

D5.2: Strategic Policy Paper on Responsible Open Science

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Abstract:	This Strategic Policy Paper has been developed with the aim to support policymakers, research institutions (RPOs and RFOs), publishers, researchers, and the global public in developing efficient policies and guidelines, and to enhance the fostering and implementation of responsible Open Science.
Keyword List:	Research Integrity, Open Science, Research Ethics, Open Access, Open Data, Open Reproducible Research, Open Science Evaluation, Open Science Policies, Open Science Tools, Citizen Science, and Open Science Training.

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List of Abbreviations

APC	Article Processing Charge
CS	Citizen Science
DORA	San Francisco Declaration on Research Assessment
EOSC	European Open Science Cloud
EU	European Union
FAIR	Findability, Accessibility, Interoperability and Reusability
GDPR	General Data Protection Regulation
HIC	High Income Country
IP	Internet Protocol
LMIC	Low- and Middle-Income Country
RE	Research Ethics
RFO	Research Funding Organisation
RI	Research Integrity
RPO	Research Performing Organisation
OA	Open Access
OS	Open Science
WP	Work Package

Strategic Policy Paper

on Responsible Open Science in Europe

This document builds on the most relevant existing international and European documents, guidelines and recommendation that foster and strengthen responsible Open Science on the national, European, and international level.

1 Introduction

Open Science (OS), as a set of principles and practices aiming to make research planning, processes, data and results free to all stakeholders, is a policy priority for the European Commission and a chance to make the scientific process more transparent, inclusive, and democratic. Such a system brings science and society closer together and improves trust in scientific processes and results by providing multilingual scientific knowledge that is openly available, accessible, and reusable, as well as a chance to foster international cooperation. OS has, therefore, great potential to close the gaps in the current inequal research system, while addressing existing complex and global social and economic challenges and enabling citizens to participate actively in all aspects of science, as, for example, citizen scientists.

The main goal of the ROSiE project is to ensure that Open Science stands on the solid foundation of human rights, integrity, fairness, and equitability. Indeed, if the importance of OS is nowadays widely recognized, and its implementation is beneficial for RE and RI, RE/RI and OS are not always perfectly aligned. The overall aim of ROSiE is, thus, to provide guidance and tools required to guarantee that RE/RI, legal and social implications, and challenges inherent to OS are well integrated and properly addressed.

This Strategic Policy Paper has been developed with the aim to support and equip policymakers, research institutions (RPOs and RFOs), publishers, researchers, and the global public with the practical tools and knowledge to facilitate the transition towards action and practice-oriented policy methods promoting, implementing, and fostering responsible Open Science in Europe. In this regard, ROSiE aims at embedding RE/RI as structural components of Open Science.

To do so, we selected the most recent and widely recognized standard-setting documents and references within the EU and globally (e.g., UNESCO Recommendation on Open Science¹). The document builds on desk research as well as mapping and analysis of existing guidelines, codes of conduct, recommendations, and policies currently in place in the fields of OS, RI, and RE in Europe.

The present paper's structure is based on the FOSTER project's Open Science taxonomy², as the most holistic and most commonly used taxonomy within the OS field and across practitioners. In addition, we included two sections on Citizen Science and OS Training in accordance with the ROSiE project's aims and research findings.

2 Methodology

The mapping of existing national public policies related to OS in Europe (submitted by the ROSiE project in February 2022) has been central in developing this document by providing a clear overview of the existing gaps and good practices across the continent. The findings from the ROSiE and other relevant EU-funded projects (e.g., the FOSTER project) have been included in developing this policy paper.

Building upon the mapping, desk research, and preliminary analysis of the selected documents, co-creation activities were conducted both online and onsite with the consortium's partners and key stakeholders during meetings, forums, and workshops. The analysis phase began with the start of the ROSiE project in February 2021 and lasted until the publication of this policy paper in June 2023. Throughout this process, relevant key stakeholders with expertise in the fields of OS, RE, and RI have been identified and involved as the Core Drafting Group in the finalisation of the present policy paper.

3 Concepts and Terminology

Open Science (OS)

OS is understood in this paper as a set of practices in science which allows others to collaborate and contribute, and where multilingual scientific knowledge, research data, lab notes and the documentation of other research processes are as freely available as possible. This availability should be promoted under terms that enable reuse, redistribution and reproduction of the research and its underlying data and methods using modern technologies and open to societal actors beyond the traditional scientific community. OS comprises all scientific disciplines and aspects of scholarly practices, including basic and applied sciences, natural and social sciences, and the humanities³.

Research Integrity (RI)

RI is the conduct of research with the highest scientific standards in accordance with principles and practices which enhance trust and rigour in the scientific process and its results.

The guiding principles of RI include:

- o Reliability in ensuring the quality of research, reflected in the design, the methodology, the analysis, and the use of resources;
- o Honesty in developing, undertaking, reviewing, reporting and communicating research in a transparent, fair, full, and unbiased way;
- o Respect for colleagues, research participants and subjects, society, ecosystems, cultural heritage, and the environment;
- o Accountability for the research from idea to publication, for its management and organisation, for training, supervision, and mentoring, and for its wider societal impacts⁴.

Research Ethics (RE)

RE is the systematic application and reflection of ethical principles and ethical theories as well as the principles of human rights to all the actions and choices at every stage of the research cycle with the goal of justifying and endorsing a particular course of action or choice over others⁵.

¹ UNESCO (2021). *Recommendation on Open Science*. <https://unesdoc.unesco.org/ark:/48223/pf0000379949.locale=en>.

² Pontika, N. & Knott, P. (2015). *Open Science Taxonomy*. <https://doi.org/10.6084/m9.figshare.1508606.v3>.

³ The working definition of Open Science the ROSiE project uses in the present document is based on the three following definitions: European Commission, Directorate-General for Research and Innovation (2019). *Open Science*. https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science_en; UNESCO (2021). *Recommendation on Open Science*. <https://unesdoc.unesco.org/ark:/48223/pf0000379949.locale=en> & FOSTER (2016). *Open Science: definitions and description*. <https://www.fosteropenscience.eu/sites/default/files/pdf/2273.pdf#:~:text=Open%20Science%20is%20the%20conduct%20of%20science%20in,re-use%2C%20redistribution%20and%20reproduction%20of%20the%20research%20%28FOSTER%3A>.

⁴ ALLEA (2017). *The European Code of Conduct for Research Integrity*. <https://allea.org/code-of-conduct/>.

⁵ The working definition of RE the ROSiE project used in the present document is based on the three following sources: Beauchamp, T. L., & Childress, J. F. (2019). *Principles of Biomedical Ethics*. Oxford University Press; Shamoo, A. & Resnik, D. R. (2015). *Responsible Conduct of Research*, 3rd. ed. Oxford University Press; Duwell, M. (2013). *Bioethics: Methods, theories, domains*. Routledge.

4 Crosscutting issues and challenges in Open Science and Research Ethics and Integrity

OS, RE, and RI are closely connected at each stage of the research cycle, from research planning to the participation of the researcher in public debate⁶. Although many existing issues within RE and RI can profit from the opportunities that OS offers (e.g., better reproducibility capacities, traceability, or transparency), new challenges for RE and RI may also arise, requiring, therefore, timely attention and management.

Open Access⁷

Inequalities and exclusionary practices impact OS, particularly regarding accessibility:

a. Deeply rooted economic, cultural, and political differences exist globally as well as in Europe. As the transition to OS is costly, lack of resources and political support may deepen inequalities. OS also brings the risk of strengthening already existing inequalities such as data exploitation by privileged actors, mostly from high income countries (HICs) to the disadvantage of low- and middle-income countries (LMICs). In addition, what could be implemented in one context might not be adaptable to another one (due to, e.g., differences in legislation, culture, values, or practices). Therefore, the definition, understanding, and implementation of responsible OS can vary depending on the context.

b. Multilingualism and language-related accessibility of data and research is necessary for an international and globally responsible OS. The Helsinki Initiative on Multilingualism in Scholarly Communication emphasises the importance of supporting native languages in research in order to keep locally relevant research alive⁸. Although English has progressively become the *lingua franca*, it is important to enable deeper inclusion and tackle language-related exclusion by supporting the publication of research in other native languages as well. While AI and new technologies also come with new challenges⁹, the development of more advanced translation technologies could solve this issue.

Open Data

2.a. Data come in many different formats which are closely linked to the particular disciplines and require, therefore, diverse types of storage, safeguards, and accessibility when made open.

The material (e.g., tools, equipment, code, or software) used in the production, collection, and analysis of data is, for some disciplines, highly relevant for reproducibility and should, therefore, be made accessible in accordance with responsible OS principles.

2. b. The expanding number of people gaining access to datasets with the implementation of OS can represent a risk to the respect and protection of personal and sensitive data.

With the implementation of OS, people from varying backgrounds and levels of training are gaining access to datasets. The understanding and knowledge regarding respect for personal data might, therefore, be lacking in some cases without relevant training and education for those sharing and accessing data. New technologies such as machine learning contribute furthermore to increase or generate potential ethical and integrity risks such as profiling and reidentification of anonymized data.

2. c. Better European and global coordination and harmonisation regarding responsible OS data protection models are needed.

OS enables greater international cooperation in the research field. This might add legal and bureaucratic complexity as well as a risk of further division of responsibilities between collaborating parties and, therefore, more challenges for the researchers and citizen scientists complying with OS principles and practices.

2.d. The opening of data could lead to misuse and abuse of research results and data if OS is not implemented in a responsible way.

The implementation of OS increases the risk of potential misuse and abuse of research data if OS is not implemented in an appropriate and efficient structure and framework. The implementation of responsible OS could tackle and prevent these risks with the development of guidance and training and/or the creation of bodies responsible for developing and implementing guidance and training, for instance.

2.e. The existing legal framework, in its current form, might not always allow for OS to be implemented responsibly.

Intellectual property rights (and their limited harmonisation at the EU level) are not always taken into consideration in the production, curation, and storage of research data. There is, therefore, a risk that the applicable legal frameworks (regarding the concept of IP ownership for instance) do not fully align with OS principles and values as already mentioned by ALLEA¹⁰.

2. f. The incentive to reuse data bears the risk to potentially inhibit innovation and the production of new data.

⁶ Council of the European Union (2015). *Council conclusions on research integrity*. <https://data.consilium.europa.eu/doc/document/ST-14853-2015-INIT/en/pdf>.

⁷ This and the following headings correspond to the first-level topics of the FOSTER Open Science Taxonomy – Pontika, N. & Knoth, P. (2015). *Open Science Taxonomy*. <https://doi.org/10.6084/m9.figshare.1508606.v3>. In accordance with the ROSiE project's aims, a section on Citizen Science and OS Training have been added.

⁸ Federation of Finnish Learned Societies; The Committee for Public Information; Publishing, The Finnish Association for Scholarly; Universities Norway; European Network for Research Evaluation in the Social Sciences and the Humanities (2019). *Helsinki Initiative on Multilingualism in Scholarly Communication*. <https://doi.org/10.6084/m9.figshare.7887059>.

⁹ The translation of new scientific and policy terms is particularly sensitive and require the involvement of specialists in the relevant disciplines and translation for instance.

¹⁰ ALLEA (2022). *Aligning intellectual property rights with Open Science*. <https://allea.org/wp-content/uploads/2022/04/ALLEA-Statement-Aligning-IPR-with-Open-Science.pdf>.

OS promotes the use of existing data and the focus on quality rather than quantity in the research process. Such incentives should, however, not jeopardise the production of new sets of data which are essential for innovation and the progress of research.

Open Reproducible Research

The reproducibility of research results is threatened by a lack of transparency throughout and trust in research processes.

OS promotes transparency and openness, which in turn should enhance the trustworthiness of science and its results. Both transparency throughout the research process as well as trust in its results can be expected to increase reproducibility. The implementation of responsible OS practices that foster and guarantee trust, reliability, and transparency should, therefore, increase the reproducibility of open research outputs and data. On the contrary, a lack of trust in research processes and results is a threat to OS and the reproducibility of its results.

OS Evaluation

OS Evaluation could be understood as either of the following: as the open reviewing of research results in accordance with OS principles, as well as the integration of OS within the evaluation process of researchers.

4.a. The opening and expansion of the options to evaluate research results potentially challenge RE and RI principles.

4.a.i. The involvement of actors without adequate expertise in and understanding of scientific methodologies in the evaluation of the research results can induce wrong assessments and risks.

4.a. ii. The implementation of new methods and systems to evaluate research results to allow community contribution in addition to the existing framework will pressure already complex and strained evaluation process structures.

4.b. In the current system, OS is not fully integrated into the evaluation of research work.

4.b.i. According to the Coalition for Advancing Research Assessment¹¹ and the San Francisco Declaration on Research Assessment (DORA) principles¹², evaluation processes lack concrete benefits or rewards for opening research as well as methods and approaches that reflect the efforts involved and advantages to be gained from complying with OS (including, for instance, the significant impact on society, science, and academia, or the involvement of the general public).

4.b.ii. The risk of excessive workload increases with the combination of OS and the traditional evaluation system. Compliance with responsible OS requires a focus on quality (which takes time and attention) rather than quantity. The evaluation system should, therefore, reflect this reality.

OS Policies

5.a. The implementation of responsible OS requires clear support at the policy level.

The support of national authorities and the European Union has a significant impact on the development and implementation of OS in Europe, particularly by introducing policies, financing mechanisms, developing, and nurturing infrastructure (databases and communication rewards¹³, for instance), as well as monitoring and improving processes. In a context of high heterogeneity in Europe regarding the level of political support for OS, policy coordination (vertically as well as horizontally) is much needed to implement coherent and responsible OS.

5.b. The fragmentation of existing public sources on OS and the lack of coordination challenge researchers' and citizen scientists' abilities to comply with OS¹⁴.

The risk of potential research misconduct increases without available and accessible coordinated public OS resources, policies, and guidelines (in multiple languages) which would equip researchers with skills and knowledge on OS and its principles.

5.c. The implementation of responsible OS requires the incorporation of discipline particularities in the production of OS policies and guidelines.

OS as well as RE and RI concern all disciplines. However, there are disciplinary specificities in the uptake of OS, RE and RI principles that should be taken into account when developing public policies and guidelines.

OS Tools

The lack of effective data management prevents the responsible implementation of OS.

Extensive data management (adapted to the requirements of sensitive data), storage, and transfer capabilities are needed to implement OS. However, guaranteeing the sustainability of infrastructures (long term storage in particular) is very challenging due to the necessity of constant improvement and adaption to new technologies which require extensive and continuous resources.

¹¹ Coalition for Advancing Research Assessment (2022). *Agreement on reforming research assessment*. https://coara.eu/app/uploads/2022/09/2022_07_19_rra_agreement_final.pdf.

¹² The Declaration on Research Assessment (DORA) (2012). *San Francisco Declaration on Research Assessment*. <https://sfdora.org/read/>.

¹³ With initiatives such as The German Open Science Award Schleswig-Holstein, presented annually since 2016 to showcase regional achievements - schleswig-holstein.de - Ministerium für Soziales, Jugend, Familie, Senioren, Integration und Gleichstellung - Erster Open Science Award vorgestellt.

¹⁴ Some initiatives aiming at tackling this challenge already exist such as the UNESCO working group on OS policies and policy instruments for instance – <https://events.unesco.org/event?id=3234150768>.

Citizen Science

The involvement of citizen science is likely to create new challenges for RE and RI.

Citizen science, as an initiative for more inclusivity in and bottom-up democratization of research and science, is an important dimension of the implementation of responsible OS. The involvement of CS contributes to the development of new standards of RI and RE, while strengthening trust in science and fighting misinformation and disinformation¹⁵. Yet, the general public's involvement in conducting research without proper support and education can also potentially challenge RE and RI principles (such as reliability, honesty, and accountability). CS necessitates extensive education, scrutiny, and guidance in order to avoid potential complex conflicts of interest which might erupt with the implementation of OS. Challenges might arise without proper channels¹⁶, methods, and relevant bodies (independent, national, or institutional) able to assess, monitor and guide citizen scientists in their involvement in the research process.

OS Training

8.a. Thorough training on responsible OS is not available/offered to researchers and citizen scientists.

In many countries, skills, and tools necessary for practicing responsible OS are often available only for people within institutions. In order to cover all training needs, national authorities and institutions should, when necessary, provide training for people outside institutions as well.

8.b. The implementation of responsible OS will create new professions which would require appropriate OS training in order to comply with RE and RI principles.

The implementation of responsible OS will require trained personnel. These new professions (OS knowledge managers or interoperability experts, for instance) should be established thoroughly and in a sustainable way in order to fulfil the requirements necessary for fostering a responsible OS environment.

5 Recommendations

Responsible OS guiding principles:

- 1. Quality, ethics, and integrity: Transparency, scrutiny, sustainability, and reproducibility**
- 2. Collective benefit: Collaboration, participation, and inclusion**
- 3. Equity, diversity, and fairness: equality of opportunities and inclusiveness**

The guiding principles for responsible OS provide a framework for enabling conditions and practices within which the above values are upheld in the implementation of OS:

Open Access

1.a. Research results should be open to peers and to the public. Open Access principles and practices ensure widespread accessibility. Balanced policies should be developed to reduce barriers within the Open Access framework (e.g., high publication fees).

1.b. Research institutions and governance bodies should promote and support the publication of research in English as well as in other native languages in accordance with the Helsinki Initiative on Multilingualism in Scholarly Communication¹⁷, for instance by taking initiatives to create and fund multilingual national, European, or international open data repositories and similar resources.

1.c. Journals and publishing platforms should be transparent about their editorial processes, including peer reviewing and procedures for corrections and retractions, and promote reuse and reproducibility of research through support of the FAIR principles and by facilitating open access to data, codes, and methodologies in a responsible manner.

1.d. Publishers using the APC (Article Processing Charge) business model should transparently disclose their pricing models as well as the services included in the pricing. Publishers should also ensure that their prices remain reasonable to avoid further intensifying already existing inequalities.

Open Data

2.a. Inequalities and diversity (gender, discipline, age, career, ethnicity, nationality, culture, etc.) should be addressed and considered when implementing OS responsibly. The CARE Principles for Indigenous Data Governance, the TRUST Global Code of Conduct for Research in Resource-Poor Settings, and the UNESCO Recommendation on OS, alongside the FAIR (Findable,

¹⁵ As defined in the European Democracy Action Plan (EDAP), *misinformation* is false or misleading content shared without harmful intent though the effects can be harmful, e.g., when people share false information with friends and family in good faith, whereas *disinformation* is false or misleading content that is spread with an intention to deceive or secure economic or political gain and which may cause public harm. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2020%3A790%3AFIN&qid=1607079662423>.

¹⁶ Such as the Swedish platform [citizenscience.se](https://medborgarforskning.se/eng/): <https://medborgarforskning.se/eng/>.

¹⁷ The promotion of publications in native languages has already been added to the Danish national OS public policy: Denmark's National Strategy for Open Access (2018). <https://ufm.dk/en/research-and-innovation/cooperation-between-research-and-innovation/open-access/Publications/denmarks-national-strategy-for-open-access/national-strategy-for-open-access-english.pdf>.

Accessible, Interoperable, and Reusable) principles, point in the right direction for responsible implementation of OS including awareness of existing inequalities.

2.b. Open research data (in all formats¹⁸) should be available to be openly used, reused, retained, and redistributed by anyone (subject to acknowledgment). The data should also be available in a user-friendly, human- and machine-readable format, in accordance with both principles of good data governance and stewardship such as the FAIR and CARE principles.

2.c. Governance bodies should be designated at the institutional and national levels to oversee the accessibility of data in accordance with OS principles and the existing OS legislation in place.

2.d. Data availability statements should be included in every publication including data analyses. Data must be stored in trusted open data repositories whenever possible and appropriate with respect to ethical and legal restrictions. In the case of restrictions due to, e.g., security, confidentiality, or commercial sensitivity, ethically justifiable explanations of the conditions for sharing research data should be provided.

2.e. The respect for personal (private or anonymous) data should be defined in detail in policy documents at the institutional, national, European, and global levels in a similar fashion as for the FAIR principles¹⁹ and in accordance with the relevant existing regulations in place such as the GDPR²⁰.

2.f. When new risks arise (e.g., in context with new technologies), withdrawal or change of the accessibility of data in repositories needs to be possible, with the inclusion of review processes.

2.g. Safeguards should be established in order to prevent and tackle potential manipulation of data.

2.h. Research methods, software, and source codes should be available under an open license that grants others the right to use, reuse, share, and reproduce the software and its source code, design, or blueprint.

2.i. Appropriate infrastructures and support services close to the researchers should be established²¹. In particular, the European Open Science Cloud must become (more) easily accessible to every researcher and should provide researchers with free of charge (basic) services and support.

2.j. Specific incentives should be provided by publishers, funders and research institutions for data and code sharing.

2.k. Incentives should also be provided to all Research Funding Organisations to develop and curate their own reliable and sustainable open data repositories at the institutional level.

2.l. National and European public authorities should promote and support better coordination initiatives aiming at harmonising the data protection models and legal framework in place in Europe in order to align with OS principles and values and tackle bureaucratic complexity.

2.m. Reuse of data, as well as the production of new data should be supported at the institutional and national levels in order to foster the creation and/or collection of high-quality research results, which are essential for innovation and progress in science.

Open Reproducible Research

When OS, RE, and RI are fostered by the researchers within their own community, trust and ownership are created. Such trust in the scientific process and results may enhance the reuse of data and allow for increased reproducibility of research results. Although safeguarding RI principles should ideally be a self-regulatory process, the potential of legal actions to support these principles should also be considered.

OS Evaluation

4.a. Reforms in research assessments to include OS must be driven by the research communities themselves.

4.b. The current research evaluation system should be reformed in order for new methods and structures to be implemented to allow community contributions, in accordance with responsible OS principles. Such restructuring should aim at constituting coherent and coordinated national, institutional, and European bodies able to scrutinise and facilitate the involvement of society in the evaluation of research results according to OS, RE, and RI values and principles. Such reform should also endorse the transition from an over-reliance on metrics (such as those promoting quantity like bibliometric indicators or journal impact factors) that do not uphold these principles and the implementation of responsible OS.

4.c. The research assessment system should be also reformed to provide proper recognition, incentives, and rewards for methodological rigour, to enable a wider uptake of OS practices,²² and to facilitate a transition towards a system that supports

¹⁸ Among others: digital and analogue data, both raw and processed, and the accompanying metadata, as well as numerical scores, textual records, images and sounds, protocols, analysis code and workflows – UNESCO (2021). *Recommendation on Open Science*. <https://unesdoc.unesco.org/ark:/48223/pf0000379949.locale=en>.

¹⁹ To include the mention of respect for data in a document such as the European Code of Conduct for instance, as a reference in term of principles, plays a crucial role in the harmonisation of values.

²⁰ <https://gdpr.eu/>.

²¹ OpenAIRE, LIBER, SPARC Europe and COAR are currently leading a joint initiative aiming at reinforcing and enhancing the European repository network: <https://www.coar-repositories.org/news-updates/openaire-liber-sparc-europe-and-coar-launch-joint-strategy-to-strengthen-the-european-repository-network/>.

²² Compliance with OS principles and values requires time and other resources while contributing to promoting quality and rigour over quantity and speed.

integrity and that rewards the diverse characteristics of high-quality research. To do so, the support of and participation of institutions in relevant initiatives supporting this transition, such as the EUA Roadmap on Research Assessment in the Transition to Open Science²³, should be encouraged by the European and national authorities.

4.d. Assessment of research achievements should be based on qualitative judgement and openly available data, supported by responsible use of quantitative indicators, taking into account the disciplinary specificities, as well as the stage of the researcher's career. It should reward adherence to OS principles, the translation of research outputs into additional languages from the original publication, the quality and impact of research, and research that meets the highest standards of ethics and integrity by diversifying the existing indicators through, for instance, the inclusion of OS badges²⁴. Metrics should consider and value the diversity of research activities and outputs, as well as transparent research processes and methodologies, including preregistration of research protocols (i.e., specification of research plans in advance of the study and submission to a registry). In particular, the publication of negative results must be promoted in line with OS, RE, and RI principles and values.

4.e. Societal interaction, such as the contribution of citizen science, could become a central part in the qualitative evaluation of research, adapted to each discipline due to the difference in opportunities for societal interactions²⁵.

4.f. A reward system²⁶ for researchers complying with OS principles, or institutions including OS in evaluation systems, could play an important role in the promotion and normalisation of OS, particularly for early career researchers.

4.g. Researchers' activities to promote OS should be considered as part of the hiring decision and assessment process, given that promoting OS (and its principles) is a fundamental part of the researchers' everyday tasks. New and more narrative indicators²⁷ need to be developed and tested while moving away from the use of journal-level metrics.

OS Policies

5.a. Whenever possible, policymakers and institutions should introduce considerations of OS, RE and RI in the guidelines on research and higher education.

5.b. Policies in place must be flexible in order to be adapted to national and discipline specificities without undermining efforts to promote responsible OS.

5.c. Cooperation between OS, RE and RI offices should be promoted at the national and institutional levels. This is essential to develop trainings and materials that contribute to supporting researchers in practicing OS and ensuring that RI and RE standards are complied with. Cooperation also helps ensure that fast-paced developments in the area of OS are taken into account and appropriately reflected in codes of conduct for RI and RE.

5.d. Information about the main OS and RI policies/documents/guidelines should be publicised at the European, national, and institutional levels to enhance visibility, notably through websites that could be considered general knowledge hubs in this regard.

5.e. The public should be provided with precise and comprehensive information regarding research processes and methodologies. Research institutions and researchers should play a role in this process by better training media and public relations professionals in the area of responsible science.

5.f. European, national, and institutional authorities should support initiatives contributing to clarification, harmonisation, and organisation of existing OS policies, resources, and training²⁸. The development and curating of such classifications are particularly necessary in order for researchers and citizen scientists to familiarise themselves with, comply with, and foster OS, RE, and RI values and principles²⁹.

5.g. National authorities in the public space, and institutions in their organisations, should promote research environments where openness, inclusivity, fairness, and equality are guaranteed. Such environments enhance the participation of researchers and the general public in the scientific process and in accordance with OS principles while fostering debates, transparency, and collaboration on OS, RE, and RI.

²³ European University Association (EUA) (2018). *EUA Roadmap on Research Assessment in the Transition to Open Science*. eua-roadmap-on-research-assessment-in-the-transition-to-open-science_v20-08-2019.pdf.

²⁴ The non-profit Center for Open Science (COS) awards Open Sciences Badges to researchers to acknowledge data and material sharing, and preregistration of scientific studies for instance: <https://www.cos.io/initiatives/badges>.

²⁵ The Finnish Advisory Board on Research Integrity, for instance, provides a CV template (TENK) for researchers to ensure the comprehensiveness and comparability of the evaluation, and enhance their compliance with OS principles and practices: <https://edition.fi/tsv/catalog/book/170>.

²⁶ The French authorities awards researchers an annual research data prize, an open science thesis prize, and a prize for the best open-source research software for instance: <https://www.ouvrirelascience.fr/deuxieme-plan-national-pour-la-science-ouverte/>.

²⁷ Alternatives to the impact factor already exist with, for instance, the EF, AI score, SJR or the SNIP – <https://www.sciencedirect.com/science/article/abs/pii/S1479666X13000978#:~:text=The%20most%20prominent%20alternatives%20to%20the%20IF%20include,the%20quality%20and%20origin%20of%20each%20individual%20citation..>

²⁸ This challenge has already been stressed in the final report of the EOSC Co-creation projects: Mustajoki, H., Pölonen, J., Gregory, K., Ivanović, D., Brasse, V., Kesäniemi, J., Koivisto, E., & Pylvänäinen, E. (2021). Making FAIRer assessments possible. Final report of EOSC Co-Creation projects: "European overview of career merit systems" and "Vision for research data in research careers". *Zenodo*. <https://doi.org/10.5281/zenodo.4701375>.

²⁹ The UNESCO working group on OS policies and policy instruments is for instance working toward this objective: <https://events.unesco.org/event?id=3234150768>.

OS Tools

6.a. Research institutions, national and European authorities should consider and scrutinise the resources and costs needed to create and curate the necessary infrastructure required to sustain OS. These processes should be continuous as the evolution of new technologies will alter the resources needed to foster OS.

6.b. OS publishing systems make it possible to disseminate preprints. Preprint publication allows for exploratory results and analyses to be quickly shared by academic peers and increases the pace of science. Such preprints should be clearly marked as such and only be used with care in public debate and policy making, since they relate to knowledge that has not yet been peer reviewed.

6.c. The publication and use of preprint manuscripts should, thus, take place in a rigorous framework of responsible OS, as the potential misuse of preprint publications should not hamper the development of this otherwise useful procedure: preprint publication will have a strong impact in terms of diffusion of research results and scientific discussions³⁰.

Citizen Science

7.a. Institutions and national authorities should clearly and thoroughly include CS in their OS policies and guidelines. They should also provide mechanisms and structures to ensure the visibility and promotion of CS without adding administrative burdens for researchers choosing to include CS in their research.

7.b. Citizens must be supported in participating in the scientific process through adequate basic education covering OS, RE, and RI principles and values in order to foster responsible OS. This education should ensure that citizen scientists are informed about the responsibilities of research work and their societal accountability.

7.c. The notion of conflict of interest must be clearly presented to the general public before their involvement in research. The implementation of responsible OS requires proactiveness in scrutinising potential conflicts of interest which might arise with the involvement of citizen science in the research process.

7.d. Structures should also be developed at the European, national, and institutional levels in order to closely monitor, address and tackle potential conflicts of interest in the general public involved in research.

OS Training

8.a. Institutions should make sure that researchers and supervisors, at every stage of their career, as well as other key stakeholders involved (internal and external³¹), receive adequate and continuous training and awareness on RI, RE, and OS.

8.b. Such training should be optional in any graduate curriculum and mandatory in any Ph.D. training programme, as well as at key milestones of a researcher's career such as the endorsement required in some countries to supervise graduate students.

8.c. Training should be tailored according to disciplines and research area specificities and needs related to OS. Adequate training should provide trainees with educational resources that can be used on a day-to-day basis, as well as to show institutional commitment and foster responsible supervision and leadership³².

8.d. Training and tools put at the disposal of OS, RE and RI trainers and researchers – and whenever possible, accessible as open educational resources – should illustrate how OS practices contribute to RE and RI, but also discuss challenges of which researchers need to be aware. These tools should also help researchers understand OS practices.

8.e. To foster responsible OS, teaching on RI should not limit itself to problems of research misconduct like falsification, fabrication, and plagiarism, but include a much wider range of integrity and ethics issues promoting a healthy research culture such as authorship-related or research environments concerns for instance.

8.f. Engagement with societal actors through science education and science communication should be promoted in order to support citizen science and to connect the development of OS with societal needs and technological evolution.

8.g. Dynamic RE, RI, and OS guidelines aimed at supporting institutions in developing their own training should be proposed at the EU level.

8.h. Training on OS should be developed and adapted in a continuous and sustainable manner, keeping in mind that the implementation of responsible OS implicates new positions, implying, therefore, new and/or changing needs and aims arising for training.

³⁰ Drury, L. (2022). The normalization of preprints. *International Science Council*. <https://doi.org/10.24948/2022.02>.

³¹ Journalists, citizen scientists, ethics and integrity governance bodies, funders, social media influencers and the general public, for instance.

³² SOPs4RI consortium (2021). *Guidelines for research institutions on continuous research integrity education*, Online version 1. <https://sops4ri.eu/>.

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ROSIE Project:

Work Package 1 inputs:

- D1.1: Report on the relationship (tensions, challenges, overlaps) between RI, the wider RE perspective and OS.

Work Package 2 inputs:

- WP2 Report on social challenges and implications related to Open Science

Work Package 3 inputs:

- D3.1: Report on a strategy to engage stakeholders.
- D3.3: Report on interviews.
- D3.4: Recommendations resulting from the analysis of the consultation process.
- MS3.1: Report on focus group 3.

Work Package 5 inputs:

- D5.1: Report on existing policies and guidelines.

Work Package 6 inputs:

- D6.1: Preliminary analysis and mapping of existing European and national Open Science infrastructures with regard to promoting responsible Open Science.
- D6.3: Comparison of existing blockchain technologies to safeguard responsible OS.

Work Package 7 inputs:

- D7.1: Didactic framework.

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