



Project Title **Implementing FAIR Workflows: a proof of concept study in the field of consciousness**

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D3.2 Guide for funders to support FAIR workflows & enable research tracking

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Executive summary

The Implementing FAIR Workflows project is a 3-year project to implement exemplar FAIR workflows in cognitive neuroscience research, based on the existing persistent identifier (PID) and metadata infrastructure. To develop this Guide for Funders, the project team at DataCite collaborated with Crossref and ORCID to harmonize a set of recommendations for research funding organizations to actively engage in implementing various types of PIDs and metadata workflows, by committing resources, enacting congruent policies and guidelines, and providing support around grant application, management, and reporting. These workflows will provide a concrete basis for FAIR practices and output tracking, benefiting both funders and the broader research community.



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Introduction

FAIR (Findable, Accessible, Interoperable, Reusable) (Wilkinson et al., 2016) is a set of principles that describe how research outputs should be made available. Making research FAIR demands action from all stakeholders across the research sector to carefully design, pilot, validate and implement a series of workflows to either improve, replace, or introduce into their current practices. Many of these workflows rely on open scholarly infrastructure and involve the implementation of persistent identifiers (PIDs) and associated metadata.

In August 2022, the United States Office of Science and Technology Policy (OSTP) issued a memo on *"Ensuring Free, Immediate, and Equitable Access to Federally Funded Research"* that includes guidance to US federal funders on improving metadata and PID uptake¹. UK Research and Innovation (UKRI) issued similar Open Access mandates in 2021, moving from previous recommendations to firm requirements for Openness²; the Australian Research Data Commons (ARDC) commissioned report on the incentives to invest in identifiers set momentum to the development in national PID strategies (Brown, Josh, Jones, Phill, Meadows, Alice, & Murphy, Fiona., 2022). In addition, funding bodies worldwide are increasingly focusing on research infrastructure for dissemination and discovery. The Open Research Funders Group (ORFG) has captured the increasing interest among the funder community in better output tracking and published an Open Letter³ to advocate for funder best practices including the adoption of PIDs in their workflows. ORCID hosts a Funders Interest Group which meets and discusses such topics as a community of practice⁴, and Crossref hosts a funder's advisory group, which helped shape the grant registration workflows⁵.

This guide aligns with these already established efforts and aims to provide a fuller perspective on the benefits of adopting PIDs, metadata workflows and recommend concrete actions funders can take to implement them. This document was created by open scholarly infrastructure organizations DataCite, Crossref and ORCID and the first version of the guide is released as part of the Implementing FAIR Workflows project⁶, to outline the role of funders in FAIR research, and how funders can use open infrastructure and metadata to support acute output tracking needs.

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<https://www.whitehouse.gov/ostp/news-updates/2022/08/25/ostp-issues-guidance-to-make-federally-funded-research-freely-available-without-delay/>

² <https://www.ukri.org/publications/ukri-open-access-policy/>

³ ORFG_OpenLetter_OutputTracking.pdf

⁴ <https://info.orcid.org/community-groups/funders-interest-group/>

⁵ <https://www.crossref.org/working-groups/funders/>

⁶ <https://doi.org/10.54224/20568>



The introduction section starts with a brief overview of the relationship between Open science, the FAIR principles, and open scholarly infrastructure, followed by the role of funders in FAIR research. In the recommendations section, we outline the three main categories of actions funders can take:

- 1) Know and maintain funder identifiers
- 2) Create and manage grant IDs
- 3) incentivizing researchers and other stakeholders (to adopt identifier and metadata best practices.)

With these in mind, we then present a table that maps identifier and metadata usage recommendations across the research project lifecycle (Xiaoli Chen, Helena Cousijn, & Kelly Stathis., 2022), structured in tandem with the FAIR Workflows specification published earlier in the project, highlighting the connections made among funders, grants, researchers, institutes, and outputs during the process.

Open science, FAIR research, and open scholarly infrastructure

Science cannot be truly open, connected, and impactful without making open the technical and human foundation upon which it is built. Infrastructure that facilitates open sharing, persistent identification, and rich standardized metadata creation is necessary to make research and research outputs not only Open (findable and accessible), but also impactful (interoperable and reusable), in another word, FAIR. PIDs for researchers, research organizations, research funders, grants, and research outputs, together with their associated metadata, illuminate the connections that exist between entities in the research ecosystem. The connections in the metadata runs on infrastructure powered by organizations such as Crossref, ORCID, ROR, and DataCite⁷. Making research FAIR starts with uniquely identifying and describing the key entities within the research life cycle with rich metadata. Much of these workflows rely on open scholarly infrastructure and involve the implementation of PIDs and associated metadata - ORCID iDs for researchers, ROR IDs for funders and research organizations, RAiDs for research projects, and DOIs for a wide range of research outputs and entities.

Open scholarly infrastructure plays a critical role in ensuring that research is discoverable, citable, and reproducible. When scholarly works, researchers, institutes, funders, and grants are uniquely identified, it is then possible for repositories, publishers, and research tools to systematically capture the links and relationships among them with confidence, thanks to the standardized metadata (as well as the stewards of the metadata), and the technical interoperability therein. When scholarly infrastructure is open, transparent, and community-driven, the infrastructure are more useful, sustainable, accountable and robust (Cousijn et al., 2021), providing better support for

⁷ <https://altum.com/forum-on-grants-management/>



scholarly services that rely on them. Open infrastructure enables more rigorous and efficient ways to conduct research reporting, facilitate output dissemination, and support reuse (Brown, Josh, Jones, Phill, Meadows, Alice, & Murphy, Fiona, 2022). For example by reporting DOI of research outputs instead of a list of references in plain text, the grant manager get access to permanent, machine actionable metadata records, based on which more meaningful metrics can be built to evaluate research, and automated workflows can be built to monitor compliance such as data management planning; using PID metadata to create connection between datasets and research papers, or outputs to DMP, or results to pre-registration, makes research outputs behind published articles more visible, and boosts their reuse.

Funders' role in making research FAIR

In this guide, we define FAIR Workflows as the various workflows, undertaken by different stakeholders, that underpin and support the identification and metadata annotation of research entities using open scholarly infrastructure. Funders play a crucial role in not only adopting FAIR workflows themselves, but also incentivizing, and normalizing the adoption of FAIR workflows within the wider community, particularly by the researchers they fund and the organizations they partner with. Grant requirements act as powerful incentives and best practices for researchers to consider, such as data management, open access publishing and other communication approaches, that will boost the implementation of FAIR workflows and enrich openly accessible metadata to satisfy a wide range of use cases that support Open Science.

Recent studies show that when it comes to FAIR research practices, particularly data sharing, researchers expect funders to provide more support and clearer guidance (Anger et al., 2022). Surveys of researchers about attitudes to metadata have shown that researchers lack awareness of the downstream impact of good metadata (Kaiser et al, 2021). At the same time, although funders are in the position to exert considerable influence on other actors, and enjoy relative freedom to take initiatives (Curry, Stephen et al., 2022), many funder's data management and sharing policies, or guidance about metadata, are not optimally aligned with recent national and international recommendations (Research Consulting, 2022).

FAIR workflows can bolster the existing process of research funding, conducting, reporting, and assessment, to generate and analyze rich metadata through the implementation of open scholarly infrastructure—the key to increased discoverability of researchers, research activities, and research outputs. Open and reusable metadata will enable all stakeholders in the scholarly enterprise to meet multiple use cases⁸. Rich and accurate metadata will in turn support interoperability across systems to simplify administrative workflows by cutting down manual data reentry (Brown, Josh et al., 2022).

⁸ <https://metadata2020.org/learn-more/outcomes>



Registering PIDs for outputs and associating them on the metadata level with the grant, the funding organization and the fundees is the basic logic behind a robust and automated output tracking mechanism. When implemented correctly, the interoperability enabled by a common information exchange framework allows components of open scholarly infrastructure to work together to make outputs and the respective links to funding sources easily discoverable, and generate the aggregation of usage and other meaningful data. Benefits for funders to adopt FAIR workflows and create trustworthy metadata in their practices are multifold. FAIR workflows enable funders to:

- Confidently demonstrate the impact of funding and other support for research
- Make better-informed decisions about future funding awards based on better impact measurement
- Improve grant proposal evaluation backed by reliable data sources
- Improve the efficiency of the grant application process by eliminating unnecessary rekeying
- Easily aggregate all related outputs and showcase the output portfolio
- Gather usage data of outputs through open infrastructure for continued impact measurement and reporting
- Save time on and increase the accuracy of internal administrative workflows in the long run
- Assess the impact of funding support far beyond the term of a project

Recommendations for funders

As the issuers and managers of research funds, funders are in the position to carry out the registration and maintenance of two types of PIDs and their associated metadata: the funder identifier for the funding organization itself, and identifiers for each grant awarded by the funding organization. Making these identifiers available is the first step towards enabling researchers, institutes, and publishers to link their own research activities and outputs back to the funder and a specific grant.

Using a community-governed funder ID means that researchers, research projects, and different types of objects and outputs can be traced back to the funder when the funder ID is embedded in the identifier metadata of these entities. A diverse set of research-supporting systems, e.g. grant management systems, data repositories, and publishing platforms, have and need to accommodate funder ID workflows to make this possible. Once the implementation is in place, like other metadata properties, the researchers, data librarians, and editors can then populate the funding reference metadata field when sharing outputs and registering other records with identifiers.



Know and maintain funder identifiers

Whenever possible, funders should ideally be able to require the inclusion of its PID, in addition to the mention of its name in plain text, when requesting acknowledgement by their grantees in various contexts, in order to establish provenance in the open scholarly record. PIDs for funding organizations, or funder IDs, are unique and relatively static, requiring only updates when significant changes happen to the organization itself, such as merging, combining, re-organising departments, or rebranding - all key reasons to have unique identifiers that are open and persistent. Funder ID relies on publishers and repositories integration to help researchers, editors, and librarians easily include them in the metadata of relevant outputs to create connections among various records through metadata and identifiers, thus it is important that funding organizations know and keep their records accurate, and actively engage with publishing and repository systems to accommodate funder ID workflows, to create the condition for funder ID usage.

Open Funder Registry (OFR)⁹

The OFR was created (as “FundRef”) in 2013, based on seed data donated by Elsevier, who continues to manage the registry, made open through Crossref. The registry is searchable¹⁰ and downloadable¹¹ and is well-established and integrated within publishing and related systems. Any funding organization can easily request to be added to the registry or to update its departmental or hierarchical information, by contacting Crossref¹². The Open Funder Registry includes about 35,000 records, and updates are released approximately monthly.

DOI String	<code>https://doi.org/10.13039/501100011730</code>
Json metadata ¹³	<pre>{ "status": "ok", "message-type": "funder", "message-version": "1.0.0", "message": { "hierarchy-names": { "501100011730": "Templeton World Charity Foundation" }, "replaced-by": [], }, }</pre>

⁹ <https://www.crossref.org/services/funder-registry/>

¹⁰ <https://search.crossref.org/funding>

¹¹ https://gitlab.com/crossref/open_funder_registry

¹² <https://support.crossref.org/hc/en-us/requests/new> funders can choose "Other questions" to request a change to their Funder ID metadata

¹³ <https://api.crossref.org/funders/501100011730>



	<pre>"work-count": 616, "name": "Templeton World Charity Foundation", "descendants": [], "descendant-work-count": 616, "id": "501100011730", "tokens": ["templeton", "world", "charity", "foundation", "templeton", "world", "charity", "foundation", "inc", "twcf"], "replaces": [], "uri": "http://dx.doi.org/10.13039/501100011730", "hierarchy": { "501100011730": {} }, "alt-names": ["Templeton World Charity Foundation, Inc.", "TWCF"], "location": "Bahamas" }</pre>
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Box 1. Example OFR ID

Research Organization Registry (ROR)

Many OFR IDs are also included within and mapped to the Research Organization Registry (ROR)¹⁴. ROR was launched in 2019 by DataCite, Crossref, and California Digital Library, as an open, free, and universal affiliation identifier. The two registries are working on alignment where ROR, as an openly-curated initiative, is intended to become the primary open Funder PID in addition to the primary open Affiliation PID. The Research Organization Registry includes over 105,000 records, and updates are released approximately biweekly. Funders can request a new record or changes to

¹⁴ <https://ror.org/>



an existing record by submitting a form to ROR¹⁵. In the meantime, both OFR ID and ROR can be used when creating connection metadata, i.e. adding funder reference to a research output's metadata record, to the same effect.

Create and manage grant identifiers

Grant IDs are fully within the funder's control and responsibility. Funders should actively create and update grant metadata records with a PID, to create openly-available multilateral connections.

Since 2019, Crossref has been enabling the registration of DOIs for grants. This includes many types of support for different funders' circumstances and terminology: awards, sponsorships, use of facilities or equipment, fellowship, training, loans, prizes, etc. All of these can be uniquely identified with a grant DOI. The metadata schema for grants includes project-level information, investigator and role information (where ORCID iDs are encouraged) and affiliation information (where ROR IDs are encouraged). The record should include 1) the start and end dates of the award, 2) the award amount if monetary, and must include 3) a distinct landing page URL for each grant DOI to resolve to. The OFR ID of the funder must also be included, and in future, the Funder's ROR ID may also be included.

DOI String	https://doi.org/10.54224/20568
Json metadata snippet ¹⁶	<pre> "project": [{ "project-title": [{ "title": "Implementing FAIR Workflows: a proof of concept study in the field of consciousness", "language": "en" }], "project-description": [{ "description": "Although formally published research papers remain the most important means of communicating science today, they do not provide a sufficient amount of information to fully evaluate scientific work...", "language": "en" }], "lead-investigator": [</pre>

¹⁵ <https://curation-request.ror.org>

¹⁶ <https://api.crossref.org/works/10.54224/20568>



	<pre>{ "ORCID": "http://orcid.org/0000-0001-6660-6214", "authenticated-orcid": false, "given": "Helena", "family": "Cousijn", "affiliation": [{ "id": [{ "id": "https://ror.org/04wxnsj81", "id-type": "ROR", "asserted-by": "publisher" }], "name": "DataCite - International Data Citation Initiative e.V." }], "award-amount": { "amount": 1004477, "currency": "USD" }, "award-start": { "date-parts": [[2021, 9, 1]] }, "award-end": { "date-parts": [[2024, 8, 30]] } },</pre>
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	<pre>"funding": [{ "type": "award", "scheme": "Accelerating Research on Consciousness", "funder": { "name": "Templeton World Charity Foundation", "id": [{ "id": "10.13039/501100011730", "id-type": "DOI", "asserted-by": "publisher" }] }] },],</pre>
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Box 2. Example Grant ID

To register grant IDs, funders join as members of Crossref and start creating DOIs by compiling metadata according to the schema¹⁷. The metadata can be registered programmatically through system integration or manually using an online form¹⁸. Implementing them in the grant management workflow can help funders effectively track outputs in a systematic and automated manner. DataCite member organizations wishing to create grant IDs using DataCite infrastructure can do so following a similar process.

Like other DOIs, grant DOIs need to resolve to an openly accessible landing page where information about the grant is displayed. This landing page needs to have a unique URL and should display the grant DOI and basic descriptive information about the grant. Funders should consider alternative methods of hosting the landing pages if the grant management system they use does not already provide this feature. Where possible, funders should select grant management systems that support PID workflows.

Provide guidance for researchers and other stakeholders

Funders provide the majority of the financial resources required to carry out research projects. Committing to open and FAIR principles in research projects should translate to the provision of

¹⁷ <https://www.crossref.org/documentation/schema-library/markup-guide-record-types/grants/>

¹⁸ <https://www.crossref.org/documentation/register-maintain-records/grant-registration-form/>



substantial support. This would be in the form of specifically allocated funding for researchers to take the steps towards the transition to Open and FAIR practices. Furthermore, providing clear instructions based on established open scholarly infrastructure and metadata workflows, for both grant managers and researchers to verify compliance and achieve expected results.

Identifier for researchers

One of the most important aspects of implementing PIDs and metadata related to researchers is the successful adoption of ORCID iDs. ORCID is a non-profit organization that provides unique PIDs for people. ORCID iDs are free to people and available from the website, orcid.org. The ORCID iD will resolve to a standard record display, which collects the person's professional research activities such as employment, funding and publications.

It is best for funders to request or require the ORCID iD from the researchers applying for funding, and from those who would like to peer review for the funder¹⁹. If the funder is a member of ORCID, the funder can write the award details to the ORCID record, which will display the funder as the source of the data along with a green check-mark, which is a visual trust marker on the researcher's ORCID record. The same can be done for peer reviewers, the funder can recognize the peer review contribution on the person's ORCID record, with minimal or full description - it is up to the funder to decide the level of detail.

With proper integration to the grant management tools, ORCID's API can be used to access the metadata in the ORCID record, and used to pre-populate forms, reducing the administrative burden on researchers and improving the quality of data received by the funder's staff and peer reviewers.

Incentivizing researchers

Funders can incentivize researchers to adopt open and FAIR practices by:

1. Including the Open and FAIR sharing track record of applicants as part of evaluation criteria for grant project proposals;
2. Setting aside specific budget for Open and FAIR practice training, process building (procedural and technical), and tool subscription;
3. Allowing time in the project schedule to accommodate the incorporation of robust FAIR workflows such as time for preregistration (Nosek, B. A., Ebersole, C. R., DeHaven, A. C., & Mellor, D. T., 2018)/ registered report (Nosek, B. A., & Lakens, D., 2014) publishing and review where applicable, documentation and preparation for data and code sharing;
4. Promoting reusable outputs to increase visibility of researchers and research teams that implemented FAIR workflows and boost impact of their work

¹⁹ <https://info.orcid.org/documentation/workflows/funding-workflow/>



To further encourage researchers to adopt FAIR practices, funders can include recommendations and clear instructions for the PID, particularly ORCID, and metadata usage to researchers in the grant announcement, grant award, and grant management process. Throughout the research process, researchers will have multiple opportunities to capitalize on open scholarly infrastructure, as they produce and disseminate interim outputs. The key to make the outputs consistently FAIR is to encourage open sharing whenever possible and provide the time and resources to support these efforts.

Engaging with other stakeholders

At the same time, funders should engage with other stakeholders, such as publishers, vendors, and policymakers, to support open scholarly infrastructure and the implementation of metadata workflows. Specifically, funders can

1. Require that grant management system providers integrate with open scholarly infrastructure to accommodate the funder and grant identifier registration and maintenance workflows;
2. Actively encourage and support efforts of journal publishers and data repositories to include funder and grant ID references in the DOI metadata, in addition to the acknowledgement statement in the article;
3. Collaborate with other funders to create alignment in best practices and metrics based on shared metadata.

Mapping identifier and metadata usage across the project lifecycle

Funders can take action by improving their own practices and by influencing the researchers/research projects they fund, to take concrete steps towards achieving better output tracking results and making research FAIR.

1. **Adopting FAIR workflows:** Implementing workflows that incorporate identifiers and metadata for the funding organization itself and the grants they award.
2. **Recommending FAIR practices:** Issuing recommendations, instructions, and/or mandates around FAIR practices, accompanied by clear instructions and tangible supports for meeting these requirements, for researchers they fund.

The following table lists actions funders can take in these two aspects across the research project lifecycle, and highlights the connections between objects captured by these actions—connections that make research and researchers traceable in a consistent and reliable manner.



Note that some of the recommendations for funders to support a specific research phase may require actions beyond the timeline of that research phase, or outside of the funded projects. For example, many funders are starting to mandate data management plans (DMP) as part of the grant application portfolio. In order to give grant applicants clear instructions for data management planning, which is a novel practice for many researchers, funders may want to consider providing a specific DMP template that incorporates these considerations and space for the researchers to define their own terms.



Stage of research project	Actions funders can take	Actions funders can instruct researchers and other parties to take	Connection metadata generate links between:
<p>Grant announcement, application, review</p>	<p>Engage with grant proposal and assessment system providers to suggest integration with DOIs for grants, ROR for affiliations and ORCID for applicants/awardees.</p> <p>Collect authenticated ORCID iDs from all applicants and grant reviewers²⁰.</p> <p>Develop a policy encouraging all applicants to have an ORCID iD, and apply them where possible.</p> <p>Commit to support awardee’s FAIR practice by including a statement in open call.</p> <p>Prepopulate grant applications with CV and publication information from applicants’ ORCID records, instead of asking the researchers to enter manually.</p>	<p>Funders can request grant applicants and reviewers to enter their ORCID iDs in the grant management system.²¹</p> <p>Request grant applicants and reviewers to enter their affiliation’s ROR IDs in the grant management system.</p> <p>Request evidence of past open sharing track record from applicants, and make clear these are considered in the application review process.</p> <p>Request or mandate data management plan as part of the grant application portfolio.</p> <p>Encourage research institutions to write Employment data to their researcher’s ORCID records - to help funders know this is a professional researcher applying for funding.</p>	<ul style="list-style-type: none"> ● Funder and applicants ● Funder and reviewers

²⁰ <https://info.orcid.org/ufags/how-do-i-collect-an-authenticated-id/>

²¹ <https://info.orcid.org/outreach-resources/>



Stage of research project	Actions funders can take	Actions funders can instruct researchers and other parties to take	Connection metadata generate links between:
	<p>Encourage educational institutions to write Education data to their graduate’s ORCID records - to help funders know the level of training this applicant has received, from a trusted source.</p>		
<p>Grant award and registration</p>	<p>Assign Grant DOIs to awarded grants and deposit all associated metadata including the awardees ORCID iDs, ROR IDs of their affiliation.</p> <p>Include the DOI of any existing works, e.g. DMP, preregistration etc. at the time of grant registration, in the metadata of the grant</p> <p>Use ORCID API to write the funding award metadata to researchers ORCID records, which will help researchers meet the new funding disclosure requirements²².</p>	<p>Instruct researchers (grant applicants and reviewers) to allow the funder to push changes to their ORCID profile (funding information) in the ORCID profile setting.</p> <p>Encourage researchers to consider registering a project identifier (e.g. RAiD) to link to research activities.</p> <p>Instruct awardees to include grant ID in subsequent open sharing workflow, i.e. enter the grant ID in the grant reference field in data deposition form and manuscript</p>	<ul style="list-style-type: none"> ● funder and grant ● grant and reviewers ● grant and grantees ● grant and institutes ● grant and research projects funded ● grant and related works (if available)

²² <https://info.orcid.org/ufags/how-do-i-add-items-to-an-orcid-record/>



Stage of research project	Actions funders can take	Actions funders can instruct researchers and other parties to take	Connection metadata generate links between:
	<p>Use ORCID API to write the funding award metadata to reviewers' ORCID record²³.</p> <p>Communicate your Grant DOIs and open grant metadata widely via human and machine interfaces.</p>	<p>submission form.</p> <p>Request grant management system to integrate with ROR API to retrieve and verify affiliation metadata .</p> <p>Request grant management system to integrate with ORCID's API to retrieve validated contributor metadata.</p>	
Data management plan	<p>Incorporate data management planning policy into grant agreement</p> <p>If mandating a DMP, consider providing a DMP template based on output tracking needs.</p> <p>Include compliance monitoring mechanism in the DMP policy.</p>	<p>Request or mandate DMP as part of the grant application portfolio.</p> <p>Encourage researchers to include resource allocation section in the DMP.</p> <p>Instruct researchers to include ORCID, ROR ID, grant ID, and funder ID in the DMP metadata.</p> <p>Recommend researcher to use DMP platform that supports machine readable DMP format and registers PIDs for DMPs.</p>	<ul style="list-style-type: none"> ● grant and DMP ● funder and DMP ● DMP and researchers ● DMP and related outputs

²³ <https://info.orcid.org/documentation/workflows/peer-review-workflow/>



Stage of research project	Actions funders can take	Actions funders can instruct researchers and other parties to take	Connection metadata generate links between:
Research design	<p>Support allocating specific time and person hours to build data management workflows suitable for the research design.</p> <p>Prioritize projects that emphasize the reproducibility of results and the reuse of outputs.</p>	<p>Encourage research design to reflect considerations of reproducibility and reuse i.e. the adoption of a pre-registration and formal registered report workflow²⁴.</p> <p>Encourage researchers to create RAIDs for research project(s) funded by the grant, and include relevant DOI, ORCID and ROR IDs in the metadata.</p> <p>Encourage researchers to consider adopting domain-specific metadata models to keep metadata standardized and interoperable.</p>	<ul style="list-style-type: none"> ● grant and preregistration/ registered report ● grant and research activities ● project and activities ● project and researchers ● project and institutes ● research project and metadata specification
Experimentation	<p>When listing budget items, allow expenses to cover required training for adoption of PID supporting tools.</p>	<p>Express support for adopting open and FAIR research supporting tools and platforms.</p>	<ul style="list-style-type: none"> ● grant and protocols ● researcher and protocols

²⁴ <https://www.cos.io/initiatives/registered-reports>



Stage of research project	Actions funders can take	Actions funders can instruct researchers and other parties to take	Connection metadata generate links between:
	<p>Support researchers to take into account the time needed for documentation of experiment workflows in the overall project timeframe.</p> <p>Register grants for facility or instrument usage, if incurred outside of the overall project budget.</p>	<p>Encourage documentation and sharing of protocols using community endorsed platforms that register DOIs.</p> <p>Encourage identification of tools and instruments created/ used in the experiment as part of documentation/protocol.</p> <p>Encourage administrators of Facilities and instruments to collect relevant PIDs, such as grant IDs, ORCID iDs and RAiD IDs, in the application form to use the facility or instrument. At the time of award, write the data about use of the facility or instrument to the ORCID iDs of the researchers with relevant PIDs.</p>	<ul style="list-style-type: none"> • grant and instrument/facility • Researcher and instrument/facility
Output sharing	Foster partnership with open data repositories to define specific terms in the data sharing policy and formulate clear instructions.	Instruct researchers to share interim outputs, such as posters, conference paper and presentations, in repositories that issue DOIs.	<ul style="list-style-type: none"> • grant and datasets, posters, presentations, interim reports etc.



Stage of research project	Actions funders can take	Actions funders can instruct researchers and other parties to take	Connection metadata generate links between:
	<p>Endorse open data repositories that have PID integrations in place.</p> <p>Learn about existing services that cater to funder output tracking needs and consider implementing to impact measurement workflow (e.g. OSF collections²⁵)</p> <p>Work with repositories that assign DOIs to include funding metadata in the DOI metadata.</p> <p>Work with repositories that include authenticated ORCID iDs in the metadata about the deposited object.</p> <p>Account for time, resources and training necessary to effectively share and maintain outputs.</p>	<p>Request researchers to prepare and share datasets in an appropriate data repository.</p> <p>Instruct researchers to allow DataCite to push changes to their ORCID profile²⁶.</p> <p>Remind researchers to include grant ID and funder ID in the metadata submitted to the repository where data is deposited.</p> <p>Request researcher to submit DOIs of outputs when reporting.</p> <p>Encourage researchers to append shared outputs to DMP, if the DMP created supports it.</p>	<ul style="list-style-type: none"> ● funder and datasets, posters, interim reports etc. ● researcher and datasets, posters, interim reports etc. ● datasets, posters, interim reports etc.

²⁵ <https://www.cos.io/products/osf-collections>

²⁶ <https://support.datacite.org/docs/how-to-activate-orcid-auto-updat>



Stage of research project	Actions funders can take	Actions funders can instruct researchers and other parties to take	Connection metadata generate links between:
Preprint sharing	<p>Funders can endorse and/or support preprint servers that register DOIs and authenticate ORCID iDs</p> <p>Request preprint server to implement metadata curation workflows to accommodate Grant ID and funder ID in the DOI metadata.</p> <p>Acknowledge preprints as important type of output.</p> <p>Acknowledge peer review for preprint as important contribution to the research ecosystem.</p> <p>Allow expenses for preprint review publishing.</p>	<p>Request preprint sharing for all journal articles, must cite conflicting policy for non-compliance.</p> <p>Instruct researchers to use open preprint servers that authenticate ORCID iDs and register DOIs for preprints</p> <p>Instruct researchers to share peer review for preprint, using open preprint review platforms that authenticate ORCID iDs and register DOIs for reviews.</p> <p>Instruct researchers to include grant DOI and funder ID when submitting preprints or reviews for open sharing.</p>	<ul style="list-style-type: none"> ● grant and preprints ● funder and preprints ● researcher and preprint ● researcher and preprint reviews
Journal publishing	<p>Work with publishers to collect ORCID iDs of the corresponding or all authors, and write the published citation to each ORCID record.</p>	<p>Recommend data citations be included in the references for published outputs.</p> <p>Instruct researchers to allow Crossref to push changes to their ORCID profile. More on</p>	<ul style="list-style-type: none"> ● grant and papers ● funder and papers ● researchers (authors and



Stage of research project	Actions funders can take	Actions funders can instruct researchers and other parties to take	Connection metadata generate links between:
	<p>Work with publishers to include funding metadata in crossref metadata record.</p>	<p>auto-update from Crossref to ORCID: https://support.orcid.org/hc/en-us/articles/360006971293-Auto-updates-in-third-party-systems-Crossref</p> <p>Instruct researchers to append DOIs to their reference list items when possible.</p>	<p>contributors) and papers</p> <ul style="list-style-type: none"> • outputs (DMP, project, preregistrations, protocols, etc.) and papers
<p>Project reporting and evaluation</p>	<p>Use ORCID's API, Crossref's API and DataCite's API to retrieve metadata to generate report on outputs</p> <p>Use Crossref and DataCite APIs to retrieve DOIs for research outputs based on researcher/ affiliation/ funder.</p> <p>Use open metadata to create benchmarks and metrics.</p> <p>Update grant ID metadata with new related outputs.</p>		

Table 1. Actions funders and researchers can take to implement FAIR workflows



Conclusion

There are many things funders can start doing today to implement and support FAIR workflows. In terms of grant management - commit to and optimize the adoption of PIDs, open infrastructure and metadata. In terms of research support - provide support at the right time, in the right way. FAIR practice can be a novel and unfamiliar concept for researchers. In the face of funder requirements, it would be reasonable and efficacious for researchers to be able to look to the funder to provide instructions and reminders to incorporate best practices into their daily work.

Actively engaging with global open scholarly infrastructure organizations that provide and facilitate PID registration (such as Crossref, DataCite, ROR, ORCID, etc.), and using open infrastructure, metadata, and identifiers, will make monitoring more straightforward and compliance easier for all stakeholders. The community around open infrastructure includes academic societies, publishers, universities, libraries, repositories, museums, NGOs and many more. Together with funding organizations, they can build services such as discovery portals and evaluation tools based on open infrastructure and metadata that are robust, credible, persistent, and interoperable.

FAIR practices enable output tracking which will benefit funders in concrete ways:

- Demonstrate clearer impact from the grants awarded
- Make more informed decisions about funding strategies
- Maintain persistent relations with grantees and partner organizations

Making research FAIR is a joint effort and funder actions will have significant impact on all other stakeholders.



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