

Open and Universal Science Project (OPUS)

**OPUS helps reform the
assessment of research towards
a system that incentivise
researchers to practice
#OpenScience**



WP3 INDICATORS AND METRICS TO TEST IN THE PILOTS

Deliverable 3.1 Indicators and Metrics to Test in the Pilots

Gareth O'Neill (Technopolis Group Belgium)

DOI: 10.5281/zenodo.10497434

Horizon Europe Programme 2021 – 2027
HORIZON-WIDERA-2021-ERA-01-45
HORIZON Coordination and Support Actions

Project number: 101058471
Project name: Open Universal Science
Project acronym: OPUS

Project starting date: 1 September 2022
Project end date: 31 August 2025
Project duration: 36 months



The OPUS project is financed by European Union through the GRANT AGREEMENT no. 101058471 concluded with the European Research Executive Agency (REA), under the powers delegated by the European Commission.

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

TABLE OF CONTENTS

1. INTRODUCTION.....	6
2. RESEARCHER ASSESSMENT FRAMEWORK.....	8
2.1. GUIDING PRINCIPLES BEHIND THE FRAMEWORK.....	8
2.2. STRUCTURE AND COMPONENTS OF THE FRAMEWORK.....	9
3. GENERIC RESEARCHER ASSESSMENT FRAMEWORK.....	12
3.1. RESEARCH.....	12
3.1.1. Proposals.....	12
3.1.2. Methods.....	12
3.1.3. Data.....	12
3.1.4. Software.....	13
3.1.5. Publications.....	14
3.1.6. Materials.....	14
3.2. EDUCATION.....	14
3.2.1. Courses.....	15
3.2.2. Resources.....	15
3.2.3. Teaching.....	15
3.2.4. Supervision.....	16
3.2.5. Skills.....	16
3.3. LEADERSHIP.....	16
3.3.1. People.....	16
3.3.2. Projects.....	17
3.3.3. Organisation.....	17
3.3.4. Recognition.....	17
3.4. VALORISATION.....	18
3.4.1. Communication.....	18
3.4.2. Engagement.....	18
3.4.3. Innovation.....	19
4. OPEN SCIENCE RESEARCHER ASSESSMENT FRAMEWORK.....	20
4.1. RESEARCH.....	20
4.1.1. Proposals.....	20
4.1.2. Methods.....	20
4.1.3. Data.....	20
4.1.4. Software.....	21
4.1.5. Publications.....	21
4.1.6. Materials.....	22
4.2. EDUCATION.....	22
4.2.1. Courses.....	22
4.2.2. Resources.....	23
4.2.3. Teaching.....	23
4.2.4. Supervision.....	23
4.2.5. Skills.....	24
4.3. LEADERSHIP.....	24
4.3.1. People.....	24
4.3.2. Projects.....	25
4.3.3. Organisation.....	25
4.3.4. Recognition.....	25
4.4. VALORISATION.....	26
4.4.1. Communication.....	26
4.4.2. Engagement.....	26
4.4.3. Innovation.....	27
5. CONCLUSION.....	28
END NOTES.....	29
REFERENCES.....	30
APPENDIX 1: RESEARCHER ASSESSMENT FRAMEWORK WITH INDICATORS.....	33

TABLE OF FIGURES

Figure 1: Categories, Subcategories, and Indicator Groups of Researcher Assessment Framework..... 11

TABLE OF TABLES

Table 1: Generic Indicators for Category Research Subcategory Proposals.....	12
Table 2: Generic Indicators for Category Research Subcategory Methods.....	12
Table 3: Generic Indicators for Category Research Subcategory Data	13
Table 4: Generic Indicators for Category Research Subcategory Software	13
Table 5: Generic Indicators for Category Research Subcategory Publications	14
Table 6: Generic Indicators for Category Research Subcategory Materials.....	14
Table 7: Generic Indicators for Category Education Subcategory Courses	15
Table 8: Generic Indicators for Category Education Subcategory Resources.....	15
Table 9: Generic Indicators for Category Education Subcategory Teaching	15
Table 10: Generic Indicators for Category Education Subcategory Supervision.....	16
Table 11: Generic Indicators for Category Education Subcategory Skills.....	16
Table 12: Generic Indicators for Category Leadership Subcategory People	17
Table 13: Generic Indicators for Category Leadership Subcategory Projects	17
Table 14: Generic Indicators for Category Leadership Subcategory Organisation.....	17
Table 15: Generic Indicators for Category Leadership Subcategory Recognition.....	18
Table 16: Generic Indicators for Category Valorisation Subcategory Communication	18
Table 17: Generic Indicators for Category Valorisation Subcategory Engagement.....	19
Table 18: Generic Indicators for Category Valorisation Subcategory Innovation	19
Table 19: Open Science Indicators for Category Research Subcategory Proposals	20
Table 20: Open Science Indicators for Category Research Subcategory Methods	20
Table 21: Open Science Indicators for Category Research Subcategory Data	21
Table 22: Open Science Indicators for Category Research Subcategory Software.....	21
Table 23: Open Science Indicators for Category Research Subcategory Publications	22
Table 24: Open Science Indicators for Category Research Subcategory Materials.....	22
Table 25: Open Science Indicators for Category Education Subcategory Courses	23
Table 26: Open Science Indicators for Category Education Subcategory Resources.....	23
Table 27: Open Science Indicators for Category Education Subcategory Teaching	23
Table 28: Open Science Indicators for Category Education Subcategory Supervision	24
Table 29: Open Science Indicators for Category Education Subcategory Skills	24
Table 30: Open Science Indicators for Category Leadership Subcategory People	24
Table 31: Open Science Indicators for Category Leadership Subcategory Projects	25
Table 32: Open Science Indicators for Category Leadership Subcategory Organisation.....	25
Table 33: Open Science Indicators for Category Leadership Subcategory Recognition.....	26
Table 34: Open Science Indicators for Category Valorisation Subcategory Communication.....	26
Table 35: Open Science Indicators for Category Valorisation Subcategory Engagement	27
Table 36: Open Science Indicators for Category Valorisation Subcategory Innovation	27

Document Information

Title	Indicators and Metrics to Test in the Pilots
Document reference	D3.1
Distribution	Public
Deliverable Leader	Technopolis Group Belgium
Authors	Gareth O'Neill
Date	12 January 2024
Status	Final (Following Review by European Commission)

Document Revision History

Version	Date	Authors/Contributors/Reviewers	Description
0.1	16/05/2023	Gareth O'Neill (TGB)	Initial Table of Contents drafted
0.2	26/06/2023	Gareth O'Neill (TGB)	First version drafted after input and discussions with project partners, advisory board, and external stakeholders
0.3	29/06/2023	Gareth O'Neill (TGB), Volker Beckmann (MESR), Emma Day (Vitae), Fleur Lehardt (TGB), Mostafa Moonir Shawrav (MCAA), Sal Music (ICoRSA), Mayya Sundukova (MCAA), and Wilhelm Widmark (SU)	Second version drafted after internal and external reviews and feedback from project partners and technical formatting
1.0	30/06/2023	Gareth O'Neill (TGB)	Final version finalised and formally submitted to European Commission
2.0	12/01/2024	Gareth O'Neill (TGB)	Final version revised after review and feedback from European Commission and resubmitted to European Commission

Responsibility

The sole responsibility for the content of this publication lies with the authors. Views and opinions expressed are those of the author(s) and do not necessarily reflect those of the European Union (EU) or European Research Executive Agency (REA). Neither the EU nor the granting authority can be held responsible for them. The European Commission is not responsible for any use that may be made of the information contained therein.

Copyright/Legal Disclaimer

This document may not be copied, reproduced, or modified in whole or in part for any purpose without written permission from the OPUS Consortium. In addition, an acknowledgment of the authors and all applicable portions of the copyright notice must be clearly referenced in any document using all or parts of this deliverable. All rights reserved. This document may change without notice.

Abbreviations and Acronyms

AAM	Author Accepted Manuscript
CERN	European Organisation for Nuclear Research
CoARA	Coalition for Advancing Research Assessment
DORA	San Francisco Declaration on Research Assessment
FAIR	Findable, Accessible, Interoperable, and Reusable
FTE	Full Time Equivalent
ICoRSA	International Consortium of Research Staff Associations
IPR	Intellectual Property Rights
JIF	Journal Impact Factor
LERU	League of European Research Universities
LIBER	Association of European Research Libraries
MCAA	Marie Curie Alumni Association
MESR	Minister of Higher Education and Research of France
OPUS	Open Universal Science
OSPP	Open Science Policy Platform
RAF	Researcher Assessment Framework
RDF	Researcher Development Framework
RFO	Research-funding Organisation
RPO	Research-performing Organisation
SU	Stockholm University
TGB	Technopolis Group Belgium
VoR	Version of Record

1. Introduction

This report is deliverable D3.1 of the OPUS project [1] on Indicators and Metrics to Test in the Pilots. The report proposes a **first draft of a researcher assessment framework (RAF) to assess researchers in an academic context**. This includes assessing researchers applying for positions at a research-performing organisation (RPO), assessing researchers in their career development and progression at an RPO, and assessing project applications and progression by researchers at an RPO or research-funding organisation (RFO). The framework includes an Open Science dimension, whereby Open Science practices are explicitly recognised and rewarded. The implementation of the framework is supported by accompanying interventions for RPOs and RFOs, which are described in deliverable D2.1 of OPUS on Interventions to Test in the Pilots [2]. Selected indicators/metrics from the framework and related interventions will be tested in pilots at 3 RPOs and 2 RFOs in OPUS.

The RAF builds on **key policy developments in research assessment and Open Science** as identified in deliverable D1.2 of OPUS on State-of-the-Art on an Open Science Ecosystem [3]:

- San Francisco Declaration on Research Assessment (DORA) [4]
- Leiden Manifesto for Research Metrics [5]
- Hong Kong Principles [6]
- Recommendations by the Open Science Policy Platform (OSSP) [7] [8]
- Recommendations on Science and Scientific Researchers [9] and Open Science [10]
- Agreement on Reforming Research Assessment [11]
- Research Evaluation in a Context of Open Science and Gender Equality [12]
- Conclusions on Research Assessment and Implementation of Open Science [13]
- European Framework for Research Careers including European Charter for Researchers [14]

The RAF also builds on **key frameworks in research assessment and Open Science** with a focus on developing new indicators/metrics and supporting Open Science as identified in D1.2:

- Researcher Development Framework (RDF) [15]
- Evaluation of Research Careers Fully Acknowledging Open Science Practices [16]
- Next-generation Metrics [17]
- Recommendations of the OSPP on Next-Generation Metrics [18]
- Mutual Learning Exercise on Open Science on Altmetrics and Rewards [19]
- Open Science Monitor [20]
- Indicator Frameworks for Fostering Open Knowledge Practices in Science and Scholarship [21]
- A Pathway towards Multidimensional Academic Careers [22]

The RAF further builds on **key recommendations for a framework for researcher assessment from D1.2** which incorporates the recognition and reward of Open Science practices by researchers:

- Develop a comprehensive RAF of indicators/metrics for RPOs and RFOs
- Include both research and non-research activities by researchers in the RAF
- Include both a generic and Open Science approach to assessment in the RAF
- Include both a quantitative and qualitative approach to assessment in the RAF
- Integrate relevant indicators/metrics from existing frameworks into the RAF

The RAF has been developed in close **collaboration with key stakeholders in research assessment and Open Science**. This includes project partners and especially the pilot organisations¹ which are already implementing researcher assessment and Open Science and will pilot the RAF in OPUS. This also includes members of the Advisory Board² in OPUS and key external stakeholders³ as identified in D1.1 of OPUS on State-of-the-Art on an Ecosystem for Open Science [23]. This lastly includes the GraspOS project [24] and other relevant stakeholders⁴. This first draft of the RAF will be further developed in iterations, including testing and feedback from the pilots, targeted feedback from key stakeholders, and an open consultation with the wider research community.

The RAF consists of a **framework to reform researcher assessment and incentivise and reward Open Science** linked to the full spectrum of activities carried out by researchers. The RAF essentially offers a wide range of indicators/metrics for RPOs and RFOs to develop new or update existing researcher assessment frameworks. The RAF is divided into 4 main categories for research, education, leadership, and valorisation activities, which are further subdivided into relevant subcategories consisting of specific groups of indicators/metrics. The RAF is furthermore divided into generic and open dimensions, whereby the indicators/metrics are either related to activities not specified in terms of openness or related to activities focused specifically on Open Science. The framework is intended to be broadly applicable across countries, across disciplines, and across organisations, whereby RPOs and RFOs can tailor the framework to their own interests and needs.

The report begins with the guiding principles behind the RAF and describes the overall structure and implementation of the RAF at RPOs and RFOs in **Section 2**. The report next presents the generic RAF and lists the generic indicators/metrics for researcher assessment at RPOs and RFOs in **Section 3**. The report then presents the Open Science RAF and lists the indicators/metrics to recognise and reward Open Science practices in researcher assessment at RPOs and RFOs in **Section 4**. The report lastly offers conclusions and next steps for OPUS in **Section 5** and provides the full RAF with all generic and Open Science indicators/metrics in table format in **Appendix 1**.

2. Researcher Assessment Framework

2.1. Guiding Principles behind the Framework

The RAF has been developed and should be implemented according to **10 guiding principles**, which the project has formulated based on existing work and feedback from relevant stakeholders:

1. Provide a comprehensive framework of indicators/metrics for RPOs and RFOs
2. Provide a framework which applies across countries, disciplines, and organisations
3. Provide a framework which combines both qualitative and quantitative assessment
4. Focus on the assessment of individual researchers and not teams, groups, or units
5. Cover the full spectrum of activities by researchers and not just research activities
6. Offer a generic framework which allows open and non-open activities by researchers
7. Offer a specific framework which focuses on Open Science activities by researchers
8. Distinguish process, output, and outcome indicators to capture the lifecycle of activities
9. Formulate indicators/metrics at a high level of description for broad application
10. Leave selection, refinement, and prioritisation of indicators/metrics to RPOs and RFOs

The RAF offers a **comprehensive framework of indicators/metrics** to assess researchers. The framework is 'comprehensive' in the sense that the indicators/metrics cover the diversity of researcher activities and are aimed to be applicable across countries, disciplines, and organisations. The RAF does not aim to address all cultural and behavioural factors (such as organisational values and interpersonal behaviours) or all organisational, regional, and national contexts (such as relevant laws, regulations, policies, and ecosystems) that are possibly relevant for researcher assessment. The RAF is instead intended as a suite of options whereby RPOs and RFOs select from the indicators/metrics and then refine and prioritise selected indicators/metrics to their own strategic priorities and needs. The embedding of the framework into a given RPO or RFO should naturally take into account the existing cultural, behavioural, and local contexts which are relevant for their researcher assessment.

The RAF is **not intended to be prescriptive** but rather provides RPOs and RFOs with a suite of indicators/metrics which can be selected and selectively deployed by the organisations. The RAF does not prioritise, rank or weight, or propose benchmarks or targets for any indicators/metrics. The RAF does not propose a scoring system or eventual rewards for the outcome of a given assessment. The RAF also does not prioritise between generic or Open Science indicators/metrics but leaves the selection and prioritisation between these indicators/metrics to RPOs and RFOs. The organisations may select and combine indicators/metrics from the generic and Open Science dimensions, refine their selected indicators/metrics, prioritise and rank and weight their selected indicators/metrics, and determine the scoring system and eventual rewards for a given assessment. The organisations may thus adopt and refine the framework as a whole or select only those components of interest to them.

The RAF does **not prioritise qualitative or quantitative approaches** to researcher assessment. The RAF proposes a framework of indicators which can be deployed to assess the activities of a researcher within a given evaluation at an RPO or RFO. The term 'indicator' here thus refers to a measure for assessing the performance of a researcher within an evaluation framework⁵. The indicator can be deployed in a qualitative or quantitative manner whereby the value or 'target' of the indicator may be qualitative (as with a 'narrative' value) or quantitative (as with a 'metric' value). The framework proposes descriptive indicators and does not specify the manifold narratives or metrics that could instantiate the indicators. That said, a metric could be realised in all cases simply by adding the phrase 'number of' to the indicator to specify a quantitative target. The framework leaves the implementation of indicators and choices between narrative and metric values to the organisations.

The RAF is mainly intended for the **assessment of individual researchers** including their individual activities as well as their contributions within research teams, groups, and units. The RAF does not address assessment beyond the individual such as for research teams, groups, and units. That does not mean, however, that the RAF could not be scaled up to accommodate groups of researchers. The indicators/metrics proposed in the RAF could be applied beyond the level of the individual researcher, although the indicators/metrics may not all be relevant or may need to be adjusted for the level of implementation. This could be the case, for instance, for an RFO assessing the overall performance of a funded project via the performance of all the researchers funded by the project. The target and nature of the assessment in such cases determine the adjustment and implementation of the RAF.

The RAF should be **translated into a workable tool** for practical implementation by RPOs and RFOs. The translation of the RAF will undoubtedly be different for RPOs versus RFOs. One example is that the RAF will likely focus on a recent (potentially annual) evaluation time frame for assessing researchers in their career development and progression at an RPO, but will be more encompassing and cumulative (including all previous activities) for assessing researchers applying for positions at a RPO or grant applications by researchers at an RPO or RFO. The translation of the RAF will also be different across RPOs and RFOs. The flexibility of the framework naturally allows for individual RPOs and RFOs to assess their researchers according to their own interests and needs. The translations of the RAF by RPOs and RFOs may lastly be presented to researchers through questionnaires or digital tools and will require clear guidelines explaining the RAF and assessment procedure for researchers.

2.2. Structure and Components of the Framework

The RAF is structured around **4 main categories of activities**, which are divided into **subcategories** of these activities, and which consist of **indicator groups** of related indicators/metrics as in Figure 1:

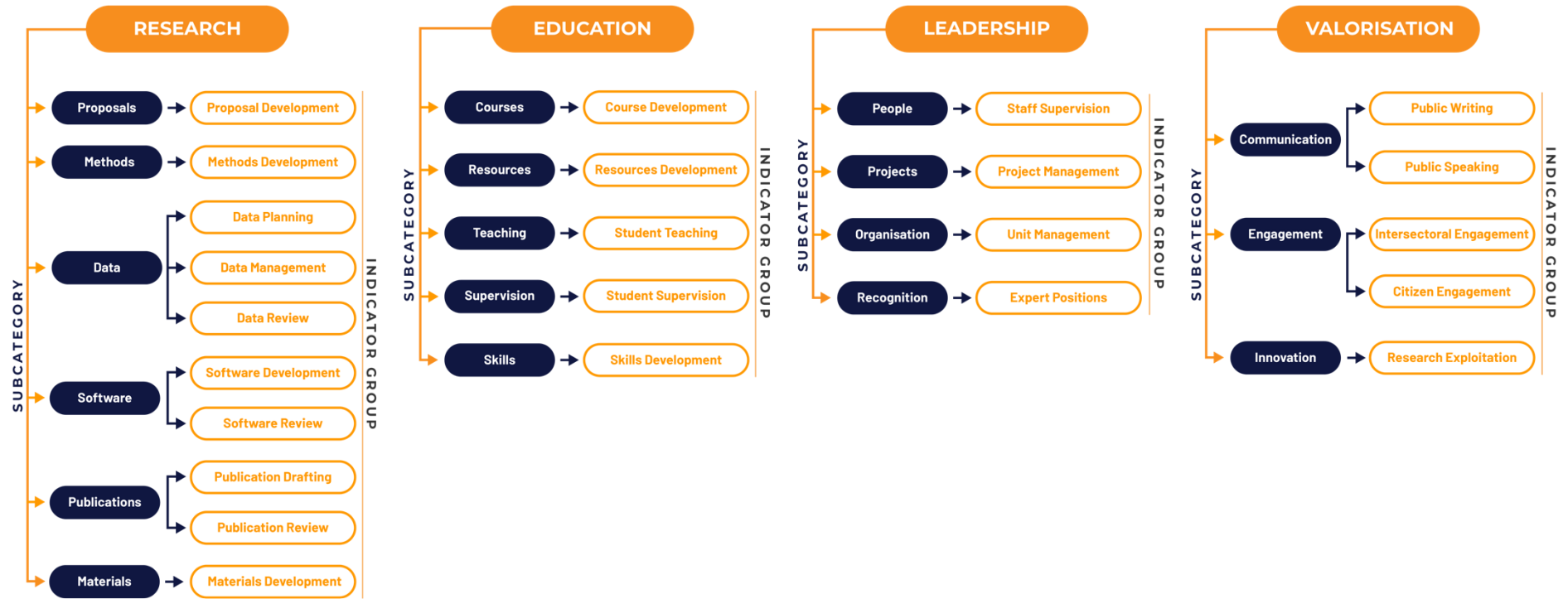
- Research:
 - Proposals = Proposal Development
 - Methods = Methods Development
 - Data = Data Planning, Data Management, and Data Review
 - Software = Software Development and Software Review
 - Publications = Publication Drafting and Publication Review
 - Materials = Materials Development
- Education:
 - Courses = Course Development
 - Resources = Resource Development
 - Teaching = Student Teaching
 - Supervision = Student Supervision
 - Skills = Skills Development
- Leadership:
 - People = Staff Supervision
 - Projects = Project Management
 - Organisation = Unit Management
 - Recognition = Expert Positions
- Valorisation:
 - Communication = Public Writing and Public Speaking
 - Engagement = Intersectoral Engagement and Citizen Engagement
 - Innovation = Research Exploitation

Each indicator group further consists of **3 types of indicators**⁶ defining the lifecycle of an activity:

- Process: Activity which is in development or is ongoing
- Output: Clear endpoint or tangible product of a process
- Outcome: Immediate or short-term result of an output

The RAF is designed to comprehensively cover the **full spectrum of researcher activities** and offer researchers the possibility to be assessed on all relevant activities in a given assessment period, rather than solely on the traditional metrics of number of peer-reviewed publications and citations and journal impact factor (JIF). The inclusion of Open Science metrics in a given RAF at an RPO or RFO ensures that Open Science activities are explicitly recognised in the assessment. It remains the prerogative of RPOs and RFOs to determine how exactly to reward researchers for Open Science.

Figure 1: Categories, Subcategories, and Indicator Groups of Researcher Assessment Framework



3. Generic Researcher Assessment Framework

3.1. Research

The research category consists of 6 subcategories for proposals, methods, data, software, publications, and materials with associated generic indicators/metrics for researcher assessment.

3.1.1. Proposals

This subcategory focuses on proposals for research projects to an RPO or RFO as in Table 1. The qualitative description of the proposal may include the associated funding call and roles, activities, and efforts of the researchers involved in the proposal development and in the to-be-granted project.

Table 1: Generic Indicators for Category Research Subcategory Proposals

Indicator Group	Indicator Type	Indicator
Proposal Development	Process	Project Proposals Being Developed
	Output	Project Proposals Submitted
	Outcome	Project Proposals Granted

3.1.2. Methods

This subcategory focuses on methods to conduct research as in Table 2. There is flexibility in the definition of 'methods' which may include research methodologies and protocols. There is also flexibility in how the method sets are 'implemented' such as by the researcher themselves or by others, how the method sets are 'accessed' which may include restricted forms of access, and how the method sets are 'cited' which may be dependent on standard practices within a specific discipline.

Table 2: Generic Indicators for Category Research Subcategory Methods

Indicator Group	Indicator Type	Indicator
Methods Development	Process	Method Sets Being Developed
	Output	Method Sets Finalised
	Outcome	Method Sets Implemented
		Method Sets Accessed
		Method Sets Cited

3.1.3. Data

This subcategory focuses on research data planning, management, and peer review as in Table 3. There is flexibility in the definition of 'data management plan', which may be dependent on standard practices within a specific discipline. There is also flexibility in the inclusion or exclusion of a focus on adopting the Findable, Accessible, Interoperable, and Reusable (FAIR) principles for research data [25].

There is further flexibility in how data sets are 'archived' which may be in a trusted repository with(out) long-term preservation, how data sets are 'accessed' including restricted forms of access, and how data sets are 'cited' which may depend on standard practices within a specific discipline. Data set peer reviews involve formal peer review requested by an academic venue or publisher.

Table 3: Generic Indicators for Category Research Subcategory Data

Indicator Group	Indicator Type	Indicator
Data Planning	Process	(FAIR) Data Management Plans Being Developed
	Output	(FAIR) Data Management Plans Finalised
	Outcome	(FAIR) Data Management Plans Implemented
Data Management	Process	(FAIR) Data Sets Being Developed
	Output	(FAIR) Data Sets Finalised
		(FAIR) Data Sets Archived
	Outcome	(FAIR) Data Sets Accessed
(FAIR) Data Sets Cited		
Data Review	Process	(FAIR) Data Set Peer Reviews Being Drafted
	Output	(FAIR) Data Set Peer Reviews Submitted
	Outcome	(FAIR) Data Set Peer Reviews Accepted

3.1.4. Software

This subcategory focuses on research software development and peer review as in Table 4. There is flexibility in the definition of 'software', which may include algorithms, code, and packages. There is also flexibility in how the software sets are 'archived' which may be in a trusted repository with(out) long-term preservation, how the software sets are 'accessed' including restricted forms of access, and how the software sets are 'cited' which may be dependent on standard practices within a specific discipline. Software set peer reviews may include non-editorial board and security check requests.

Table 4: Generic Indicators for Category Research Subcategory Software

Indicator Group	Indicator Type	Indicator
Software Development	Process	Software Sets Being Developed
	Output	Software Sets Finalised
		Software Sets Archived
	Outcome	Software Sets Accessed
Software Sets Cited		
Software Review	Process	Software Set Peer Reviews Being Drafted
	Output	Software Set Peer Reviews Submitted
	Outcome	Software Set Peer Reviews Accepted

3.1.5. Publications

This subcategory focuses on research publications and peer reviews as in Table 5. There is flexibility in the definition of 'publications', which may include books, chapters, and articles. There is also flexibility for the recognition of the JIF of the academic venue or publisher. There is further flexibility in how publications are 'archived' which may be in a trusted repository with(out) long-term preservation, how publications are 'accessed' including restricted forms of access, and how publications are 'cited' which may depend on standard practices within a discipline. Publication peer reviews always involve formal peer review which is requested by an (editorial board of an) academic venue or publisher.

Table 5: Generic Indicators for Category Research Subcategory Publications

Indicator Group	Indicator Type	Indicator
Publication Drafting	Process	Publications Being Drafted
	Output	Publications Submitted
	Outcome	Publications Published
		Publications Accessed
	Publications Cited	
Publication Review	Process	Publication Peer Reviews Being Drafted
	Output	Publication Peer Reviews Submitted
	Outcome	Publication Peer Reviews Accepted

3.1.6. Materials

This subcategory focuses on research materials as in Table 6. There is flexibility in the definition of 'materials' which may include artwork, tools, instruments, and hardware. There is also flexibility in how the material sets are 'implemented' and 'accessed' which may be dependent on the type of materials, and how the material sets are 'cited' which may be dependent on standard practices in a discipline.

Table 6: Generic Indicators for Category Research Subcategory Materials

Indicator Group	Indicator Type	Indicator
Materials Development	Process	Material Sets Being Developed
	Output	Material Sets Finalised
	Outcome	Material Sets Implemented
		Material Sets Accessed
		Material Sets Cited

3.2. Education

The education category consists of 5 subcategories for courses, resources, teaching, supervision, and skills development with associated generic indicators/metrics for researcher assessment.

3.2.1. Courses

This subcategory focuses on educational courses as in Table 7. There is flexibility in the definition of 'courses' which may include variation in the scope and duration of the courses. There is also flexibility in how the courses are 'implemented' such as by the researcher themselves or by other researchers.

Table 7: Generic Indicators for Category Education Subcategory Courses

Indicator Group	Indicator Type	Indicator
Course Development	Process	Courses Being Developed
	Output	Courses Finalised
	Outcome	Courses Implemented

3.2.2. Resources

This subcategory focuses on educational resources as in Table 8. There is flexibility in the definition of 'resources' which may include articles, books, recordings, images, games, and digital tools. There is also flexibility in how the resources are 'implemented', 'accessed', and 'cited' which may depend on the type of resources and also on the standard practices for resources within a specific discipline.

Table 8: Generic Indicators for Category Education Subcategory Resources

Indicator Group	Indicator Type	Indicator
Resource Development	Process	Resources Being Developed
	Output	Resources Finalised
	Outcome	Resources Implemented
		Resources Accessed
		Resources Cited

3.2.3. Teaching

This subcategory focuses on teaching students and courses as in Table 9. There is flexibility in the definition of 'courses' which may include variation in course scope and duration as well as 'students' which may include bachelor, master, and if applicable doctoral students. There is also flexibility in the number of students 'passed in courses' which may be the number per course or total across courses.

Table 9: Generic Indicators for Category Education Subcategory Teaching

Indicator Group	Indicator Type	Indicator
Student Teaching	Process	Course Hours Assigned
	Output	Courses Hours Taught
	Outcome	Students Passed in Courses

3.2.4. Supervision

This subcategory focuses on supervising students as in Table 10. There is flexibility in the definition of 'supervision' which may include mentoring students and supervision of student theses as well as in the definition of 'students' which may include bachelor, master, and if applicable doctoral students.

Table 10: Generic Indicators for Category Education Subcategory Supervision

Indicator Group	Indicator Type	Indicator
Student Supervision	Process	Students Being Supervised
	Output	Students Supervised
	Outcome	Supervised Student Theses
		Supervised Students Graduated

3.2.5. Skills

This subcategory focuses on skills development by researchers as in Table 11. There is flexibility in the definition of 'courses' and 'certificates' which may include variation in course scope and duration. The courses and certificates may cover any research, education, leadership, and valorisation skills.

Table 11: Generic Indicators for Category Education Subcategory Skills

Indicator Group	Indicator Type	Indicator
Skills Development	Process	Skills Courses Being Followed
	Output	Skills Courses Completed
	Outcome	Skills Certificates Obtained

3.3. Leadership

The leadership category consists of 4 subcategories for managing people, projects, organisational units, and recognition with associated generic indicators/metrics for researcher assessment.

3.3.1. People

This subcategory focuses on supervising staff as in Table 12. There is flexibility in the definition of 'supervision' which may include mentoring staff and supervision of (post)doctoral theses as well as 'staff' which may include local and visiting (post)doctoral and senior researchers and other staff. There is also flexibility in the definition of 'theses' which may include (post)doctoral theses as well as 'projects' which may include research and non-research projects managed by supervised staff.

Table 12: Generic Indicators for Category Leadership Subcategory People

Indicator Group	Indicator Type	Indicator
Staff Supervision	Process	Staff being Supervised
	Output	Staff Supervised
	Outcome	Supervised Staff Theses
		Supervised Staff Projects

3.3.2. Projects

This subcategory focuses on managing projects as in Table 13. There is flexibility in the definition of 'projects' which may be funded or non-funded but should involve official management responsibility. A project which is 'successfully evaluated' has been formally reviewed and successfully closed.

Table 13: Generic Indicators for Category Leadership Subcategory Projects

Indicator Group	Indicator Type	Indicator
Project Management	Process	Projects Being Managed
	Output	Projects Completed
	Outcome	Projects Successfully Evaluated

3.3.3. Organisation

This subcategory focuses on managing organisational units as in Table 14. There is flexibility in the definition of 'units' which may include a team, group, institute, faculty, or university. The 'positions' should involve official management responsibility. There is also flexibility in the selection of 'unit management outputs' and 'unit management outcomes' which could be taken from relevant outputs and outcomes already identified in the RAF and should be formally agreed within the organisation.

Table 14: Generic Indicators for Category Leadership Subcategory Organisation

Indicator Group	Indicator Type	Indicator
Unit Management	Process	Unit Management Positions Assigned
	Output	Unit Management Positions Completed
		Agreed Unit Management Outputs
	Outcome	Agreed Unit Management Outcomes

3.3.4. Recognition

This subcategory focuses on the recognition of researchers through expert positions as in Table 15. There is flexibility in the definition of 'expert positions' including invited strategic, advisory, and honorary roles which recognise researchers for their expertise and experience. There is also flexibility in the definition of 'expert position outputs' which may include meetings, presentations, and reports as well as 'expert position outcomes' depending on the type of expert position. The 'achievement awards' may be for any recognised research, education, leadership, and valorisation contributions.

Table 15: Generic Indicators for Category Leadership Subcategory Recognition

Indicator Group	Indicator Type	Indicator
Expert Positions	Process	Expert Positions Assigned
	Output	Expert Positions Completed
		Expert Position Outputs
	Outcome	Expert Position Outcomes
Expert Achievement Awards		

3.4. Valorisation

The valorisation category consists of 3 subcategories for communication, engagement, and innovation activities along with associated generic indicators/metrics for researcher assessment.

3.4.1. Communication

This subcategory focuses on research communication via public writing and public speaking as in Table 16. There is flexibility in the definition of 'publications' which may include print and social media and 'appearances' which may be physical or digital and include talks, conferences, workshops, and recordings. There is also flexibility in the definition of 'accessed' which may include readership, attendees, views, and downloads and 'cited' which may include mentions in print and social media.

Table 16: Generic Indicators for Category Valorisation Subcategory Communication

Indicator Group	Indicator Type	Indicator
Public Writing	Process	Publications Being Drafted
	Output	Publications Published
	Outcome	Publications Accessed
Publications Cited		
Public Speaking	Process	Appearances Planned
	Output	Appearances Made
	Outcome	Appearances Accessed
		Appearances Cited

3.4.2. Engagement

This subcategory focuses on intersectoral and citizen engagement as in Table 17. There is flexibility in the definition of 'intersectoral' which may include academic, public, and private organisations and 'collaborations' which may include research collaboration, staff secondments and exchanges, volunteering and advocacy, and policy development. There is also flexibility in the definition of 'citizen science', which may include any research activities with citizens and encompass activities in projects with a citizen science dimension or full projects on citizen science. There is also flexibility in the selection

of 'intersectoral outputs' and 'intersectoral outcomes' as well as 'citizen science outputs' and 'citizen science outcomes' which could be taken from relevant outputs and outcomes in the RAF.

Table 17: Generic Indicators for Category Valorisation Subcategory Engagement

Indicator Group	Indicator Type	Indicator
Intersectoral Engagement	Process	Intersectoral Engagements
	Output	Intersectoral Outputs
	Outcome	Intersectoral Outcomes
Organisations Engaged		
Citizen Engagement	Process	Citizen Science Activities Ongoing
	Output	Citizen Science Activities Completed
		Citizen Science Outputs
	Outcome	Citizen Science Outcomes
Citizen Scientists Engaged		

3.4.3. Innovation

This subcategory focuses on the innovation of research through research exploitation and entrepreneurial spirit as in Table 18. There is flexibility in the definition of 'being legalised', including defining Intellectual Property Rights (IPR), patenting, and licensing of research outputs, which may include innovative products and services. There is also flexibility in the size of spin-offs and start-ups as well as the definition of 'employees' in terms of number of people or Full Time Equivalent (FTE).

Table 18: Generic Indicators for Category Valorisation Subcategory Innovation

Indicator Group	Indicator Type	Indicator
Research Exploitation	Process	Research Outputs Being Legalised
	Output	Research Outputs with Defined IPR
		Research Outputs Patented
Outcome	Research Outputs with Licenses	
Entrepreneurial Spirit	Process	Spin-offs/Start-ups Being Created
	Output	Spin-offs/Start-ups Created
	Outcome	Spin-off/Start-up Employees
		Spin-off/Start-up Products
Spin-off/Start-up Services		

4. Open Science Researcher Assessment Framework

4.1. Research

The research category consists of 6 subcategories for proposals, methods, data, software, publications, and materials with Open Science indicators/metrics for researcher assessment.

4.1.1. Proposals

This subcategory focuses on proposals for research projects to an RPO or RFO which are openly available as in Table 19. There is flexibility in how the proposals are made 'openly available'.

Table 19: Open Science Indicators for Category Research Subcategory Proposals

Indicator Group	Indicator Type	Indicator
Proposal Development	Process	Developing Project Proposals Openly Available
	Output	Submitted Project Proposals Openly Available
	Outcome	Granted Project Proposals Openly Available

4.1.2. Methods

This subcategory focuses on methods to conduct research which are openly available as in Table 20. There is flexibility in how the method sets are actually made 'openly available' for use by the public.

Table 20: Open Science Indicators for Category Research Subcategory Methods

Indicator Group	Indicator Type	Indicator
Methods Development	Process	Developing Method Sets Openly Available
	Output	Finalised Method Sets Openly Available
	Outcome	Openly Available Method Sets Implemented
		Openly Available Method Sets Accessed
	Openly Available Method Sets Cited	

4.1.3. Data

This subcategory focuses on research data planning, management, and peer review which are openly available as in Table 21. There is flexibility in the inclusion or exclusion of a focus on FAIR and how data management plans, data sets, and data peer reviews are made 'openly available' for public use.

Table 21: Open Science Indicators for Category Research Subcategory Data

Indicator Group	Indicator Type	Indicator
Data Planning	Process	(FAIR) Developing Data Management Plans Openly Available
	Output	(FAIR) Finalised Data Management Plans Openly Available
	Outcome	(FAIR) Implemented Data Management Plans Openly Available
Data Management	Process	Developing (FAIR) Data Sets Openly Available
	Output	Finalised (FAIR) Data Sets Openly Available
		Archived (FAIR) Data Sets Openly Available
	Outcome	Openly Available (FAIR) Data Sets Accessed
Openly Available (FAIR) Data Sets Cited		
Data Review	Process	Draft (FAIR) Data Set Peer Reviews Openly Available
	Output	Submitted (FAIR) Data Set Peer Reviews Openly Available
	Outcome	Accepted (FAIR) Data Set Peer Reviews Openly Available

4.1.4. Software

This subcategory focuses on research software development and peer review which are openly available as in Table 22. There is flexibility in software sets and peer reviews being 'openly available'.

Table 22: Open Science Indicators for Category Research Subcategory Software

Indicator Group	Indicator Type	Indicator
Software Development	Process	Developing Software Sets Openly Available
	Output	Finalised Software Sets Openly Available
		Archived Software Sets Openly Available
	Outcome	Openly Available Software Sets Accessed
Openly Available Software Sets Cited		
Software Review	Process	Draft Software Set Peer Reviews Openly Available
	Output	Submitted Software Set Peer Reviews Openly Available
	Outcome	Accepted Software Set Peer Reviews Openly Available

4.1.5. Publications

This subcategory focuses on research publications and peer reviews which are openly available as in Table 23. There is flexibility in how the publications and peer reviews are made 'openly available'. There is also flexibility in the version of the publication which may be a preprint, Author Accepted Manuscript (AAM), or Version of Record (VoR) as well as the type of open access such as green or gold. There is further flexibility in whether the publications adhere to the principles of Plan S [26].

Table 23: Open Science Indicators for Category Research Subcategory Publications

Indicator Group	Indicator Type	Indicator
Publication Drafting	Process	Draft Publications Openly Available
	Output	Submitted Publications Openly Available
	Outcome	Published Publications Openly Available
		Openly Available Publications Accessed
Publication Review	Process	Draft Publication Peer Reviews Openly Available
	Output	Submitted Publication Peer Reviews Openly Available
	Outcome	Accepted Publication Peer Reviews Openly Available

4.1.6. Materials

This subcategory focuses on research materials which are openly available as in Table 24. There is flexibility in how the material sets are made 'openly available' depending on the type of materials.

Table 24: Open Science Indicators for Category Research Subcategory Materials

Indicator Group	Indicator Type	Indicator
Materials Development	Process	Developing Material Sets Openly Available
	Output	Finalised Material Sets Openly Available
	Outcome	Implemented Material Sets Openly Available
		Openly Available Material Sets Accessed
		Openly Available Material Sets Cited

4.2. Education

The education category consists of 5 subcategories for courses, resources, teaching, supervision, and skills development with related Open Science indicators/metrics for researcher assessment.

4.2.1. Courses

This subcategory focuses on educational courses which are on Open Science or openly available as in Table 25. There is flexibility in the definition of courses on 'Open Science' which may focus on many or specific Open Science practices as well as how the courses are made 'openly available'.

Table 25: Open Science Indicators for Category Education Subcategory Courses

Indicator Group	Indicator Type	Indicator
Course Development	Process	Open Science Courses Being Developed
		Developing Courses Openly Available
	Output	Open Science Courses Finalised
		Finalised Courses Openly Available
	Outcome	Open Science Courses Implemented
		Implemented Courses Openly Available

4.2.2. Resources

This subcategory focuses on educational resources which are on Open Science or openly available as in Table 26. There is flexibility in the definition of resources on 'Open Science' which may focus on many or specific Open Science practices as well as how the resources are made 'openly available'.

Table 26: Open Science Indicators for Category Education Subcategory Resources

Indicator Group	Indicator Type	Indicator
Resource Development	Process	Open Science Resources Being Developed
		Developing Resources Openly Available
	Output	Open Science Resources Finalised
		Finalised Resources Openly Available
	Outcome	Open Science Resources Implemented
		Implemented Resources Openly Available

4.2.3. Teaching

This subcategory focuses on teaching students and courses which are on Open Science or openly available as in Table 27. There is flexibility in the definition of courses on 'Open Science' which may focus on many or specific Open Science practices as well as how the courses are 'openly available'.

Table 27: Open Science Indicators for Category Education Subcategory Teaching

Indicator Group	Indicator Type	Indicator
Student Teaching	Process	Open Science Course Hours Assigned
	Output	Open Science Course Hours Taught
	Outcome	Students Passed in Open Science Courses
		Students Passed in Openly Available Courses

4.2.4. Supervision

This subcategory focuses on supervising students in Open Science and making student theses openly available as in Table 28. There is flexibility in the definition of 'Open Science' which may include many or specific Open Science practices and how the student theses are 'openly available'.

Table 28: Open Science Indicators for Category Education Subcategory Supervision

Indicator Group	Indicator Type	Indicator
Student Supervision	Process	Students Being Supervised in Open Science
	Output	Students Supervised in Open Science
	Outcome	Supervised Student Theses Openly Available
		Supervised Students in Open Science Graduated

4.2.5. Skills

This subcategory focuses on skills development in Open Science by researchers as in Table 29. There is flexibility in the definition of 'courses' and 'certificates' which may include variation in course scope and duration and 'Open Science' which may focus on many or specific Open Science practices. Courses and certificates may cover research, education, leadership, and valorisation skills.

Table 29: Open Science Indicators for Category Education Subcategory Skills

Indicator Group	Indicator Type	Indicator
Skills Development	Process	Open Science Skills Courses Being Followed
	Output	Open Science Skills Courses Completed
	Outcome	Open Science Skills Certificates Obtained

4.3. Leadership

The leadership category consists of 4 subcategories for people, project, and organisational unit management and recognition with Open Science indicators/metrics for researcher assessment.

4.3.1. People

This subcategory focuses on supervising staff in Open Science as in Table 30. There is flexibility in the definition of 'Open Science' which may include many or specific Open Science practices. There is also flexibility in how these are 'openly available' and how projects are 'involving Open Science'.

Table 30: Open Science Indicators for Category Leadership Subcategory People

Indicator Group	Indicator Type	Indicator
Staff Supervision	Process	Staff Being Supervised in Open Science
	Output	Staff Supervised in Open Science
	Outcome	Supervised Staff Theses Openly Available
		Supervised Staff Projects involving Open Science

4.3.2. Projects

This subcategory focuses on managing projects involving Open Science as in Table 31. There is flexibility in the definition of 'involving Open Science' which may include variation in the scope and duration of projects and 'Open Science' which may include many or specific Open Science practices.

Table 31: Open Science Indicators for Category Leadership Subcategory Projects

Indicator Group	Indicator Type	Indicator
Project Management	Process	Projects involving Open Science Being Managed
	Output	Projects involving Open Science Completed
	Outcome	Projects involving Open Science Successfully Evaluated

4.3.3. Organisation

This subcategory focuses on managing organisational units involving Open Science as in Table 32. There is flexibility in the definition of 'Open Science' which may include many or specific Open Science practices. There is also flexibility in the selection of 'unit management outputs' and 'unit management outcomes' involving Open Science, which could be taken from relevant outputs and outcomes already identified in the RAF and should be formally agreed within the organisation.

Table 32: Open Science Indicators for Category Leadership Subcategory Organisation

Indicator Group	Indicator Type	Indicator
Unit Management	Process	Unit Management Positions in Open Science Assigned
	Output	Unit Management Positions in Open Science Completed
		Agreed Unit Management Outputs involving Open Science
	Outcome	Agreed Unit Management Outcomes involving Open Science

4.3.4. Recognition

This subcategory focuses on the recognition of researchers through expert positions in Open Science as in Table 33. There is flexibility in the definition of 'Open Science' including many or specific practices and how 'expert position outputs' and 'expert position outcomes' are 'openly available'.

Table 33: Open Science Indicators for Category Leadership Subcategory Recognition

Indicator Group	Indicator Type	Indicator
Expert Positions	Process	Expert Positions in Open Science Assigned
	Output	Expert Positions in Open Science Completed
		Open Science Expert Position Outputs
		Expert Position Outputs Openly Available
	Outcome	Expert Position Outcomes Openly Available
		Expert Achievement Awards for Open Science

4.4. Valorisation

The valorisation category consists of 3 subcategories for communication, engagement, and innovation along with associated Open Science indicators/metrics for researcher assessment.

4.4.1. Communication

This subcategory focuses on research communication via public writing and public speaking which is openly available as in Table 34. There is flexibility in how the publications and appearances are made 'openly available' and also in the definition of 'Open Science' including many or specific practices.

Table 34: Open Science Indicators for Category Valorisation Subcategory Communication

Indicator Group	Indicator Type	Indicator
Public Writing	Process	Draft Publications Openly Available
	Output	Published Publications Openly Available
	Outcome	Openly Available Publications Accessed
		Openly Available Publications Cited
Public Speaking	Process	Appearances on Open Science Planned
	Output	Appearances on Open Science Given
	Outcome	Appearances on Open Science Accessed
		Appearances on Open Science Cited
		Appearances Openly Available

4.4.2. Engagement

This subcategory focuses on intersectoral and citizen engagement involving Open Science as in Table 35. There is flexibility in the definition of 'Open Science' including many or specific Open Science practices. There is also flexibility in the selection of 'intersectoral outputs' and 'intersectoral outcomes' as well as 'citizen science outputs' and 'citizen science outcomes' for Open Science, which could be taken from relevant outputs and outcomes for Open Science already identified in the RAF.

Table 35: Open Science Indicators for Category Valorisation Subcategory Engagement

Indicator Group	Indicator Type	Indicator
Intersectoral Engagement	Process	Intersectoral Engagements involving Open Science
	Output	Intersectoral Outputs involving Open Science
	Outcome	Intersectoral Outcomes involving Open Science
Organisations Engaged for Open Science		
Citizen Engagement	Process	Citizen Science Activities involving Open Science Ongoing
	Output	Citizen Science Activities involving Open Science Completed
		Citizen Science Outputs involving Open Science
	Outcome	Citizen Science Outcomes involving Open Science
		Citizen Scientists Engaged in Open Science

4.4.3. Innovation

This subcategory focuses on the open innovation of research including research exploitation and entrepreneurial spirit involving Open Science as in Table 36. There is flexibility in the definition of 'Open Science' including many or specific Open Science practices and how research outputs are 'openly available'. Spin-offs and start-ups may be focused on supporting or exploiting Open Science.

Table 36: Open Science Indicators for Category Valorisation Subcategory Innovation

Indicator Group	Indicator Type	Indicator
Research Exploitation	Process	Openly Available Research Outputs Being Legalised
	Output	Openly Available Research Outputs with Defined IPR
		Openly Available Research Outputs Patented
	Outcome	Research Outputs with Open Licenses
Entrepreneurial Spirit	Process	Open Science Spin-offs/Start-ups Being Created
	Output	Open Science Spin-offs/Start-ups Created
	Outcome	Open Science Spin-off/Start-up Employees
		Open Science Spin-off/Start-up Products
		Open Science Spin-off/Start-up Services

5. Conclusion

The **RAF is a framework to reform the assessment of researchers and incentivise and reward Open Science** in their applications for projects and positions as well as in their project and career development and progression at RPOs and RFOs. The RAF offers a framework which covers the full spectrum of research, education, leadership, and valorisation activities by researchers and which is applicable across countries, disciplines, and organisations. The RAF allows a quantitative and qualitative approach to implementing the indicators in the framework. The RAF also combines a generic and Open Science approach to assessment, whereby the generic framework recognises all activities and the Open Science framework recognises Open Science activities by researchers. The RAF further distinguishes process, output, and outcome indicators to capture the lifecycle of researcher activities and formulates relevant indicators/metrics at a high level of description for broad application.

The **RAF offers a comprehensive suite of indicators/metrics which can be selected and refined** according to the strategic interests and needs of RPOs and RFOs. It remains the prerogative of the organisations to select, refine, prioritise, and rank or weight the indicators/metrics for their own researcher assessment. It also remains the prerogative of the organisations to include relevant indicators/metrics for Open Science and how exactly to reward researchers for practising Open Science. While the RAF is focused on the assessment of individual researchers, there must be a comparative benchmarking of peer groups of researchers at a given RPO and RFO. An individual researcher cannot be assessed in isolation but must be compared to either standardised results or actual results for a given assessment period for selected indicators/metrics for a specific peer group. Such peer groups could be defined according to researcher stage or research discipline or organisational unit. The successful implementation of the RAF will require tailored interventions to support adoption of the RAF and help researchers understand and use the RAF at RPOs and RFOs.

The **first draft of the RAF will be subject to extensive consultation with key stakeholders** in research assessment. The RAF will be piloted by 3 RPOs and 2 RFOs in OPUS, will be sent for feedback to key organisations, and will be openly shared with the research community. Questions remain if the RAF is comprehensive enough and captures all relevant activities by researchers, if the right categories and indicator groups have been selected, if the distinction in indicator types is useful, and if the right indicators have been selected and are formulated at the right level of description. Questions also remain about the implementation of the RAF at RPOs and RFOs including the interplay between the generic and Open Science dimensions, interplay between the quantitative and qualitative approaches, selection and refinement and prioritisation of specific indicators/metrics, and actual translation of the RAF into questionnaires and digital tools to be used by researchers. These questions will be addressed in future deliverables on the RAF and interventions in the OPUS project.

End Notes

¹ There are 5 pilot organisations in OPUS. The 3 pilot RPOs are Nova University of Lisbon, University of Cyprus, and University of Rijeka. The 2 pilot RFOs are Research Council of Lithuania and Executive Agency for Higher Education, Research, Development, and Innovation Funding.

² We would like to thank Amanda Crowfoot, Barend Mons, Cecilia Cabello Valdés, Volker Beckmann, and Wilhelm Widmark for their extensive input and feedback on the framework and deliverables.

³ We would like to thank Association of European Research Libraries (LIBER), Coalition for Advancing Research Assessment (CoARA), cOAlition S, EOSC Steering Board, and European Organisation for Nuclear Research (CERN) for preliminary discussions on the framework.

⁴ We would like to thank Clifford Tatum, Ismael Refols Garcia, Karel Luijben, Ludo Waltman, Mark van de Sanden, Paolo Budroni, and Rob Johnson for extensive discussions on the framework, reforming research assessment, and indicators/metrics for researcher assessment and Open Science.

⁵ This report refers consistently to 'indicators/metrics' as requested in the project call but in reality focuses on indicators and does not describe all possible qualitative and quantitative indicator values.

⁶ Five types of indicators were originally considered: Input; Process; Output; Outcome; Impact. The input indicator was ruled out as this was not deemed relevant for the activities of researchers. The impact indicator was also ruled out as this typically looks at long-term and societal impact which is difficult to define and causally prove within the scope of individual researcher assessment.

References

- [1] Webpage of the Open Universal Science (OPUS) project on CORDIS hosted by the European Commission. Link: [<https://cordis.europa.eu/project/id/101058471>]. Accessed 12 January 2024.
- [2] Day, Emma (2023) *Interventions to Test in the Pilots*. Deliverable D2.1 of the Open Universal Science (OPUS) project. To be published in 2023.
- [3] Huntingford, Jessica, Juliana Chaves Chaparro, John Crowley, Emma Day, Katarina Haluskova, Fleur Lehardt, Dragana Mitrovic, and Gareth O'Neill (2023) *Initial State-of-the-Art on an Open Science Ecosystem*. Deliverable D1.2 of the Open Universal Science (OPUS) project. To be published in 2023.
- [4] Website of the San Francisco Declaration on Research Assessment (DORA). Link: [<https://sfdora.org>]. Accessed 12 January 2024.
- [5] Website of the Leiden Manifesto for Research Metrics. Link: [<http://www.leidenmanifesto.org>]. Accessed 12 January 2024.
- [6] Webpage of the Hong Kong Principles hosted by the World Conference on Research Integrity Foundation (WCRIF). Link: [<https://www.wcrif.org/guidance/hong-kong-principles>]. Accessed 12 January 2024.
- [7] Open Science Policy Platform (OSPP) (2018) *OSPP-REC. Open Science Policy Platform Recommendations*. Link: [<https://op.europa.eu/en/publication-detail/-/publication/5b05b687-907e-11e8-8bc1-01aa75ed71a1>]. Accessed 12 January 2024.
- [8] Open Science Policy Platform (OSPP) (2020) *Progress on Open Science. Towards a Shared Research Knowledge System*. Link: [<https://op.europa.eu/en/publication-detail/-/publication/d36f8071-99bd-11ea-aac4-01aa75ed71a1>]. Accessed 12 January 2024.
- [9] United Nations Educational, Scientific, and Cultural Organisation (UNESCO) (2017) *Recommendation on Science and Scientific Researchers*. Annex II of the Records of the 39th Session of the UNESCO General Conference. Link: [<https://unesdoc.unesco.org/ark:/48223/pf0000260889>]. Accessed 12 January 2024.
- [10] United Nations Educational, Scientific, and Cultural Organisation (UNESCO) (2021) *Recommendation on Open Science*. Link: [<https://unesdoc.unesco.org/ark:/48223/pf0000379949>]. Accessed 12 January 2024.
- [11] Webpage of the Agreement on Reforming Research Assessment hosted by the Coalition for Advancing Research Assessment (CoARA) Link: [<https://coara.eu/agreement/the-agreement-full-text>]. Accessed 12 January 2024.
- [12] European Research Area and Innovation Committee (ERAC) Triangle Task Force (2021) *Research*

Evaluation in a Context of Open Science and Gender Equality. Link: [<https://data.consilium.europa.eu/doc/document/ST-1201-2021-INIT/en/pdf>]. Accessed 12 January 2024.

[13] European Council (2022) *Council Conclusions on Research Assessment and Implementation of Open Science*. Conclusions adopted by the European Council at European Council Meeting 3877 in June 2022. Link: [<https://www.consilium.europa.eu/media/56958/st10126-en22.pdf>]. Accessed 12 January 2024.

[14] European Commission (2023) *Technical Document on a European Framework for Research Careers*. Unpublished document for the European Research Area and Innovation Committee (ERAC) Plenary Meeting in February 2023.

[15] Vitae (2011) *Researcher Development Framework*. Link: [<https://www.vitae.ac.uk/vitae-publications/rdf-related/researcher-development-framework-rdf-vitae.pdf>]. Accessed 12 January 2024.

[16] O'Carroll, Conor, Cecilia Cabello Valdés, Fulvio Esposito, Eeva Kaunismaa, Karen Maas, David McAllister, Janet Metcalfe, Bernard Rentier, and Karen Vandeveld (2017) *Evaluation of Research Careers Fully Acknowledging Open Science Practices. Rewards, Incentives, and/or Recognition for Researchers Practising Open Science*. Link: [<https://op.europa.eu/en/publication-detail/-/publication/47a3a330-c9cb-11e7-8e69-01aa75ed71a1>]. Accessed 12 January 2024.

[17] Wilsdon, James, Judit Bar-Ilan, Robert Frodeman, Elisabeth Lex, Isabella Peters, and Paul Wouters (2017) *Next-generation Metrics. Responsible Metrics and Evaluation for Open Science*. Link: [<https://op.europa.eu/en/publication-detail/-/publication/b858d952-0a19-11e7-8a35-01aa75ed71a1>]. Accessed 12 January 2024.

[18] Rossel, Christophe, Marta Dias Agostinho, Kristiina Hormia-Poutanen, Ernst Kristiansen, Rebecca Lawrence, Sabina Leonelli, Natalia Manola, Eva Méndez, and Michela Vignoli (2017) *Recommendations of the OSPP on Next-Generation Metrics*. Presentation by the Altmetrics Working Group of the Open Science Policy Platform (OSPP) in November 2017. Link: [https://projects.research-and-innovation.ec.europa.eu/sites/default/files/rio/events/Next-Generation%2520Metrics_C.%2520Rossel%2520and%2520R.%2520Lawrence.pdf] Accessed 12 January 2024.

[19] Miedema, Frank, Kim Holmberg, Sabina Leonelli, and Katja Mayer (2018) *Mutual Learning Exercise. Open Science. Altmetrics and Rewards*. Link: [<https://op.europa.eu/en/publication-detail/-/publication/449cc187-693f-11e8-ab9c-01aa75ed71a1>]. Accessed 12 January 2024.

[20] Webpage of the Open Science Monitor hosted by the European Commission. Link: [<https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open->

[science/open-science-monitor/about-open-science-monitor_en](#)]. Accessed 12 January 2024.

[21] Wouters, Paul, Alis Oancea, Ismael Ràfols Garcia, James Holbrook, Merle Jacob, and Shina Caroline Lynn Kamerlin (2019) *Indicator Frameworks for Fostering Open Knowledge Practices in Science and Scholarship*. Link: [<https://op.europa.eu/en/publication-detail/-/publication/b69944d4-01f3-11ea-8c1f-01aa75ed71a1>]. Accessed 12 January 2024.

[22] League of European Research Universities (LERU) (2022) *A Pathway towards Multidimensional Academic Careers. A LERU Framework for the Assessment of Researchers*. Link: [<https://www.leru.org/publications/a-pathway-towards-multidimensional-academic-careers-a-leru-framework-for-the-assessment-of-researchers>]. Accessed 12 January 2024.

[23] Huntingford, Jessica, Brian Cahill, Sebastian Dahle, Emma Day, and Raquel Vega (2023) *Initial State-of-the-Art on Open Science Initiatives*. Deliverable D1.1 of the Open Universal Science (OPUS) project. To be published in 2023.

[24] Webpage of the Next Generation Research Assessment to Promote Open Science (GraspOS) project on CORDIS hosted by the European Commission. Link: [<https://cordis.europa.eu/project/id/101095129>]. Accessed 12 January 2024.

[25] Wilkinson, Mark, Michel Dumontier, IJsbrand Aalbersberg, Gabrielle Appleton, Myles Axton, Arie Baak, Niklas Blomberg, Jan-Willem Boiten, Luiz Bonino da Silva Santos, Philip Bourne, Jildau Bouwman, Anthony Brookes, Tim Clark, Mercè Crosas, Ingrid Dillo, Olivier Dumon, Scott Edmunds, Chris Evelo, Richard Finkers, Alejandra Gonzalez-Beltran, Alasdair Gray, Paul Groth, Carole Goble, Jeffrey Grethe, Jaap Heringa, Peter 't Hoen, Rob Hooft, Tobias Kuhn, Ruben Kok, Joost Kok, Scott Lusher, Maryann Martone, Albert Mons, Abel Packer, Bengt Persson, Philippe Rocca-Serra, Marco Roos, Rene van Schaik, Susanna-Assunta Sansone, Erik Schultes, Thierry Sengstag, Ted Slater, George Strawn, Morris Swertz, Mark Thompson, Johan van der Lei, Erik van Mulligen, Jan Velterop, Andra Waagmeester, Peter Wittenburg, Katherine Wolstencroft, Jun Zhao, and Barend Mons (2016) *FAIR Guiding Principles for Scientific Data Management and Stewardship*. Scientific Data. Volume 3. Article Number 160018. Link: [<https://www.nature.com/articles/sdata201618>]. Accessed 12 January 2024.

[26] Webpage on the Principles and Implementation of Plan S hosted by cOAlition S: [<https://www.coalition-s.org/addendum-to-the-coalition-s-guidance-on-the-implementation-of-plan-s/principles-and-implementation>]. Accessed 12 January 2024.

Appendix 1: Researcher Assessment Framework with Indicators

Category	Subcategory	Indicator Group	Dimension	Indicator Type	Indicator	
Research	Proposals	Proposal Development	Generic	Process	Project Proposals Being Developed	
				Output	Project Proposals Submitted	
				Outcome	Project Proposals Granted	
		Open	Process	Developing Project Proposals Openly Available		
			Output	Submitted Project Proposals Openly Available		
			Outcome	Granted Project Proposals Openly Available		
		Methods	Methods Development	Generic	Process	Method Sets Being Developed
					Output	Method Sets Finalised
					Outcome	Method Sets Implemented
						Method Sets Accessed
						Method Sets Cited
					Open	Process
	Open		Output	Finalised Method Sets Openly Available		
			Outcome	Openly Available Method Sets Implemented		
				Openly Available Method Sets Accessed		
	Data	Data Planning	Generic	Process	(FAIR) Data Management Plans Being Developed	
				Output	(FAIR) Data Management Plans Finalised	
				Outcome	(FAIR) Data Management Plans Implemented	
Open		Process	(FAIR) Developing Data Management Plans Openly Available			
		Output	(FAIR) Finalised Data Management Plans Openly Available			

[Deliverable 3.1: Indicators and Metrics to Test in the Pilots]

			Outcome	(FAIR) Implemented Data Management Plans Openly Available	
		Data Management	Generic	Process	(FAIR) Data Sets Being Developed
				Output	(FAIR) Data Sets Finalised
					(FAIR) Data Sets Archived
				Outcome	(FAIR) Data Sets Accessed
					(FAIR) Data Sets Cited
			Open	Process	Developing (FAIR) Data Sets Openly Available
				Output	Finalised (FAIR) Data Sets Openly Available
					Archived (FAIR) Data Sets Openly Available
				Outcome	Openly Available (FAIR) Data Sets Accessed
					Openly Available (FAIR) Data Sets Cited
		Data Review	Generic	Process	(FAIR) Data Set Peer Reviews Being Drafted
				Output	(FAIR) Data Set Peer Reviews Submitted
				Outcome	(FAIR) Data Set Peer Reviews Accepted
			Open	Process	Draft (FAIR) Data Set Peer Reviews Openly Available
				Output	Submitted (FAIR) Data Set Peer Reviews Openly Available
				Outcome	Accepted (FAIR) Data Set Peer Reviews Openly Available
	Software	Software Development	Generic	Process	Software Sets Being Developed
				Output	Software Sets Finalised
					Software Sets Archived
				Outcome	Software Sets Accessed
					Software Sets Cited
			Open	Process	Developing Software Sets Openly Available
				Output	Finalised Software Sets Openly Available

[Deliverable 3.1: Indicators and Metrics to Test in the Pilots]

				Outcome	Archived Software Sets Openly Available Openly Available Software Sets Accessed Openly Available Software Sets Cited
		Software Review	Generic	Process	Software Set Peer Reviews Being Drafted
				Output	Software Set Peer Reviews Submitted
				Outcome	Software Set Peer Reviews Accepted
			Open	Process	Draft Software Set Peer Reviews Openly Available
				Output	Submitted Software Set Peer Reviews Openly Available
				Outcome	Accepted Software Set Peer Reviews Openly Available
	Publications	Publication Drafting	Generic	Process	Publications Being Drafted
				Output	Publications Submitted
				Outcome	Publications Published
					Publications Accessed
					Publications Cited
			Open	Process	Draft Publications Openly Available
				Output	Submitted Publications Openly Available
				Outcome	Published Publications Openly Available Openly Available Publications Accessed Openly Available Publications Cited
		Publication Review	Generic	Process	Publication Peer Reviews Being Drafted
				Output	Publication Peer Reviews Submitted
				Outcome	Publication Peer Reviews Accepted
			Open	Process	Draft Publication Peer Reviews Openly Available
				Output	Submitted Publication Peer Reviews Openly Available

[Deliverable 3.1: Indicators and Metrics to Test in the Pilots]

			Outcome	Accepted Publication Peer Reviews Openly Available	
	Materials	Materials Development	Generic	Process	Material Sets Being Developed
				Output	Material Sets Finalised
				Outcome	Material Sets Implemented
					Material Sets Accessed
					Material Sets Cited
			Open	Process	Developing Material Sets Openly Available
				Output	Finalised Material Sets Openly Available
				Outcome	Implemented Material Sets Openly Available
					Openly Available Material Sets Accessed
					Openly Available Material Sets Cited
Education	Courses	Course Development	Generic	Process	Courses Being Developed
				Output	Courses Finalised
				Outcome	Courses Implemented
			Open	Process	Open Science Courses Being Developed
					Developing Courses Openly Available
				Output	Open Science Courses Finalised
					Finalised Courses Openly Available
				Outcome	Open Science Courses Implemented
					Implemented Courses Openly Available
	Resources	Resource Development	Generic	Process	Resources Being Developed
				Output	Resources Finalised
				Outcome	Resources Implemented
					Resources Accessed

[Deliverable 3.1: Indicators and Metrics to Test in the Pilots]

					Resources Cited
			Open	Process	Open Science Resources Being Developed
					Developing Resources Openly Available
				Output	Open Science Resources Finalised
					Finalised Resources Openly Available
				Outcome	Open Science Resources Implemented
					Implemented Resources Openly Available
	Teaching	Student Teaching	Generic	Process	Course Hours Assigned
				Output	Course Hours Taught
				Outcome	Students Passed in Courses
			Open	Process	Open Science Course Hours Assigned
				Output	Open Science Course Hours Taught
				Outcome	Students Passed in Open Science Courses
					Students Passed in Openly Available Courses
	Supervision	Student Supervision	Generic	Process	Students Being Supervised
				Output	Students Supervised
				Outcome	Supervised Student Theses
					Supervised Students Graduated
			Open	Process	Students Being Supervised in Open Science
				Output	Students Supervised in Open Science
				Outcome	Supervised Student Theses Openly Available
					Supervised Students in Open Science Graduated
	Skills	Skills Development	Generic	Process	Skills Courses Being Followed
				Output	Skills Courses Completed

[Deliverable 3.1: Indicators and Metrics to Test in the Pilots]

				Outcome	Skills Certificates Obtained
			Open	Process	Open Science Skills Courses Being Followed
				Output	Open Science Skills Courses Completed
				Outcome	Open Science Skills Certificates Obtained
Leadership	People	Staff Supervision	Generic	Process	Staff Being Supervised
				Output	Staff Supervised
				Outcome	Supervised Staff Theses
					Supervised Staff Projects
			Open	Process	Staff Being Supervised in Open Science
				Output	Staff Supervised in Open Science
				Outcome	Supervised Staff Theses Openly Available
					Supervised Staff Projects involving Open Science
	Projects	Project Management	Generic	Process	Projects Being Managed
				Output	Projects Completed
				Outcome	Projects Successfully Evaluated
			Open	Process	Projects involving Open Science Being Managed
				Output	Projects involving Open Science Completed
				Outcome	Projects involving Open Science Successfully Evaluated
	Organisation	Unit Management	Generic	Process	Unit Management Positions Assigned
				Output	Unit Management Positions Completed
					Agreed Unit Management Outputs
				Outcome	Agreed Unit Management Outcomes
			Open	Process	Unit Management Positions in Open Science Assigned
				Output	Unit Management Positions in Open Science Completed

[Deliverable 3.1: Indicators and Metrics to Test in the Pilots]

			Agreed Unit Management Outputs involving Open Science		
			Agreed Unit Management Outcomes involving Open Science		
	Recognition	Expert Positions	Generic	Process	Expert Positions Assigned
				Output	Expert Positions Completed
					Expert Position Outputs
				Outcome	Expert Position Outcomes
					Expert Achievement Awards
			Open	Process	Expert Positions in Open Science Assigned
				Output	Expert Positions in Open Science Completed
					Open Science Expert Position Outputs
					Expert Position Outputs Openly Available
				Outcome	Expert Position Outcomes Openly Available
					Expert Achievement Awards for Open Science
Valorisation	Communication	Public Writing	Generic	Process	Publications Being Drafted
				Output	Publications Published
				Outcome	Publications Accessed
					Publications Cited
			Open	Process	Draft Publications Openly Available
				Output	Published Publications Openly Available
				Outcome	Openly Available Publications Accessed
					Openly Available Publications Cited
		Public Speaking	Generic	Process	Appearances Planned
				Output	Appearances Made
				Outcome	Appearances Accessed

[Deliverable 3.1: Indicators and Metrics to Test in the Pilots]

					Appearances Cited
			Open	Process	Appearances on Open Science Planned
				Output	Appearances on Open Science Given
				Outcome	Appearances on Open Science Accessed
					Appearances on Open Science Cited
					Appearances Openly Available
	Engagement	Intersectoral Engagement	Generic	Process	Intersectoral Engagements
				Output	Intersectoral Outputs
				Outcome	Intersectoral Outcomes
					Organisations Engaged
			Open	Process	Intersectoral Engagements involving Open Science
				Output	Intersectoral Outputs involving Open Science
				Outcome	Intersectoral Outcomes involving Open Science
					Organisations Engaged for Open Science
		Citizen Engagement	Generic	Process	Citizen Science Activities Ongoing
				Output	Citizen Science Activities Completed
					Citizen Science Outputs
				Outcome	Citizen Science Outcomes
					Citizen Scientists Engaged
			Open	Process	Citizen Science Activities involving Open Science Ongoing
				Output	Citizen Science Activities involving Open Science Completed
					Citizen Science Outputs involving Open Science
				Outcome	Citizen Science Outcomes involving Open Science
					Citizen Scientists Engaged in Open Science

[Deliverable 3.1: Indicators and Metrics to Test in the Pilots]

	Innovation	Research Exploitation	Generic	Process	Research Outputs Being Legalised
				Output	Research Outputs with Defined IPR
					Research Outputs Patented
				Outcome	Research Outputs with Licenses
			Open	Process	Openly Available Research Outputs Being Legalised
				Output	Openly Available Research Outputs with Defined IPR
				Outcome	Openly Available Research Outputs Patented
					Research Outputs with Open Licenses
		Entrepreneurial Spirit	Generic	Process	Spin-offs/Start-ups Being Created
				Output	Spin-offs/Start-ups Created
				Outcome	Spin-off/Start-up Employees
					Spin-off/Start-up Products
					Spin-off/Start-up Services
			Open	Process	Open Science Spin-offs/Start-ups Being Created
				Output	Open Science Spin-offs/Start-ups Created
				Outcome	Open Science Spin-off/Start-up Employees
					Open Science Spin-off/Start-up Products
					Open Science Spin-off/Start-up Services