Open Science

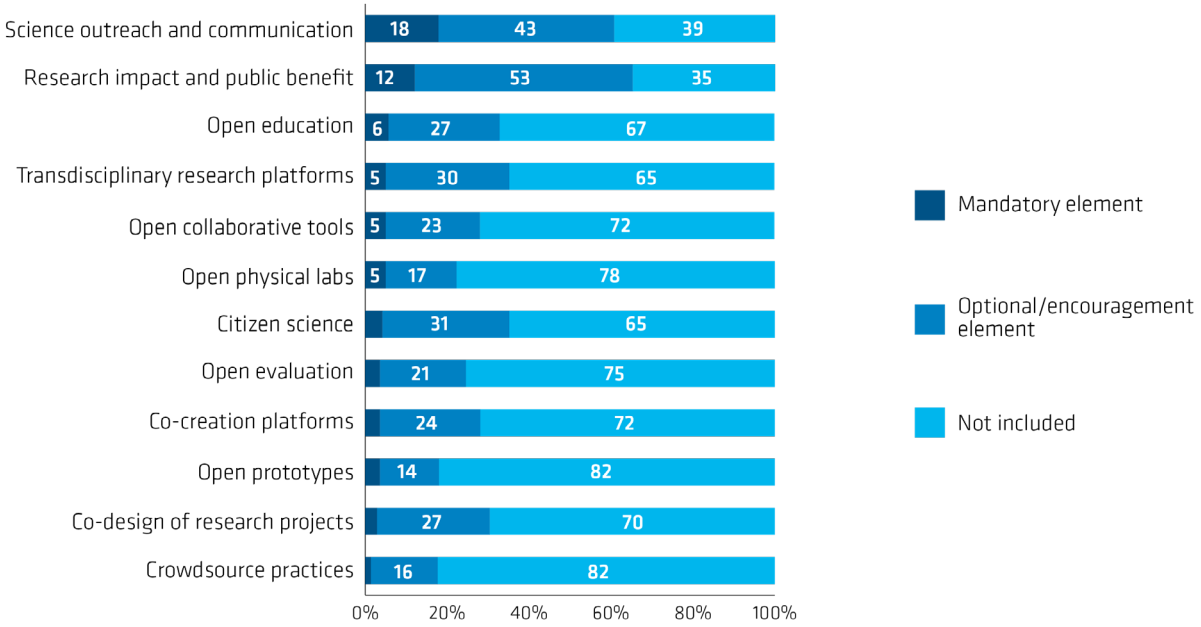
6

This section focuses on emerging areas of Open Science. It opens by examining the existence of institutional policies to address emerging fields of Open Science (e.g., citizen science, open education), then describes the levels of institutional engagement, skill availability, activities and the available funding sources.

6.1. INSTITUTIONAL POLICY COVERAGE OF EMERGING OPEN SCIENCE

As shown in section 3, 54% of the surveyed institutions indicated having an Open Science policy. These respondents were then asked about the inclusion of emerging areas of Open Science in their policy (Figure 39). Their answers show that research impact and public benefit, as well as science outreach and communication are included in most policies: 65% and 61%, respectively. Transdisciplinary research platforms, citizen science, open education and the co-design of research projects are also covered by Open Science policies (mostly as optional/supporting elements) at 30-35% of institutions.

Figure 39 – Emerging areas of Open Science included in institutional policy
Number of respondents: 138-142/146.



Note: This question only applied to institutions that reported having an Open Science policy.

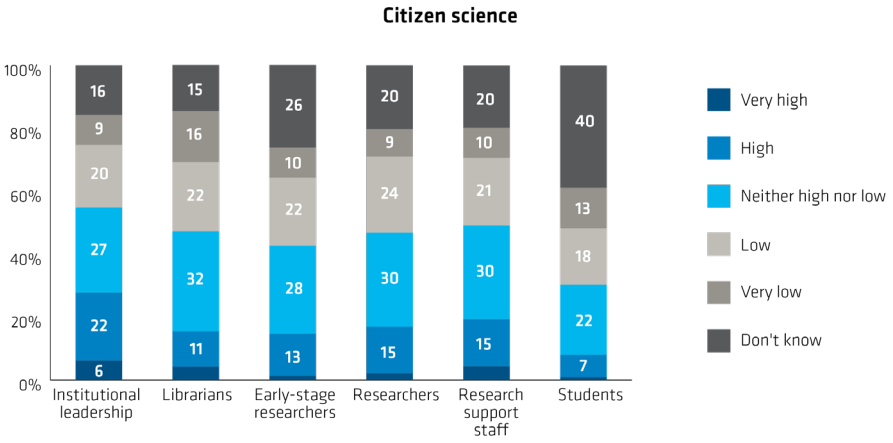
6.2. LEVEL OF ENGAGEMENT

Respondents were also asked about their perceptions of different groups' engagement to the emerging areas of Open Science mentioned (see Figure 40). Science outreach and communication was seen as highly important (categories high and very high) for institutional leadership, researchers, early-stage researchers, research support staff and librarians by 42-67% of the respondents. Citizen science, and open education came in second and third place, with high engagement levels across several groups, a

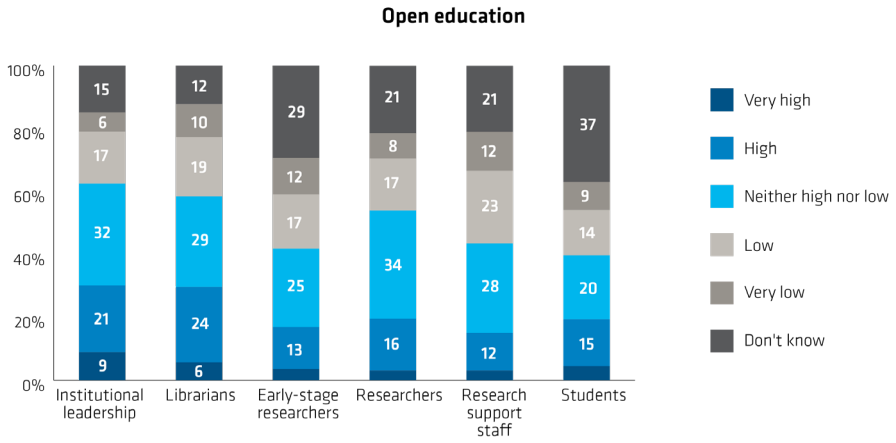
long way ahead of science outreach, where 15-28% rated institutional leadership, librarians, researchers and early-stage researchers, as well as research support staff engagement as high or very high.

Engagement in co-creation platforms and open peer review was perceived as lower and more heterogeneous. It is also important to mention that the proportion of institutions indicating not knowing the level of engagement of different groups in the latter activities was higher (ranging between around 20-40% for all groups except students), so it is difficult to assess universities' real engagement in these activities from the survey data. It is also important to note the high proportion of institutions indicating that they did not know their students' level of engagement in these emerging areas of Open Science (approximately 40-50%), which does not allow us to infer their commitment to these activities.

Figure 40 –Level of engagement and practice of emerging areas of Open Science

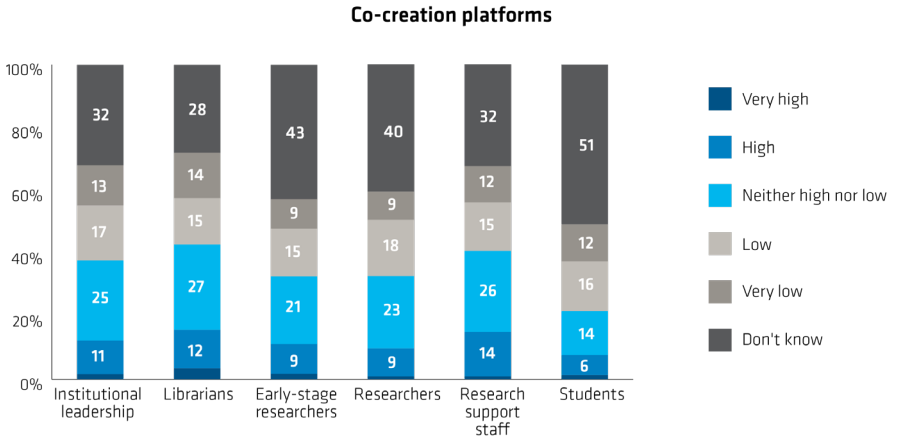


Number of respondents: 224-241/272.

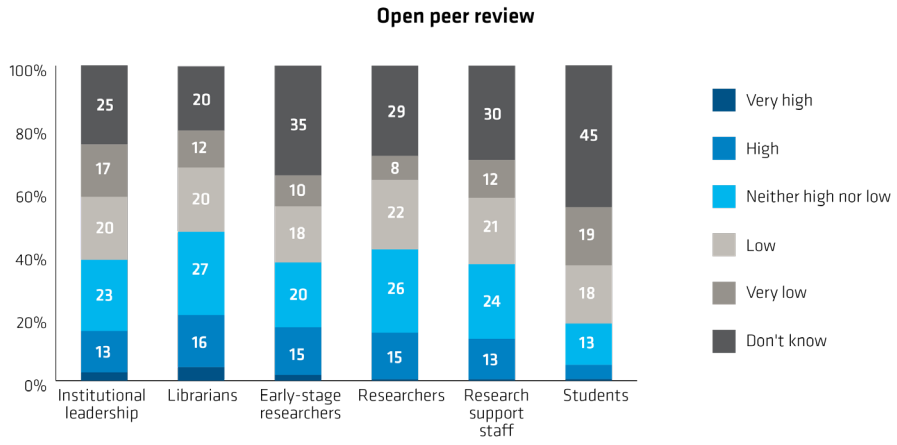


Number of respondents: 222-235/272.

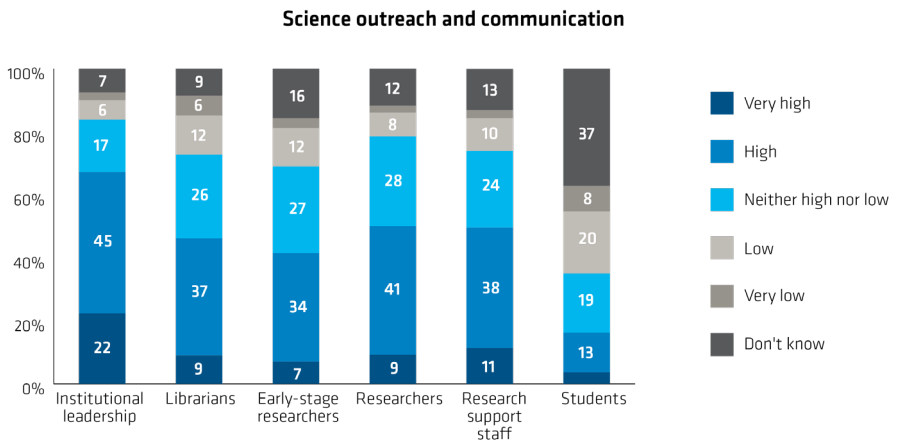
Figure 40 –Level of engagement and practice of emerging areas of Open Science (continuation)



Number of respondents: 221-235/272.



Number of respondents: 222-235/272.

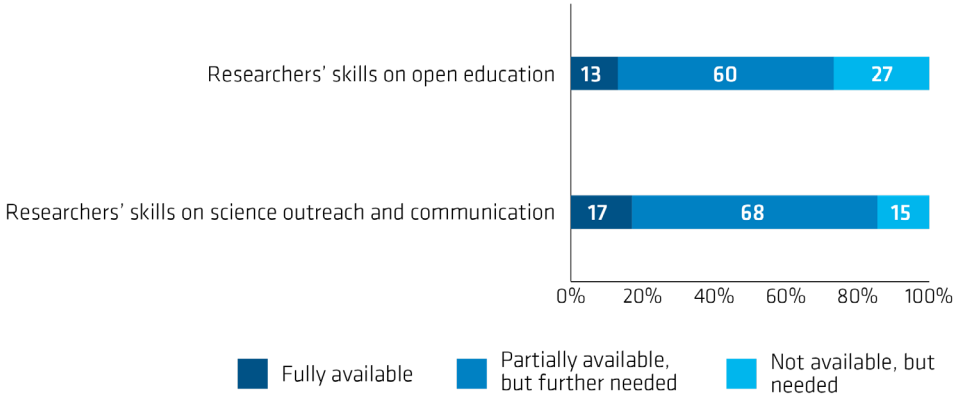


Number of respondents: 228-241/272.

6.3. AVAILABILITY OF THE SKILLS NEEDED IN EMERGING AREAS OF OPEN SCIENCE

The survey asked institutions to indicate the availability of skills in two emerging areas of Open Science: Science outreach and communication; and open education (Figure 41). Between 60-69% reported that their researchers had some skills in both areas, but that further resources and skills were needed at institutional level. Importantly, 27% of the respondents reported a lack of researcher skills in open education and 17% in science outreach and communication. Only a minority (13-17%) deemed these skills fully available at institutional level.

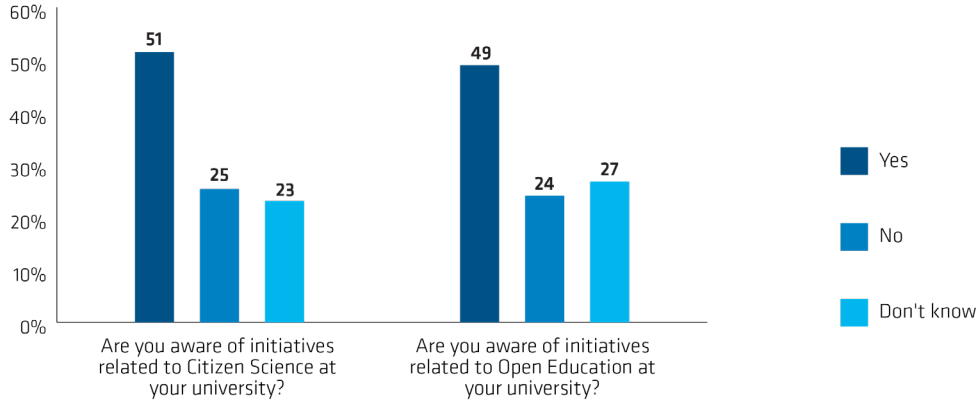
Figure 41 – Institutional availability of open education, and science outreach and communication skills
Number of respondents: 206-235/272.



6.4. INSTITUTIONAL ACTIVITIES

Figure 42 shows the existence of both citizen science and open education activities at institutional level. Approximately 50% of the respondents reported awareness of such initiatives at their institutions, although around a quarter indicated not knowing if any were taking place.

Figure 42 – Institutional activities in emerging areas of Open Science
Number of respondents: 261-264/272.

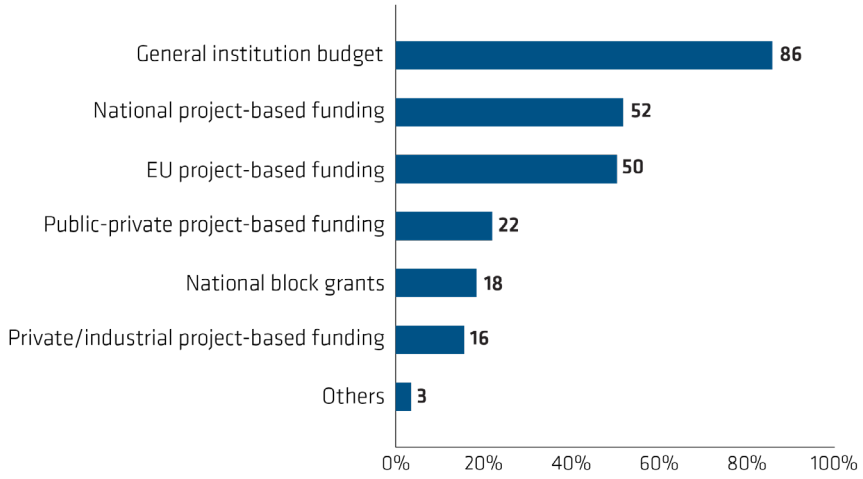


6.5. FUNDING

A large proportion of surveyed institutions did not answer questions on the funding sources for emerging areas of Open Science. Figure 43 therefore shows only the funding sources reported for science outreach and communication because at least 50% of respondents replied to this question.

Approximately 86% of the respondents reported using the general institution budget for science outreach and communication activities, and approximately 50% used both national and European project-based funding. Only 15-22% of respondents used the other funding categories.

Figure 43 – Funding sources used for science outreach and communication
Number of respondents: 141/272.



Open Science in academic assessment

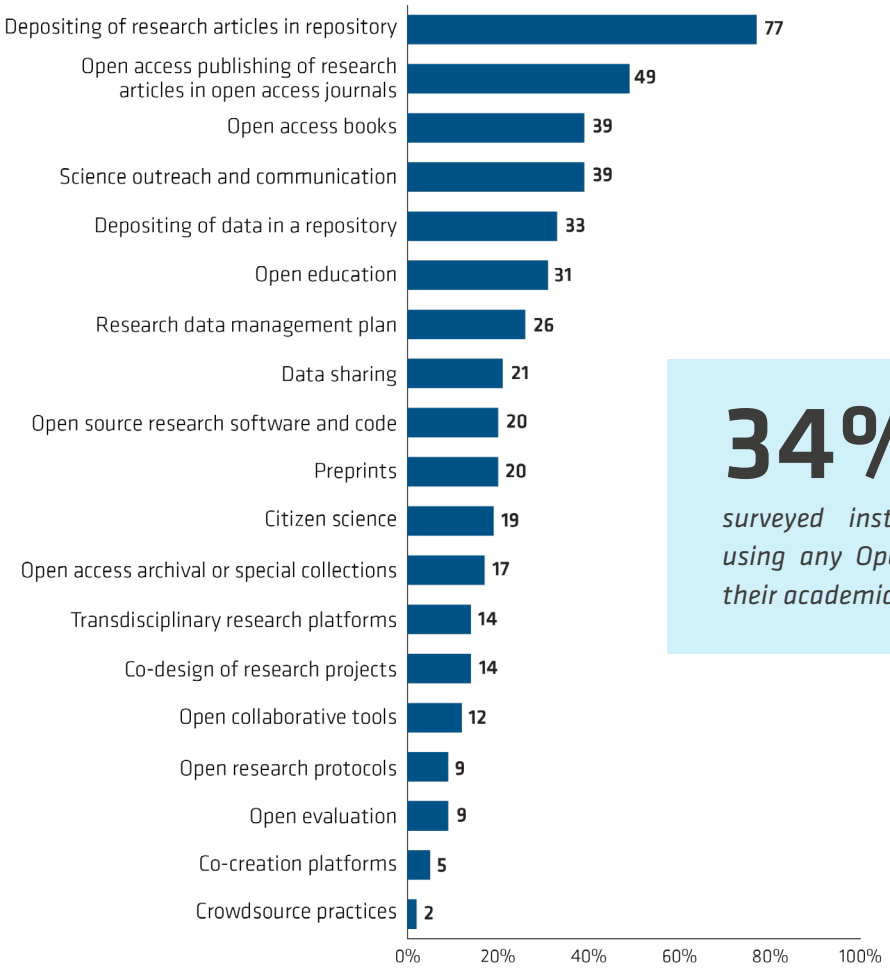
7

This section outlines the inclusion of Open Science in current institutional assessments and then explores their potential use in future.

Institutions were asked about the use of different Open Science elements in their internal academic assessments (e.g. career progression, academic unit performance evaluation and/or funding allocations within the institution). The results in Figure 44 show that 34% of respondents reported using none of the Open Science elements under analysis in their academic assessments. Amongst the institutions that used some of these elements in their academic assessments, 77% consider article deposition in a repository as part of their assessment approaches, while 49% look at the publication of articles in Open Science journals. Open Access books, science communication activities, depositing data in a repository and open education were examined as part of academic assessments at 33-39% of institutions. Other Open Science elements were considered by up to 25% of institutions.

Figure 44 – Open Science elements included in academic assessments

Number of respondents: 172/272.



34%

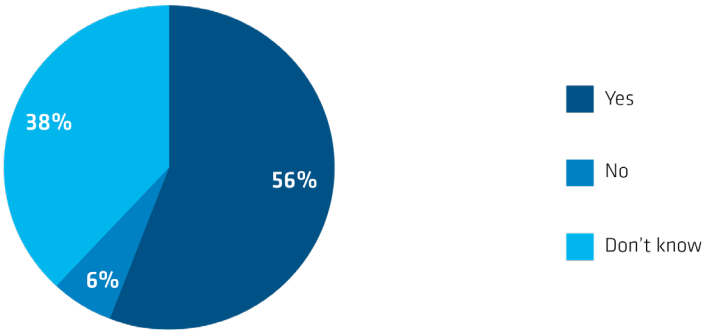
surveyed institutions reported not using any Open Science elements in their academic assessments.

Note: Only institutions that indicated using at least one Open Science element in their academic assessments are included in this Figure.

Just over half of the institutions surveyed (56%) reported planning to expand the range of Open Science elements used in future academic assessments, although about a third did not know if this would be the case (Figure 45). This response pattern may be partially explained by the high proportion of research support or library staff respondents, who may not be privy to institution-wide strategic decisions.

Figure 45 –Likelihood that the range of Open Science elements considered in academic assessments will be expanded

Number of respondents: 271/272.



Conclusions

8

The 2020-2021 EUA Open Science Survey highlights universities' progress in different areas of Open Science. For the first time, it focused on a broad Open Science spectrum, including more established areas of Open Science like: Open Access to research publications, RDM and FAIR data, plus emerging areas, namely: open education, citizen science, and science outreach and communication.[12]

Since the first survey in 2014, over 700 European universities and higher education institutions from over 30 countries in Europe have answered EUA's Open Science and Access surveys. This illustrates the broad scope of respondents' profiles, in terms of their geographical distribution, size, and national and policy contexts.

8.1. KEY RESULTS

The key results of the 2020-2021 EUA Open Science survey are summarized below:

General Open Science principles and practices

- Over half (59%) of the surveyed institutions rated Open Science's strategic importance as very high or high. The gap between levels of importance and implementation varies in different Open Science areas. Open Access to research publications achieves higher levels of importance and implementation (high importance at 90% of the institutions surveyed, with high levels of implementation at 60%) and science outreach and communication achieves high importance at 80% of the institutions surveyed with high levels of implementation at 55%. However, the gap between importance and implementation is much wider in data-related areas (RDM, FAIR and data sharing): high importance at between 55-70% of the institutions surveyed, with high levels of implementation at 15-25%.
- Most respondents deemed Open Science's overall inclusion in institutional priorities and practices either sporadic (43%) or gaining traction (45%). Institutions may address/include some of the aspects of Open Science examined at a strategic level, but actual implementation remains ad-hoc or in development. Implementation of the different areas of Open Science followed this pattern: Open Access to research publications achieved the highest levels, while RDM, data sharing/FAIR data scored more moderately.
- The survey showed that 54% of its respondents have an Open Science policy and 37% are developing one. Only 9% of these institutions lack an Open Science policy or are not planning to draft one.
- At most institutions, the transition to Open Science was primarily facilitated by external factors, including national and European policies/guidelines and research funder requirements. And a lack of incentives, or legal and financial concerns were seen as the main hurdles.

12 As section 3 shows, universities have carried out science outreach and communication activities beyond the scope of Open Science for a long time. In the framework of this report, science outreach and communication is understood as an emerging area that is part of a more holistic approach to Open Science.

Open Access to research publications

- The absence of specific Open Access targets or an Open Access timeline was reported by 64% of the respondents. However, 80% monitored the number of publications in their repository and 70% monitored articles published by their researchers in Open Access journals. In addition, almost 60% reported monitoring the cost of publications by their researchers in Open Access journals.
- Some 90% of the institutions surveyed have their own repository, participate in a shared repository or both. This figure goes down to 66% for journal hosting or publishing platforms, and levels out at 57% for monograph hosting/publishing. In addition, 66% of those surveyed reported that their institution has participated in or supported non-commercial Open Access publishing.
- In countries where the main research funders have adopted Plan S, 68% of the respondents are preparing for its implementation and only 17% of institutions are not. In countries where the main research funders have not yet adopted Plan S, only 24% are preparing for its implementation, and 51% are not.

Research data

- Dedicated research data support services are available at 51% of the surveyed institutions and 36% have dedicated research data support roles at central and library levels. However, 32% of the respondents noted that these specialist support roles were not available.
- Over 50% of the surveyed institutions reported that research data skills were only partially available. Moreover, all of the institutions that indicated the absence or partial availability of data skills, considered that more of these skills are needed at institutional level.

Emerging areas of Open Science

- Approximately 50% of the respondents know of citizen science and open education activities at their institutions, although around 25% indicated not knowing of any.
- When asked about their perceptions of different groups' engagement in different areas of Open Science, science outreach and communication was seen as highly important by institutional leadership (67%), researchers (50%), early-stage researchers (42%), research support staff (50%) and librarians (46%). Open education and citizen science were ranked as second and third most important.

Research assessment

- In 34% of institutions, none of the Open Science elements examined by the survey were included in academic assessments.
- Amongst the institutions that included Open Science activities in their academic assessments, 77% took into consideration article deposition in a repository.

8.2. POLICY IMPLICATIONS AND RECOMMENDATIONS

Open Science

The survey results show that although Open Science is seen as an important strategic priority (at just over 50% of the institutions surveyed), implementation lags behind. The gap between strategic importance and implementation is smaller in the established area of Open Access to research publications but gets much wider in data-related areas (e.g. RDM, FAIR data, data sharing), which are nevertheless given relatively high importance. When asked about their perception of how far Open Science is embedded in institutional priorities and practices, most respondents answer that it is sporadic or gaining traction, and less than 10% consider Open Science to be fully embedded.

These results are in line with the conclusions of the EU Open Science Policy Platform (OSPP), which show persistent substantial differences in the awareness, planning and implementation of various areas of Open Science between disciplines, professional groups, institutions and countries. The final report notes: "[...] *even though the tools and technology to enable Open Science have been available for almost two decades, progress has been slower than anticipated and there remain real obstacles to overcome.*" (OSPP Final Report, 2020, p.22). The report goes on to note that universities and research organisations report a lack of funding for additional support activities during the transition period (e.g. establishment of Open Science support services, infrastructures).

Open Science must be steadily nurtured and further developed by researchers, institutions, research funders, national and European authorities in order to achieve a research system that is open, transparent, equitable and that enables diversity and innovation. The OSPP highlights that "*Open Science for its own sake has never been the goal. While a focus on Open Science as a mechanism must be emphasised in any transition, Open Science must ultimately be embedded as part of a larger, more systemic effort to foster all practices and processes that enable the creation, contribution, discovery and reuse of research knowledge more reliably, effectively and equitably*" (OSPP Final Report, 2020, p.22).

Open Access to research publications and research data

The survey results reveal a discrepancy between the implementation of Open Access, data sharing and the implementation of other areas of Open Science. While Open Access to research publications has now become more established, data sharing and especially FAIR data are less developed. These differences in maturity and implementation at institutional level are probably due to different institutional awareness timelines and the varying national/European relevance of each area. Open Access has now been high on national, European and university agendas for many years, so universities have had time to implement it. The lack of funding for Open Access publishing is blocking further progress, as mentioned in the OSPP Final Report (2020). RDM, data sharing and FAIR data received attention from national and European policymakers more recently and universities are still developing policies and practices in these areas. The OSPP sees enabling and facilitating the mainstreaming of FAIR research data management as one of the main challenges for universities and research organisations. Supportive infrastructure, scientific protocols and workflows, improved acceptance and adequate funding are cited as conducive to that mainstreaming. The EUA Open Science Survey supports the points made by the OSSP. The results

demonstrate that universities are developing their data infrastructure (e.g. 82% of the institutions surveyed have either internal and/or external data storage facilities and 78% have internal and/or external data repositories), and providing different types of support to researchers interested in RDM, FAIR data or data sharing (e.g. specialist data training is available at 75% of the institutions surveyed).

Similar national trends can be identified across Europe. A survey by the Landscape Working Group of the EOSC Executive Board highlighted how most EU Member States and Associated Countries currently have Open Access to scholarly publications policies, but that this number drops significantly when it comes to policies regarding FAIR data. The EUA Open Science Survey reveals that approximately 50% of the respondent institutions with an Open Science policy have included data provisions in that policy. These data provisions are either mandatory or optional/incentives.

While a direct correlation cannot be established between national and institutional levels, institutional initiatives to advance the full panoply of Open Science do not usually exist in isolation, and should be contextualised in the framework of wider, national-driven plans. Forthcoming top-down regulations, such as the requirement for FAIR-compliant Data Management Plans (DMP) under Horizon Europe and by an increasing number of funding organisations, might therefore drive universities to bridge the gap between the importance attributed to data sharing and FAIR data and their actual implementation.

EUA survey results also suggest that while monitoring the use of repositories, Open Access publications and their related costs are relatively well established at most of the institutions surveyed, the resulting indicators are not always used to establish or inform specific strategic Open Access targets. This could be because universities do not see the need to establish institutional targets in countries with a national target for Open Access, because they have to comply with that national target.

The results also illustrate the general trend of a gap between the shared importance and value given to Open Science and the availability of the skills needed for researchers and research support staff to take advantage of Open Science. While skilled technical staff seem slightly more available than before, a lack of data management, data mining/visualisation and research software engineering skills are still reported. Due to the increasingly variable distribution of research team skills, especially between researchers and their support staff, it has become crucial to provide all researchers with basic data management skills (OECD, 2020).

Universities are knowledge-providers and can therefore implement actions to address their own shortage of data-skilled professionals and help develop the next generation of Open Science and data professionals. This is one of the main EOSC implementation priorities. In particular, higher education institutions should focus efforts on expanding training for researchers and research support staff, and foster the development of new career paths. This process should be supported by ad-hoc evaluation, recognition, and reward mechanisms (OECD, 2020).

Academic librarians can take up a key role in extending training provision. As the survey results show, librarians are still those most involved in data sharing and FAIR data. Librarians can and therefore should be encouraged to drive capacity building at their institutions, using their experience and knowledge to train researchers in data and software practices (OECD, 2020).

Many resources support the mainstreaming of Open Science through a new set of data skilled professionals. These include: the Framework of Actors in the EOSC Ecosystem developed by the EOSC Skills and Training Working Group, which EUA co-chaired. They can be useful in helping higher education institutions identify the roles and skills needed to close gaps and meet the increasing demand for RDM-skilled researchers and research support staff.

Emerging areas of Open Science

These results confirm that while some universities are actively engaged in emerging areas of Open Science, such as citizen science and open education, these areas are at a much earlier stage of development at most of the institutions surveyed. The OSPP Final Report (2020) also acknowledges that universities and research organisations do not mainstream citizen science in their structure and working process (including undergraduate training and education).

A high proportion of the respondents did not know about their students' involvement in many of the areas of Open Science examined by the survey. This was probably as most were involved in leadership or high-level management, which is relatively detached from student contact. While this is a survey limitation, EUA will further address the role of students and their importance in the implementation of Open Science through other surveys (e.g. the upcoming TRENDS survey).

In future, EUA will also focus its attention on the need to better connect and embed Open Science activities in education. Indeed, Open Science is not only relevant for universities' research and innovation missions, it is also important for education and social engagement.

Open Science in academic assessment

The survey results show the limited or even very limited consideration of Open Science in academic assessments, which confirms and expands on the findings of the last edition of the survey. This is even more striking given the strategic importance given to Open Science by this survey's respondents (see above).

Early-career researchers seem disproportionally affected. While their research activities are still primarily assessed via publication, specifically the journal impact factor, more pressure is also on them in the transition to Open Science. Allen and Mehler (2019) note that early-career researchers encounter specific obstacles beyond the recognition and reward structure, for example: different disciplinary practices, the increased cost of skills acquisition and the extra time needed to make research openly available (archiving, documenting, data quality control, etc).

Reflecting on these elements results in two observations. Firstly, it will be difficult to make Open Science integral to most academics work without incentives and rewards. We know, for example, from national-level surveys, that early-career researchers expect to produce more diverse research outputs in five to ten years, but will be mainly driven by career impact. More work is needed to incentivise and reward Open Science throughout the research process and not, as now, by limiting it to Open Access to research publications.

Secondly, these results point to how challenging it is for institutions to incentivise and reward Open Science. Previous survey editions revealed that institutions are unsure about how they can integrate the full scope of Open Science in academic assessments, especially as academics themselves do not always have the necessary skills and training, or access to Open Science infrastructure. More work is therefore also needed to develop and provide responsible criteria and methods that incentivise and reward Open Science throughout the entire research process. For this reason, together with DORA and SPARC Europe, EUA has started to bring together and analyse recent university and national consortia initiatives to implement practical changes.

Recommendations

The following **recommendations** are for institutions, researchers, research funders and policymakers

Create the conditions to mainstream Open Science. If Open Science is to become the standard way of producing and sharing scientific knowledge, the continued involvement of all stakeholders is crucial. The active involvement of institutional leaders, in addition to national and European guidelines and regulatory frameworks, is also instrumental to creating a favourable context for the transition to Open Science.

Fully integrate Open Science in reward and incentive practices. For Open Science to become the norm, it must become an integral part of academic assessments. Research funders and institutions play a key role in making this transition possible, by increasingly incorporating Open Science contributions in assessment and restructuring current award and recognition systems.

Continue to invest in embedding Open Science in institutional policies and practices. Institutions should continue to develop internal Open Science policies that are aligned with national and European policies (whenever possible). They need to continue to create incentives and opportunities for researchers and staff to increase their involvement in both established (e.g. Open Access to research publications, RDM and FAIR data) and emerging areas of Open Science (e.g. citizen science, open education). Institutions should also expand training in the key skills needed for the transition towards Open Science (e.g. data skills) for researchers and staff.

EUROPEAN UNIVERSITY ASSOCIATION

The European University Association (EUA) is the representative organisation of universities and national rectors' conferences in 48 European countries. EUA plays a crucial role in the Bologna Process and in influencing EU policies on higher education, research and innovation. Thanks to its interaction with a range of other European and international organisations, EUA ensures that the voice of European universities is heard wherever decisions are being taken that will impact their activities.

The Association provides unique expertise in higher education and research as well as a forum for exchange of ideas and good practice among universities. The results of EUA's work are made available to members and stakeholders through conferences, seminars, websites and publications.

EUROPEAN
UNIVERSITY
ASSOCIATION

Avenue de l'Yser, 24
1040 Brussels
Belgium

T: +32 2 230 55 44
info@eua.eu
www.eua.eu