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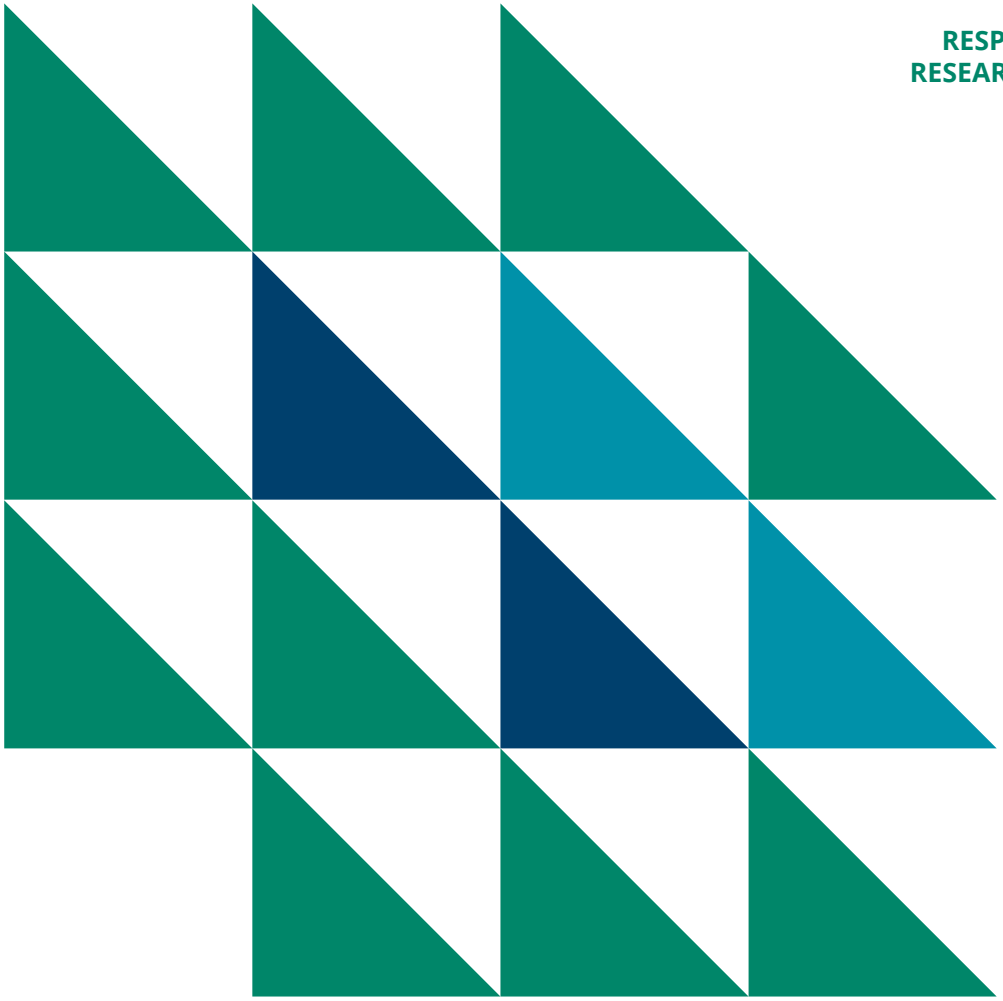

OPEN RESEARCH DATA AND METHODS. NATIONAL POLICY AND EXECUTIVE PLAN BY THE HIGHER EDUCATION AND RESEARCH COMMUNITY FOR 2021–2025.

Policy components 1 (Open access to research data) and 2 (Open access to research methods and infrastructures)

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Open research data and methods. National policy and executive plan by the higher education and research community for 2021–2025: Policy component 1 (Open access to research data) and 2 (Open access to research methods and infrastructures)

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EXECUTIVE SUMMARY

THIS POLICY FOR OPEN ACCESS to Research Data and Methods supports the *Declaration for Open Science and Research 2020–2025* and its overarching principle that research should be *as open as possible and as closed as necessary*. This policy builds on extensive national and international work and dialogue. It has been drawn up by the Finnish research community and coordinated by National Coordination for Open Science and Research (the Federation of Finnish Learned Societies).

The policy focuses on the openness of research data, methods, and infrastructures. It views openness as an element of research *quality* and *impact* across the full life cycle of research and as an opportunity to advance global inclusivity in research. It considers research data and methods as independent research outputs, and generally encourages opening up the research process as early and widely as possible, and requests that limitations to openness should be justified. Existing frameworks, such as the *FAIR principles*, can be used to regulate the level of openness for research data and various types of methods.

All fields of higher education and research are covered by this policy. The diversity across fields forms challenges for translating and implementing best practices. The policy emphasises general principles of responsible management of research resources, access to appropriate services, and responsible research evaluation. These guiding principles have been formulated as specific objectives and actions for researchers, research and funding organisations, and other actors. The Open Science Coordination at the Federation of Finnish Learned Societies will monitor the implementation and further development of this policy as part of the national open science monitoring programme.

POLICY OBJECTIVE

RESEARCH DATA, METHODS AND INFRASTRUCTURES are as open as possible and as closed as necessary. The data is managed appropriately with the aim of implementing the FAIR principles[1]. The FAIR principles are also applied to methods when appropriate. Research methods and research data are identified as independent research outputs.

INTRODUCTION

THIS POLICY FOR OPEN ACCESS to Research Data and Methods consists of two policy components that were published in 2021–2023 by the Federation of Finnish Learned Societies. The policy components focus on research data and research methods and infrastructures, respectively.

Openness and good management of research resources – including data, methods and infrastructures – support the key goals of research *quality* and *impact*. These broad concepts may emphasise different aspects in different disciplines. On a general level, openness allows broad dissemination and more efficient verification and reuse, increasing the availability, trustworthiness, and efficiency of research beyond traditional conventions[2]. This can be supported by the FAIR principles, which provide a systematic framework for defining and implementing the appropriate level of openness and for assessing it as part of responsible research evaluation.

Openness can strengthen various aspects of research quality, including for instance integrity and credibility, reproducibility and verifiability, and translatability of research into new uses. These objectives are challenged by cultural and technical bottlenecks as well as the continuous, iterative processual nature of methods development and application, which is often inseparable from research and innovation. Increased openness can thus support the transparency of the entire research process. Openness can also increase the impact of research on society at large as well as on research practice, including for instance enhanced accessibility, transparency, speed, efficiency, or new opportunities for collaboration, development and innovation. Openness is thus a component of research quality and impact.

1 The FAIR principles refer to the quality of research data from the viewpoint of further use. The goal of the principles is to make research data Findable, Accessible, Interoperable and Re-usable. See Glossary.

2 The goal of responsible research and innovation is to encourage operators to produce ethically acceptable, sustainable and societally interesting research and innovation outputs. See RRI Tools: What does RRI mean?

Researchers and research organisations (see Glossary) can benefit from openness through increased visibility and impact of their work. Openness can remove barriers to access and promote inclusivity and equal access to knowledge by facilitating interdisciplinary research, global equality and the achievement of the Sustainable Development Goals[3]. It can advance collaborative knowledge creation and the emergence of new innovations. In order to implement equality both on a national and an international level, funders and research organisations should promote openness of research in an economically sustainable way. Open methods and infrastructures should be non-profit oriented, but they may include minimal maintenance costs for research use. Organisations should encourage and support researchers in adopting and promoting open practices in all fields of research. This includes both technical support and resources as well as the social aspects of recognition and incentives. Scholarly publishers and funders increasingly require that researchers provide open access to their data and methods in connection to good practices in the management of research resources. An example of this is Science Europe's guideline *Practical Guide to the International Alignment of Research Data Management*[4]. Moreover, the development and adoption of improved citation practices concerning data, methods and infrastructures can further incentivise and support openness[5, 6, 7].

This policy builds on extensive national and international work towards promoting the openness of research data, methods, and infrastructures. In line with international guidelines, the policy recommends that research and funding organisations, learned societies, publishers and editorial boards should adopt policies that require and advance open access to research.[8, 9] Relevant summaries of this work are, among others, *UNESCO recommendation on open science* (2021), CERN's open science policy, the EU's Open Science Policy (2019), *Minimum conditions supporting research reproducibility* by Knowledge Exchange's FDSR Group, *Open Science and its Role in Universities: A Roadmap for Cultural Change* (2018) drawn up by the Association of European Research Universities, and two European Commission documents, *Turning FAIR into Reality. Final report and action plan*

3 UNESCO Recommendation on Open Science (2021).
4 Science Europe (2018): Practical Guide to the International Alignment of Research Data Management.
5 Software Heritage (2021): Research Software gets on stage in two new European projects.
6 FAIRCORE4EOSC (2022)
7 Schindler D, Bensmann F, Dietze S, Krüger F. (2022): The role of software in science: a knowledge graph-based analysis of software mentions in PubMed Central. PeerJ Computer Science 8:e835.
8 UNESCO Recommendation on Open Science (2021).
9 See also Ministry of Higher Education, Research and Innovation, France (2021): Second French Plan for Open Science. Generalising Open Science in France 2021–2024, p. 16–19.

from the European Commission expert group on FAIR data (2018), and *Six Recommendations for Implementation of FAIR Practice* (2020)[10, 11, 12, 13, 14, 15]. The operating environment is further shaped by current and future EU regulation on the openness of data, e.g. the Open Data Directive.[16] The Finnish research community participates in the creation of common international practices in this rapidly growing and developing area, and ensures that the Finnish policy reflects international development. Finnish operators actively participate in European and international work, e.g. in the European Open Science Cloud (EOSC), the Research Data Alliance (RDA), International Science Council Committee on Data (CODATA) communities, and European research infrastructure work[17]. The Finnish research community participates actively in dialogue where it can support the openness of research and contribute to the establishment of practical solutions in national and international cooperation.

This policy generally encourages researchers and research organisations to open up the research process – including data, methods and infrastructures – as early and widely as possible[18, 19]. Early dissemination can help researchers establish priorities and receive timely feedback to improve the work, thus increasing the overall research quality and impact. As a general rule, researchers should justify limitations to the openness of data and methods underlying published research and expert statements, and not limit openness more than necessary.

10 UNESCO Recommendation on Open Science.
11 CERN's Open Science Policy.
12 The EU's Open Science Policy.
13 Knowledge Exchange's Fair Data and Software Supporting Reproducible Research (FDSR) group: Activity Outline: "Minimum conditions supporting research reproducibility".
14 Ayris, Paul; López de San Román, Alea; Maes, Katrien; Labastida, Ignasi (2018): Open Science and its Role in Universities: A Roadmap for Cultural Change. League of European Research Universities.
15 European Commission, Directorate-General for Research and Innovation (2018), Turning FAIR into reality. Final report and action plan from the European Commission expert group on FAIR data; European Commission, Directorate-General for Research and Innovation (2020): Six Recommendations for implementation of FAIR practice by the FAIR in practice task force of the European open science cloud FAIR working group. See also European Commission, Directorate-General for Research and Innovation, Mendez, E., Lawrence, R. (2020): Progress on open science: towards a shared research knowledge system. Final report of the open science policy platform, Lawrence, R. (editor).
16 Directive (EU) 2019/1024 of the European Parliament and of the Council on open data and the re-use of public sector information.
17 European Commission, Directorate-General for Research and Innovation (2016): European charter of access for research infrastructures. Principles and guidelines for access and related services.
18 Also EU Open Science Policy encourages early sharing of research outputs.
19 OpenAIRE (2020): Open Science in Horizon Europe proposal.

FREEDOM OF RESEARCH AND THE RESPONSIBILITY OF THE RESEARCHER

This policy supports the principles of open science as well as researchers' freedom and possibilities to distribute and utilise research-based knowledge across the full life cycle of research. Researchers and research organisations are responsible for carrying out and disseminating research of the best possible quality and impact, and they have the right and freedom to choose the approaches that best serve these goals. This includes responsible management and openness of data, methods and infrastructures, which must be evaluated in the context of the research domain and lifecycle. As an element of research quality and impact, openness is therefore compatible with the freedom of research and the intellectual and other rights of a researcher.[20]

Responsible openness is an essential aspect of research integrity[21, 22]. Open research practices raise significant questions related to research integrity and legislation. These may imply restrictions, of which researchers and others working with the management of research data, methods, and infrastructures must be aware. Whereas legislative, ethical, contractual or other restrictions and ambiguities can limit openness, good research practice justifies such limitations. Limitations to openness should not be justified merely by established traditions, and funders and research organisations should generally encourage and support the adoption of good open research practices across fields[23, 24].

The Finnish legislation supports broad availability of research data and methods for commercial purposes[25, 26]. Open research data, methods and infrastructures provide new opportunities for governmental and industrial actors to benefit from research. This policy supports national recommendations for open science[27] in collaboration with non-academic partners, including governmental and non-governmental organisations, companies, and commercialisation[28]. Limitations on commercial use are not

20 UNESCO Recommendation on Open Science.
21 Finnish Board on Research Integrity TENK: Responsible Conduct of Research (RCR).
22 ALLEA – All European Academies (2017): European Code of Conduct for Research Integrity.
23 See e.g. Strasser C, Hertweck K, Greenberg J, Taraborelli D, Vu E (2022): Ten simple rules for funding scientific open source software. *PLoS Comput Biol* 18(11): e1010627.
24 See e.g. van Eijnatten, J., Barker, M., Azzarà, V., Bakker, T., Katz, D. S, Martinez-Ortiz, C., Cruz, M. J. & Pang, V. (2022): Amsterdam Declaration on Funding Research Software Sustainability (0.2). Zenodo.
25 Act on the Re-use of Research Materials Produced through Public Funding: "The publisher of research data shall allow the use of research data for commercial or non-commercial purposes. – – The use of research data shall be free of charge."
26 Directive (EU) 2019/1024.
27 National Open Science and Research Coordination: Policies.
28 National Open Science and Research Coordination (2022): Open science recommendation and checklist for research, development and innovation activities in collaboration between research organisations and companies.

compliant with the open source definition; non-commercial clauses in open licences do not qualify as open access and shall be generally avoided[29]. Industrial collaboration, commercialization, and other development and innovation activities may, however, also create the need and justification to limit the level of openness[30]. Researchers are hence responsible for seeking solutions that are compatible with the overarching principle "*as open as possible, as closed as necessary*", and research organisations should provide the necessary support and incentives for the responsible opening of research resources.

Funders and research organisations should evaluate openness according to the guidelines on responsible research evaluation[31, 32, 33, 34] based on the overall research quality and impact. Recognising the diversity of research and paying attention to variations in the type, life cycle, and role of data and methods in different disciplines are critical factors in responsible evaluation[35]. The different roles related to the development and use of open practices at different stages of research should be recognised, and merit mechanisms can be designed to reward operators at different levels from individuals to teams, units, and entire organisations.

RISKS AND THREATS

The responsible management of research acknowledges that opening up research resources and combining proprietary and open platforms brings up juridical (e.g. contractual) questions as well as the legal protection of researchers and research subjects. The process of selecting the appropriate degree of openness should be knowledge-driven. When there are ethical, legal, or other clear and justifiable limitations that prevent the opening of data, methods or infrastructures, it is important to describe the resources as transparently as possible, for instance by releasing

29 The use of non-commercial (NC) clause in licenses has been generally discouraged in research recommendations. Determining commercial usage is problematic; making the NC clause is unclear and may remarkably discourage further use. See e.g. Facilitate Open Science Training for European Research (FOSTER) FAQ and CLARIN-ERIC license instructions.

30 This is also stated in the EU's Open Science Policy.

31 Coalition for Advancing Research Assessment (CoARA, 2022): Agreement on Reforming Research Assessment.

32 National Open Science and Research Coordination, Finland (2020): Good practice in researcher evaluation. Recommendation for the responsible evaluation of a researcher in Finland.

33 Council of the European Union (2022): Conclusions on Research Assessment and Implementation of Open Science. See also CoNOSC (2022): Summary of the European Council Conclusions on Research Assessment and Implementation of Open Science.

34 CoARA (2022): Agreement on Reforming Research Assessment.

35 See also the EU's Open Science Policy that highlights the need for new indicators that can be used to merit researchers' efforts on open science.

metadata or other descriptions of the research design. Access to clear definitions, guidelines and support services that take into account discipline-specific differences and economic sustainability can facilitate the openness of research. Researchers may face risks of declining funding and publishing difficulties if research data and methods cannot be opened as planned.

Certain types of research data or methods can be openly used based on established community norms[36]. However, researchers and research organisations can remarkably increase the level of openness and clarify the reuse rights by granting explicit permissions for reuse. In some fields, this can be achieved through open licences, allowing the sharing of derivative versions of, for example, source code, software or protocols[37]. The concept of ownership may vary across research fields, however; in some fields, sharing and reuse may be broadly allowed by community norms rather than explicit licences or permissions. Researchers may also find it challenging to define the boundary between the need for privacy protection and openness, and questions related to this topic can be beyond the expertise of an individual researcher. The FAIR principles can be used to set the balance between openness and protection of data and methods when necessary.

A Data Management Plan (DMP)[38] is a tool required by many research funders and research organisations. It supports the systematic planning, definition, and management of the level of openness of data, methods, and infrastructures, starting from the early stages of the research life cycle, and it should be actively maintained and updated as necessary during research. A DMP facilitates risk assessment, and it includes accessible justifications for possible limitations to the level of openness. The research community, together with the research ethical committees[39], could benefit from the development of general guidelines on how the openness of data, methods and infrastructures can be advanced as part of responsible research and reconciled with the other aspects of research integrity, such as the need to protect research subjects or control dual use of technology, for instance.

The advancement of open research practices also relies on the available resources. The lack of resources, skills, services or infra-

36 See e.g. Finnish Social Science Data Archive.
37 Protocols.io: How to make your protocol more reproducible, discoverable, and user-friendly.
38 See e.g. DMPTuuli.
39 Initiating a dialogue with the Finnish National Board on Research Integrity (TENK) could help to clarify and strengthen the role of openness as an element of research integrity.

structures may challenge open practices. Researchers should have the necessary skills and support to apply open research practices.[40] Research organisations must secure the availability of sufficient support, incentives, and resources for opening data, methods, and infrastructures in a way that respects the work and equality of the researchers and facilitates efficient and collaborative knowledge creation. The implementation of responsible conduct of research and good management of research resources requires resources and economic incentives targeted towards research organisations during the entire lifecycle of research and across all levels of education. Organisations in different roles should commit to the development and maintenance of such resources, with a parallel investment in services promoting more efficient utilisation of the resources and creating savings.

STRUCTURE AND BACKGROUND OF THE POLICY

This policy has been drawn up by the Finnish research community. The progress has been the responsibility of two working groups assembled by the expert group on open data at the National Coordination for Open Science and Research (the Federation of Finnish Learned Societies). The work has been directed by the National Open Science and Research Steering Group. The policy supports the *Declaration for Open Science and Research 2020–2025*.

This policy on open access to research data and methods consists of strategic principles common to the entire policy and two policy components in which more specific objectives and actions have been outlined. The strategic principles describe general preconditions for the pursuit of open access to research data, methods and infrastructures. They formulate principles that are important for the research community and must be adhered to when implementing openness. The specific objectives listed in the policy components comprise more time-bound and measurable objectives to support and advance openness. The objectives are accompanied by concrete actions that are required to achieve the objectives. The changing international environment affects the objectives and the related actions more quickly than the principles.

The relevant vocabulary differs across research fields and the terms, definitions, and translations vary greatly in legislation and different contexts. The Glossary clarifies key terminology and aims to support the overall readability and comprehensibility of this policy document.

40 The development of education and skills towards this goal is also one element in the EU's open science policy.

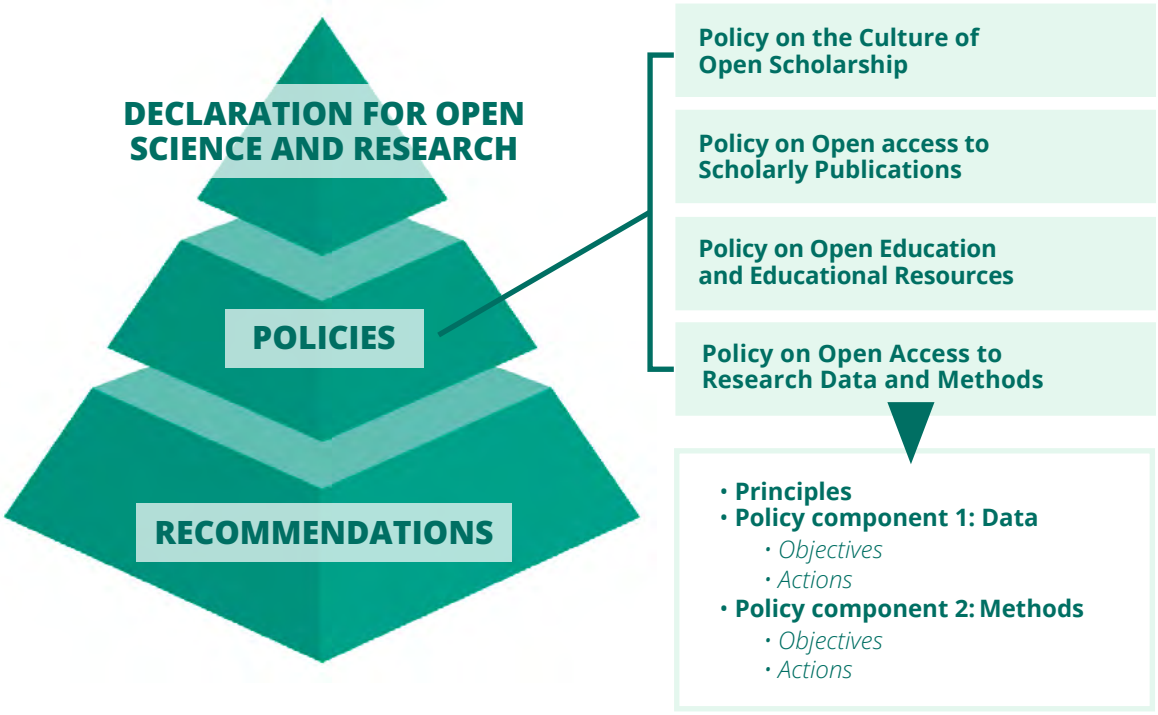

Figure 1. *National policy work for open science and research. The declaration for open science and research is complemented by specific policies and further guidelines in the form of recommendations. The policy on open access to research data and methods consists of two policy components that cover research data and research methods and infrastructures, respectively.*

IMPLEMENTATION AND MONITORING

The implementation of this policy is the responsibility of the entire Finnish research community, and the policy will come into effect gradually. The policy component on open access to research data was completed in spring 2021, and the policy component on research methods in 2023. The entire policy, including the two policy components, will be reviewed no later than 2025.

The evaluation of the implementation of this policy should embrace the diversity across research fields while encouraging early, broad, and responsible openness and long-term availability. Research organisations should support researchers in implementing this policy and in disseminating and adopting good practices across disciplines. Research data and methods can be also considered as independent research outputs that can support the overall research quality and impact.

The monitoring of the implementation of the policy is the responsibility of the Open Science Coordination at the Federation of Finnish Learned Societies. It is the Coordination's responsibility to support and promote continuous discussion in order to reach the objectives and to keep the policy up to date. The monitoring mechanisms for the openness of research data, methods and infrastructures will be part of the national open science monitoring programme.

STRATEGIC PRINCIPLES

PRINCIPLE 1:

Research data, methods and infrastructures shall be managed, opened and used responsibly and appropriately.

Ensuring and monitoring implementation:

A. Baseline: Responsible management of research data, methods and infrastructures is the most important pre-requisite for openness. The research community has identified deficiencies in its practices.

B. Continuous monitoring will be carried out as part of the national monitoring of open science and research.

PRINCIPLE 2:

Researchers have access to infrastructures and services that enable responsible management of data and methods, and these are developed further in an economically sustainable way, taking into account the researchers' needs.

Ensuring and monitoring implementation:

A. Baseline: During 2021, the Open Science Coordination will, in cooperation with the research organisations and service providers, specify a minimum level of research data management infrastructures and services. The need to create a similar specification for research methods will be evaluated as part of the national architecture work.

B. Continuous monitoring: No later than 2022, the Open Science Coordination will draw up an evaluation template[41] for future use in organisations as an evaluation tool for regular self-evaluation. Continuous monitoring will be carried out as part of the national monitoring of open science and research.

41 Rans, J and Whyte, A. (2017). Using RISE, the Research Infrastructure Self-Evaluation Framework. Digital Curation Centre, Edinburgh.

PRINCIPLE 3:

The researcher's merits in the promotion of good data management, work related to research data and methods, and the appropriate opening of research data and methods are valued and can support the researcher's career.

Ensuring and monitoring implementation:

A. Baseline: No later than 2022, the Open Science Coordination will draw up a recommendation on good practices, i.e. how the promotion of good data management, work related to research data, and the opening of research data shall be considered in the researcher's work, and how these merits will be evaluated. The need for similar recommendations for research methods and infrastructures will be evaluated in 2023.

B. Continuous monitoring will be carried out as part of the national monitoring of open science and research.

POLICY COMPONENT 1: OPEN ACCESS TO RESEARCH DATA

THIS NATIONAL POLICY COMPONENT is the Finnish research community's[42] shared guideline for the advancement of open access to research data. The policy component does not include research methods as these will, in accordance with the policy structure, be discussed in a separate policy component.

The policy component on open access to research data primarily concerns research data that has been produced or used as part of a research or development process as of 1 July 2021 and

- where the researcher is working in or is affiliated with a Finnish research organisation and/or working with funding by a Finnish research funding organisation

or

- where the research or development project involving the compilation or use of the research data takes place in a Finnish research organisation and/or is funded by a Finnish research funding organisation.

The objectives below do not take a position on how organisations decide matters, which means that research organisations are tasked with planning according to their own starting points.

OBJECTIVES AND ACTIONS

OBJECTIVE 1: No later than 2023, data management plans have been drawn up as part of quality management for all starting research and development projects, taking into account the needs of different fields of science and the lifecycle of the research data.

Actions required to achieve the objective:

- No later than 2022, higher education institutions will offer instructions, practices and training in the field of data management planning for students, researchers and other personnel.

42 The Research community is defined according to the *Declaration for Open Science and Research 2020–2025* (2020, 5).

- No later than 2023, research organisations will include creation and maintenance of data management plans in their research and service processes at each stage of the data lifecycle.
- No later than 2024, higher education institutions will ensure that thesis supervisors are able to evaluate and comment on data management plans as part of their supervisory work.
- No later than 2022, research organisations support research planning so as to ensure preparedness for sufficient resourcing and costs of data management and its support.
- Higher education institutions include data management training in their curricula for basic and further education when curricula are updated.
- No later than 2024, research organisations have developed monitoring to ensure implementation of good and responsible data management practices.
- No later than 2022, research organisations have regularly updated data policies.

OBJECTIVE 2: No later than 2022, research organisations apply operating models with which all rights, terms and licenses related to the use of research data can be clearly agreed between all participants in research work.

Actions required to achieve the objective:

- During 2021, the Open Science Coordination will produce a report on the legal questions related to open science. Recommendations on the content of agreements will be created in co-operation with the Finnish research community.
- In 2021, research organisations have basic principles concerning the agreements on the rights and responsibilities related to research data. Advice and guidance are available for special cases.
- In 2021, research funding organisations and research organisations will instruct researchers either to appropriately license research data to be opened or to guarantee the societal impact of the research outputs through commercialisation.
- In 2021, research funding organisations and research organisations will instruct researchers on licensing according to the requirements of legislation on the reuse of research data produced with public funding.

- In 2021, research organisations will offer education and/or training and advice on rights related to research data and open science licenses.

OBJECTIVE 3: No later than 2022, research data produced in starting research and development projects have been documented so that the documentation supports the opening, re-use, findability, interoperability and accessibility of research data.

Actions required to achieve the objective:

- No later than 2022, research organisations support researchers in the production of metadata through support services and incentives.
- No later than 2022, research organisations will offer training and support as well as tools for documentation of research data to various target groups, taking into account the skills development of the target groups, the needs of various fields of science, and the lifecycle of the research.
- In 2021, research organisations support research planning so that research projects are able to prepare for the documentation costs of research data.
- No later than 2022, the working group for open science and research monitoring will specify indicators for open science.
- No later than 2023, research organisations will utilise suitable indicators with which they monitor their progress in good data management as part of the quality system.

OBJECTIVE 4: No later than 2022, a storage solution, infrastructure, and services have been created for research data. These are appropriate for good data management and take into account the lifecycle of research data.

Actions required to achieve the objective:

- In 2021, Finnish research organisations will review the existing services as part of the national architecture work. The organisations will, on their part, initiate necessary development measures and promote the use of national and international services.
- No later than 2022, research organisations, in co-operation with national and international operators, will produce and provide instructions and sufficient support services for researchers and research groups in order to enable data storage and publication in accordance with the principles of good data management.

- The research community will ensure that the key open research data infrastructures are not profit-oriented.[43]

OBJECTIVE 5: No later than 2022, research organisations apply an operating model according to which expertise and multi-professional cooperation is utilised for the development of training, skills, and required data management services.

The operating model cannot be restricted to the research data to be opened. Good data management requires the management of the entire lifecycle, regardless of the end result.

Actions required to achieve the objective:

- The research community develops the structures and content for skills and services in national and international cooperation.
- In 2021, research organisations will offer, independently or in co-operation, training in good data management according to the needs of their community for researchers, teachers, supervisors and support personnel at all career stages.
- No later than 2023, research organisations will describe required expert roles in co-operation on a national level and create possible career paths for them.
- Higher education institutions will develop expert training as part of their course selection for students.

43 UNESCO Recommendation on Open Science.

APPENDIX 1: POLICY COMPONENT WORKING GROUP

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POLICY COMPONENT 2: OPEN ACCESS TO RESEARCH METHODS AND INFRASTRUCTURES

Figure 2. *The policy on open access to research methods and infrastructures consists of three general objectives. The first objective supports the overall quality and impact of research. The second objective focuses on support services and infrastructures, and the third objective aims to clarify agreements regarding the rights, terms and conditions related to open research methods and infrastructures.*

THIS POLICY PROVIDES general recommendations for the openness of research methods and infrastructures for research organisations, infrastructure providers, funders, publishers, the research community, and other operators. As stated in the actions, it will be necessary to design more specific recommendations and guidelines that consider differences between disciplines. The national open science architecture work will further complement this policy by mapping the available services and infrastructures for research data and methods, and by helping to identify the prevailing needs for services and infrastructures at the local, national, and international levels.

Research methods should always be communicated at a sufficient level of detail and completeness that allows a thorough public evaluation of how the results have been derived and how the chosen methodology may impact the results and conclusions of a study. The requirement of openness covers not only

individual methods or components, but the whole workflow of research that is needed to proceed from observations to results and conclusions. Openness helps expose all methodological choices to an extent that has not been possible or feasible through more traditional forms of academic communication. In quantitative research this may indicate exact *replicability* of a study or parts of it, whereas in qualitative research enhancements in the transparency of documentation and argumentation may be emphasised. Documentation, versioning, open dissemination, and clear permissions for reuse support the *reusability* and further development of the methods. Although universal definitions for reproducibility and other key terms are lacking[44], they generally emphasise comprehensive documentation and sharing of full methodological workflows for purposes of verification, validation, and reuse. Openness of methods can support standardisation and reduce the possibilities for biased methodology and conclusions. Openness can thus remarkably facilitate the quality and impact of methods across the entire *research process and its life cycle*.

The higher education and research community has, for a long time, recognised the transparent communication of methods as an essential part of research and dissemination. Research organisations, funders, publishers, and infrastructure providers have an important role in incentivising and supporting the early and broad dissemination of the research process, tools, and intermediate research outputs. Whereas researchers have traditionally reported methods in publications, the diversification of research, changes in technology and society, and the need to increase the impact of research through, for example, the adoption and reuse of methods, have set new challenges and opportunities towards these goals. Methods are increasingly recognised as independent research outputs and disseminated through various channels, such as methods sections and supplementary materials, distinct data or methods publications, public protocols, code and material availability statements, open repositories, and in micropublications. Ensuring the early and long-term availability and preservation of methods may require new solutions that complement more traditional forms of research dissemination.

Research infrastructures and infrastructure services are essential instruments for supporting research and advancing the openness of research, and they should be built with a long-term vision. This policy supports the broadest possible openness of research infrastructures as a means to support and advance

44 Plesser, H. E. (2018): Reproducibility vs. Replicability: A Brief History of a Confused Terminology. *Frontiers in Neuroinformatics*. 11:76.

open scholarship. Funders and research infrastructure providers can advance these goals by providing specific guidelines, supporting national[45] and international[46, 47, 48] recommendations on open research infrastructures. This also includes the development and adoption of standardised documentation on and citations of research infrastructure use based on dedicated and citable infrastructure identifiers (e.g. PID/ROR). The open availability of information on research infrastructures and their usage policies is part of the openness of research infrastructures. Access to research infrastructures may need to be controlled for ethical, legal, or financial, or other essential reasons. Infrastructure providers should define explicit policies to regulate access when the infrastructure and its service capacity are limited. Researchers or research organisations should be able to apply for infrastructure services based on public calls organised by the infrastructure provider. Funders and publishers can support these practices. Economically sustainable fostering of openness means that publicly funded research infrastructures must be openly accessible for the widest possible audience and not profit-oriented. They can, however, request unit costs for service and maintenance, and have limited economic activity[49, 50, 51, 52] in order to ensure sustainability of the infrastructure development and maintenance. Research may also rely on infrastructures based on proprietary software (including software used to conduct statistical or qualitative analyses), devices, services, or other innovation, development, and technology infrastructures or platforms and collaboration agreements that limit the level of openness. Whereas such infrastructures may be necessary for carrying out research, researchers and research organisations are encouraged to advance open alternatives.

OBJECTIVES AND ACTIONS

This national policy component is the Finnish research community's shared guideline for the advancement of *open access to research methods and infrastructures*. It complements the policy component on open access to research data (Figure 1). Many steps have already been taken towards these goals in

45 Academy of Finland Roadmap for Finnish Research Infrastructures 2021–2024.
46 UNESCO Recommendation on Open Science.
47 European Commission (2016): European charter of access for research infrastructures.
48 Rules for creating a European Research Infrastructure Consortium (ERIC): Regulation (EC) No 723/2009.
49 UNESCO Recommendation on Open Science.
50 Rules for creating a European Research Infrastructure Consortium (ERIC): Regulation (EC) No 723/2009.
51 Council Regulation (EU) 2021/1173 on establishing the European High Performance Computing Joint Undertaking.
52 Academy of Finland Roadmap for Finnish Research Infrastructures 2021–2024.

Finland: national research infrastructure services are required to have explicit open access and data management policies, open licences have become more widely understood and used, and the need for improving the transparency and reusability of research outputs has been widely recognised. This policy aims to further support and advance open access to research methods and infrastructures.

The implementation details and scope in supporting the openness of research methods and infrastructures may vary significantly. In the development and monitoring of openness it is essential to consider differences in the type, scope and management structure of the infrastructure and infrastructure services as well as the international context and complementary policies on e.g. ownership[53], funding[54] and data management[55]. The development of discipline-specific guidelines for open research methods and infrastructures may be necessary and should be considered as part of the national policy work[56].

Research is encountering new challenges and expectations in the changing world in terms of transparency, accessibility, reproducibility, and reusability. Addressing these issues can improve the overall research quality and impact as well as public trust in science. This policy defines three broad objectives (Figure 2) and associated tasks (Figure 3) to solve pragmatic challenges in opening up research methods.

This policy component primarily concerns research methods that have been produced or used as part of a research or development process as of 1 January 2023 and

- where the researcher is working in or is affiliated with a Finnish research organisation and/or working with funding by a Finnish research funding organisation

or

- where the research or development project involving the compilation or use of research methods takes place in a Finnish research organisation and/or is funded by a Finnish research funding organisation.

53 Academy of Finland: Tutkimusinfrastruktuurikomitean (TIK) linjaus: Kansallisten tutkimusinfrastruktuurien hallinnollisen omistajuuden tunnusmerkit.

54 Academy of Finland: Tutkimusinfrastruktuurikomitean (TIK) linjaus: Tutkimusinfrastruktuurien rahoituksen tunnusmerkit.

55 All research infrastructures that are on the national roadmap have an explicit data management policy; see Academy of Finland: Data management policy for research infrastructures.

56 National Open Science and Research Coordination: Policies.

The objectives below do not take a position on how organisations decide matters, which means that research organisations are tasked with planning according to their own starting points.

Summary of objectives for the open methods policy:

1. By 2023, open research methods and infrastructures are recognised as key components of research **quality and impact**.
2. By 2024, research organisations and infrastructure providers **support** open research methods.
3. By 2025, the **rights and terms** related to research methods and infrastructures are clearly agreed on between all participants in research work.

OBJECTIVE 1: By 2023, open research methods and infrastructures are recognised as key components of research quality and impact.

Research evaluation and incentives do not sufficiently reflect the importance of open methods and infrastructures. It is therefore necessary to develop more systematic means to recognise openness of methods and infrastructures.

Actions required to achieve this objective:

- No later than 2023, the Secretariat for Open Science and Research will, together with research organisations and the research community, initiate the creation of indicators and minimum requirements to monitor the implementation of this policy based on internationally recognised metrics of responsible research evaluation[57, 58].
- No later than 2023, the Secretariat for Open Science and Research will, together with research organisations and the research community, initiate assessment of the need to create additional discipline-specific recommendations[59] and minimum information standards for specific topics, such as qualitative and mixed methods research, algorithms and software, research infrastructures, or other topics, in order to complement and support this policy.
- No later than 2023, the Secretariat for Open Science and Research will participate in international dialogue on

57 CoARA (2022): Agreement on Reforming Research Assessment.
58 National Open Science and Research Coordination, Finland (2020): Good practice in researcher evaluation.
59 National Open Science and Research Coordination: Recommendations of open science and research in Finland.

the creation of recommendations on how to strengthen the documentation, citations and acknowledgment of research methods and infrastructures as independent research outputs.

- No later than 2024, research organisations and funding organisations will initiate planning to develop resources, incentives and merit mechanisms, together with the national and international research community as well as the steering group on responsible research evaluation in Finland, to support the objectives of this policy in responsible research evaluation[60].

OBJECTIVE 2: By 2024, research organisations and infrastructure providers support open research methods.

Opening up research methods and infrastructures requires dedicated knowledge, skills, and resources. It is necessary to systematically assess the need to develop the current policies, training and services, and strengthen the openness of methods and infrastructures in routine research practice.

Actions required to achieve this objective:

- No later than 2023, the national open science architecture will include research methods and their open access policies, services and infrastructures as well as the development of related skills.
- No later than 2024, research organisations and infrastructure providers will, in national cooperation, review the current status of their research infrastructures and services for open research methods in relation to the national open science architecture and initiate further actions in order to fulfil the identified gaps.
- No later than 2024, research organisations will provide support and recommendations for training and services for students, researchers and other personnel on open research methods and open research infrastructures according to their capabilities[61] and in cooperation with the relevant stakeholders. Openness will be considered as a factor in the purchase and development of services and products for research.
- No later than 2024, the DMP consortium will support this policy by strengthening the incorporation of open research

60 Responsible Research: Responsible assessment.

61 Existing services, such as research.fi and OpenIRIS, and openness of research infrastructures shall be considered as part of this work.

methods and infrastructures in the research project Data Management Plan (DMP)[62].

- No later than 2025, research organisations will describe expert roles in open methods and infrastructures according to their needs and in co-operation on a national level. They will assess the opportunities for creating specialised career paths in this area[63].

OBJECTIVE 3: By 2025, the rights and terms related to research methods and infrastructures are clearly agreed on between all participants in research work.

The objectives need to be supported by clear terms and conditions.

Actions required to achieve the objective:

- No later than 2023, the Secretariat for Open Science and Research will, together with research organisations and the research community, initiate the establishment of recommendations and guidelines for documenting the rights, terms, and licences supporting the openness of research methods and infrastructures[64].
- No later than 2024, the Secretariat for Open Science and Research will initiate discussion with the Finnish National Board on Research Integrity on the possibility of developing general guidelines and recommendations for reconciling open access to research data, methods, and infrastructures with other elements of research integrity.
- No later than 2025, research and funding organisations, in cooperation with the Finnish research community, have set up national guidelines to advance clear and unambiguous agreements on the rights and responsibilities related to open research methods and infrastructures.

62 In some cases, dedicated plans can be considered; see e.g. Science Europe Open Science work group developing national guidelines for software management plans (SMP; open draft).

63 Professional roles and career paths will be aligned with the outputs of the European project Skills4EOSC.

64 Including, but not limited to, developing citation practices and, where applicable, the use of FAIR, machine actionable, and open licenses according to the Open Source Definition.

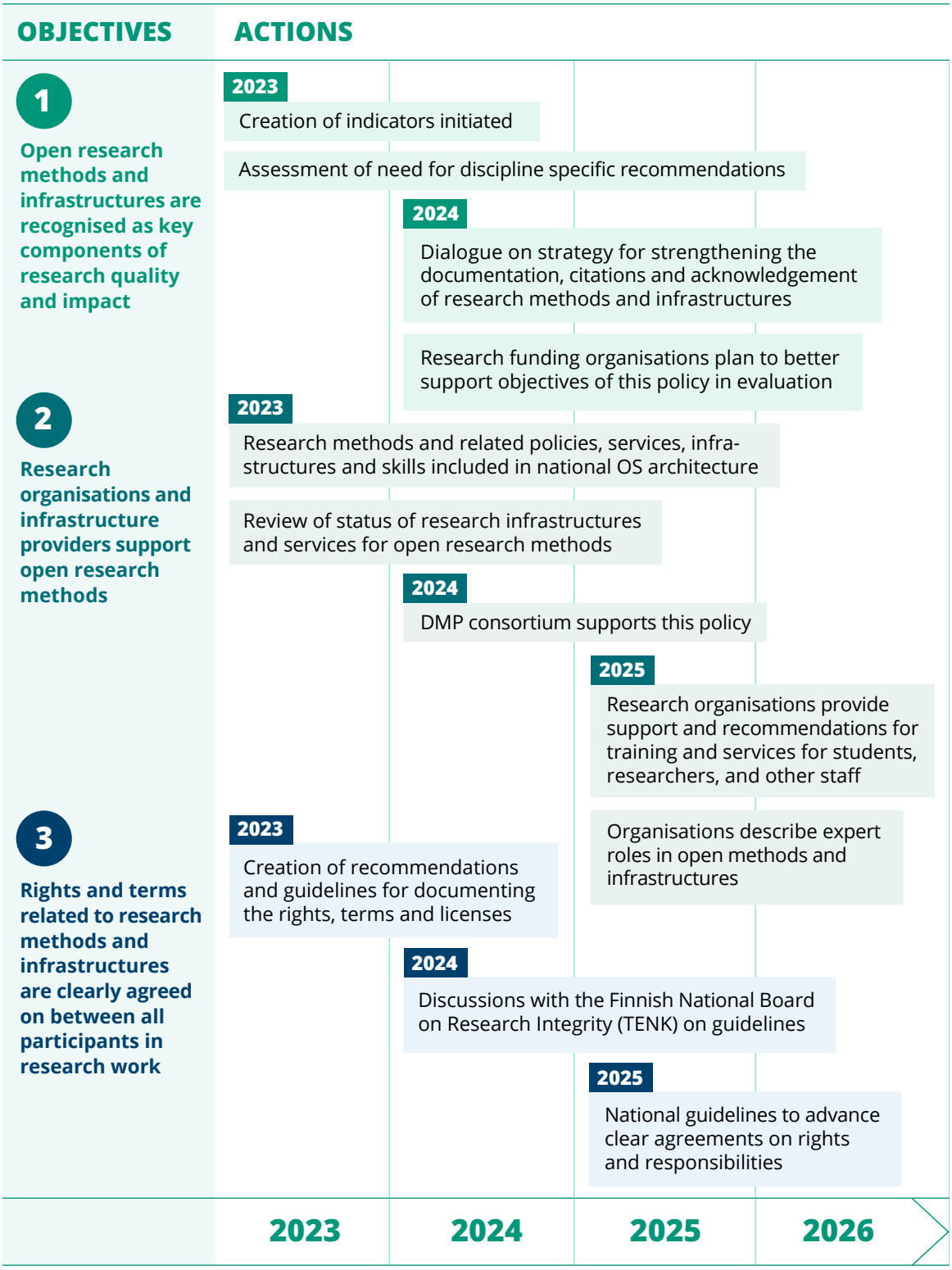

Figure 3. *Timeline for the objectives and actions related to the national policy on open access to research methods and infrastructures.*

APPENDIX 2: POLICY COMPONENT WORKING GROUP

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TIMELINE FOR ACTIONS 2021–2025

2021

Data

- **The Open Science Coordination** will produce a report on the legal questions related to open science. Thereafter, **the research community** will create recommendations for agreement content, which means that the **research organisations** will have basic principles governing agreement on rights and responsibilities related to research data (licensing, commercialisation and transfer of rights).
- **Research organisations** will offer, independently or in co-operation, training in good data management according to the needs of their community, as well as advice and guidance.
- **Research organisations** support the planning of research so that research projects are able to prepare for the costs of materials and documentation.
- **The research community** will launch a review of the services of national and international research organisations as part of national architecture work.

2022

Data

- **Research organisations** have regularly updated data policies.
- **Research organisations** offer instructions, practices and training in data management planning according to the needs of their community, using multi-professional co-operation.
- **Research organisations** support researchers in the production of metadata through support services and incentives, taking into account the opening, further use, findability, interoperability and accessibility of research data.
- **The working group on open science and research monitoring** at the Open Science Coordination specifies indicators for open science.

- **Research organisations**, in co-operation with national and international operators, produce and offer instructions and sufficient support services for the researchers and research groups in order to enable data storage and publication in accordance with the principles of good data management.

2023

Data

- Research organisations include the creation and maintenance of data management plans in their research and service processes at each stage of the data lifecycle.
- Research organisations utilise suitable indicators with which they monitor their progress in good data management as part of a quality system.
- Research organisations will describe the required expert roles in national co-operation and create possible career paths for expert roles.

Methods and infrastructures

- The Secretariat for Open Science and Research together with research organisations and the research community initiates the creation of indicators and minimal requirements to monitor the implementation of this policy.
- The Secretariat for Open Science and Research together with research organisations and the research community initiates assessment of the need to create additional discipline-specific recommendations and minimum information standards for specific topics.
- The Secretariat for Open Science and Research participates in international dialogue on the creation of recommendations on how to strengthen the documentation, citations and acknowledgment of research methods and infrastructures as independent research outputs.
- The national open science architecture includes research methods and their open access policies, services and infrastructures as well as the development of related skills.
- The Secretariat for Open Science and Research together with research organisations and the research community initiates the creation of recommendations and guidelines for documenting the rights, terms, and licences supporting the openness of research methods and infrastructures.

2024

Data

- Higher education institutions ensure that thesis supervisors are able to evaluate and comment on data management plans as part of their supervisory work.
- Research organisations have developed monitoring to ensure the implementation of good and responsible data management practices.

Methods and infrastructures

- Research and funding organisations initiate planning to develop resources, incentives and merit mechanisms, together with the national and international research community and including the steering group on responsible research evaluation in Finland, to support the objectives of this policy in responsible research evaluation.
- Research organisations and infrastructure providers (in national cooperation) review the current status of their research infrastructures and services for open research methods in relation to the national open science architecture and initiate further actions in order to fulfil the identified gaps.
- Research organisations provide support and recommendations for training and services for students, researchers and other personnel on open research methods and open research infrastructures according to their capabilities and in cooperation with the relevant stakeholders. Openness will be considered as a factor in the purchase and development of services and products for research.
- The DMP consortium supports this policy by strengthening the incorporation of open research methods and infrastructures in the research project Data Management Plan (DMP).
- The Secretariat for Open Science and Research initiates discussion with the Finnish National Board on Research Integrity on the possibility of developing general guidelines and recommendations for reconciling open access to research data, methods, and infrastructures with other elements of research integrity.

2025

Methods and infrastructures

- Research organisations describe expert roles in open methods and infrastructures according to their needs and in co-operation on a national level. They will assess the opportunities for creating specialised career paths in this area.
- Research and funding organisations, in cooperation with the Finnish research community, have set up national guidelines to advance clear and unambiguous agreements on the rights and responsibilities related to open research methods and infrastructures.

GLOSSARY

Please refer to the Helsinki Term Bank for the Arts and Sciences for further definitions and clarifications.

DMP (Data Management Plan) is a formal and dynamic document that specifies how research resources are managed across the life cycle of a research project, covering, for instance, research data, analysis steps (e.g. protocols, algorithms, procedures), devices and tools (e.g. information on lab equipment and manufacturers, reagents, infrastructure, software), other relevant documentation, versioning, preservation, services, terms and conditions, and open development and sharing of research data, methods and infrastructures.

Expert roles related to research methods include, for instance, research software engineers, statisticians, data management support, library information specialists, legal staff, laboratory engineers, and laborants.

FAIR principles are a set of guidelines to make research data Findable, Accessible, Interoperable and Reusable, facilitating scientific discovery and access to knowledge[65]. The closely related FAIR4RS principles have been developed for research software[66].

Free and open source software (FOSS). See *Open source software*.

Good and responsible research data management: For the purposes of this policy, *good management* means that research data and the related metadata has been "created, saved and organised so that the research data remains usable and reliable, and that data security and privacy are ensured throughout the lifecycle of the research data".13 In addition, good research data management in the very context of open science means that the principle of "as open as possible, as closed as necessary", the FAIR principles and the principle of responsibility are taken into account at all stages of the research process. **Good research data management is a necessary prerequisite for open access.** Evaluation of good research data management is based on the following viewpoints:

1. According to the principle "*as open as possible, as closed as necessary*", data that can be opened for access and reuse must be opened. Correspondingly, data which cannot be

65 GO FAIR: FAIR Principles.

66 Chue Hong, N. P., Katz, D. S., Barker, M., Lamprecht, A.-L., Martinez, C., Psomopoulos, F. E., Harrow, J., Castro, L. J., Gruenpeter, M., Martinez, P. A., Honeyman, T., et al. (2021). FAIR Principles for Research Software (FAIR4RS Principles). *Research Data Alliance*.

opened and shared must be protected and safely stored. It is ultimately the researcher's responsibility to deter mine which group the research data falls into. Refraining from opening data always requires justification.

2. The FAIR principles[67] refer to the quality of research data from the viewpoint of its further use. The principles aim to make research data:
   - **F**indable
   - **A**ccessible
   - **I**nteroperable
   - **R**eusable.

   Research data and metadata complying with the FAIR principles are semantically interoperable, i.e. they must be structured, described, tagged and licensed well enough, as well as stored safely, to be findable and machine readable. In most areas, it is not yet possible to create data that is fully compliant with the FAIR principles due to lack of skills and services or due to the nature of the data.

3. For the purposes of this policy, responsible data management refers to:
   - knowledge of and compliance with the principles of the field of research
   - knowledge of and compliance with the principles of research integrity
   - knowledge of and compliance with legislation
   - knowledge of and compliance with the principles of data security and privacy

   Responsible research data management is a prerequisite for all forms of data openness. Responsible data management requires that the data and metadata are managed in a way that is compliant with data security, privacy and research integrity. Responsible data management and the possibility for opening research data it entails are part of responsible conduct of research.

Licences are issued by authors and copyright holders to give expanded usage rights to data, creative works, and code. For computer software and scripts, numerous established licences are available. Open licences refer to licences that support the Open Source Definition[68]. Some open licences include conditions for sharing derivative works (e.g. GPL, CC BY-SA). Permissive open licences (e.g. MIT, BSD-2-clause, CC BY, CC0) set minimal requirements for reuse and licensing of derivative material. Licence compatibility issues may affect the choice of a licence[69].

67 FORCE11: The FAIR Data principles.
68 Open Source Initiative: Open Source Definition.
69 Stallman, R.: License Compatibility and Relicensing.

Mature research methods or infrastructures have been used for a sufficiently long period of time to enable the detection and removal of initial shortcomings and problems, a deeper understanding of essential performance characteristics, and possibly enhanced usability by professional and non-professional users. Methods and infrastructures at varying levels of maturity are regularly used in research, and maturation of the methods and infrastructures can be an essential part of the research process. Documentation and support can be seen as additional elements of maturity and openness. Maturity levels in open research software can cover, for instance: 1) the availability of a repository for raw source code that documents how the analyses could be reproduced and has been released with an *open source licence*; 2) additional design choices and documentation to make the code/software more generally applicable beyond the immediate original use; 3) a full software library that follows good design practices, such as comprehensive unit tests and other recommendations[70]; 4) provision of a fully reproducible data analytical workflow that covers the complete details from raw data to reporting. In qualitative fields, the maturity of the method could refer, for instance, to a protocol or questionnaire that has been more extensively tested and developed across multiple studies. Mature methods can also help to standardise research.

Metadata refers to data describing the context, content and structure, management and/or processing and compilation of research data.[71]

Micropublications provide peer-reviewed and citable means to publish brief, novel findings and results which may lack a broader scientific narrative. Micropublications can also be used for communicating and sharing information about negative results and failed experiments of implementations.

Minimum information standards ensure that data is reported in a way that can be verified, interpreted, and analysed by others.

Openness of research methods and infrastructures refers to transparency, findability, accessibility, shareability, and reusability. Reusability is an essential element of openness. Openness is implemented through, for instance, documentation, standards and FAIR principles, semantic interoperability, machine readability, open licensing, pre-registration, public protocols, development in open source repositories, dissemination of material collections, and digital libraries. Certain types of methods, such as questionnaires, source code, or notebooks, for instance, can be also interpreted as research data, in which case the definitions regarding open research data may be applicable. Openness of

70 See e.g. *Journal of Open Software* Review Criteria.
71 The Helsinki Term Bank for the Arts and Sciences.

research infrastructures can refer to, for instance, 1) information on access and ownership policies and transparent governance structure; 2) infrastructure use; 3) research outputs that have been enabled by the infrastructure. Other important aspects include support for collaborative use and for citing research methods. Open methods and infrastructures are not necessarily free of cost, but they should be non-profit oriented and include minimal costs for research use.

Open source software, a computer software in which the source code is released under a licence where the copyright holder grants users the rights to use, study, change and distribute the software to anyone and for any purpose. Source code of research methods provides complementary information in repeatability, reproducibility and reuse, compared to textual descriptions of algorithms.[72]

Preregistration specifies, in advance, the study plan and declares it in a trusted open registry. This helps to distinguish exploratory hypothesis-generating research from confirmatory hypothesis testing. Pre-registration can be declared in the research report.

Protocols document the numbered steps to follow to reproduce the results obtained in a specific study: data collection, analysis including methods, or output production, for instance. In certain domains, such as laboratory work or computational research, some protocols can be automated.

Repository is a database or a virtual archive established to collect, disseminate and preserve scientific output[73, 74]. There are repositories that have been specifically intended for research methods, including the Open Science Framework, as well as digital repositories for data processing and software packages (such as GitHub or Zenodo).

Research data is a resource used by a researcher or a research group during a research process, i.e. the basic data of scientific or artistic research, in digital, analogue or physical form. Research data has been collected, observed, measured or created to confirm hypotheses and verify results.

Research data openness: For the purposes of this policy, research data openness, refers to the findability, accessibility, usability and shareability of research data for other researchers. Open access to research data requires good and responsible data management. Reuse of research data is supported through licenses[75], or its use may require an appropriate research permit.

72 See also Second French Plan for Open Science. Generalising Open Science in France 2021–2024, p. 16–19.
73 OpenAIRE: What are repositories?
74 Aalto University Open Science and Research Policy.
75 Ball, A. (2014). How to License Research Data. *DCC How-to Guides*. Edinburgh: Digital Curation Centre.

The responsible processing of research data that contains personal information or is sensitive or confidential requires the researcher to comply with both legislation and good practices in research integrity. In such cases, however, it is often possible to open the metadata of the research data and to provide other researchers with the opportunity to access the data through a separate agreement on the transfer.

Researcher is in this policy used to refer broadly to the members of the higher educational and research community, including individuals who participate in research. This includes not only professional researchers but also others working in various roles in carrying out, enabling or supporting the research work, as well as teachers and students in the higher educational and research organisations.

Research infrastructures are often a result of collaborative effort and long-term resource accumulation, and they enhance collaboration and efficient use of research resources. They can be instruments, equipment, information networks, databases, materials and services, or research organisations that serve to facilitate research, promote research collaboration and reinforce research and innovation capacity and know-how. Research infrastructures (e.g. library, greenhouse, research forest, barn, laboratory, computational hardware, database, software repository) can be used to provide infrastructure services (research service carried out in the greenhouse). The responsible organisation can provide support in, for instance, the use of machines and equipment to carry out successful experiments. These services can have virtual access (e.g. data products), remote access (e.g. remotely controlled measurement devices), or physical access (e.g. physical visit to calibrate a measurement device) services. Hence, research infrastructures may be single-sited, distributed or virtual, or a combination of these, and they are often used to collect data that will be stored to databases. The scope varies from local to national and international equipment and infrastructure services. Europe hosts several large-scale research infrastructures that are open to collaborative use across national boundaries. Research infrastructures are maintained primarily for research purposes. Examples of other types of infrastructures that may be additionally utilised in research include innovation, development and technology.

Research methods are organised and documented procedures for carrying out research and working with research data in order to generate research results[76]. Specific research methods often cover some part of the research life cycle from data collection to study design, access, data selection and manipulation, docu-

76 The Helsinki Term Bank for the Arts and Sciences (definition in Finnish)

mentation and reporting of the research contexts, protocols and plans like interview guides, and process of analysis including concrete actions and reasoning. The openness of research methods covers the specific methods as well as their overall combination that forms the overall research workflow across the full life cycle of research. Examples of research methods include documented argumentation chains, systematic reviews, questionnaires, interview guides, research diaries, interview template, writing requests, dictation, coding, documentation of the setup (e.g. hardware setup), experimental materials (e.g. reagents), design aspects such as determination of sample size, data exclusion, manipulations, and all relevant measures[77], methods and documentation of data collection (e.g. with non-open measurement software), lab notebooks, guidelines, technology, hardware, software, algorithms, AI methods, source code, workflows, scripts, protocols, and models. Research data and research methods are not always distinguishable. A method may be published in a peer reviewed venue, or otherwise accepted and adopted by a research community.

Research organisation refers to an organised entity that conducts or supports independent research. Examples include universities, universities of applied sciences, research institutes, technology transfer agencies, or innovation hubs. Research infrastructures may also be interpreted as research organisations when they conduct or support independent research. The size and scope of research organisations can vary considerably.

Research resources in this policy refers collectively to research data, methods, and infrastructures. It may additionally include other types of research outputs, for instance preprints, publications, material, or social networks.

Responsible management of research methods and infrastructures is part of good research practices and includes documentation that supports the ability to trace all relevant methodological steps. This allows the critical evaluation of all relevant methodological choices and are necessary for transparency and reproducibility of research. Moreover, it supports backups, long-term storage and versioning where applicable (e.g. in software, devices, or protocols), and complies with legislation and research integrity.

Reusability refers to the ease by which either the exact code or abstract research procedure can be further developed and adapted for future use in the same or different context.

77 Center of Open Science: Transparency and openness promotion guidelines; see e.g. section 5.7.

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