



# FAIRsFAIR

Fostering Fair Data Practices in Europe

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## D5.5 Report 2 of the Synchronisation Force

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## Abstract

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This is the report of the second FAIRSFAR Synchronisation Force workshop, organised online as a series of eight sessions from 29th of April until 11th of June 2020. The objective of these sessions was to measure the progress towards implementing the recommendations outlined in the *Turning FAIR into Reality* report (2018). To do this, FAIRSFAR brought together representatives of the Working Groups of the EOSC Executive Board, INFRAEOSC5 projects, ESFRI clusters, and the FAIRSFAR European Group of FAIR Champions to share information on the progress of their FAIR-oriented activities and to discuss commonalities and priorities. This report summarises the workshop outcomes and leads to recommendations for the EOSC Executive Board and Governing Board and their successors, and the European Commission’s EOSC programme.

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## Disclaimer

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## Abbreviations and Acronyms

API	Application Programming Interface
DMP	Data Management Plan
EGFC	European Group of FAIR Champions
EOSC	European Open Science Cloud
ESFRI	European Strategy Forum on Research Infrastructures
FAIR	Findable, Accessible, Interoperable, Reusable
IG	Interest Group
maDMP	machine-actionable Data Management Plan
NOAD	National Open Access Desk
RDA	Research Data Alliance
RDM	Research Data Management
RSE	Research Software Engineers
SLA	Service Level Agreement
TFiR	Turning FAIR into Reality (report)
WG	Working Group

Project names, which are often acronyms, can be found in Appendix 1.




## Executive Summary
















This is the report of the second FAIRsFAIR Synchronisation Force workshop, organised online as a series of eight sessions from 29th of April until 11th of June 2020. The objective of these sessions was to measure the progress towards implementing the recommendations outlined in the *Turning FAIR into Reality* report (2018). To do this, FAIRsFAIR brought together representatives of the Working Groups of the EOSC Executive Board, INFRAEOSC5 projects, ESFRI clusters, and the FAIRsFAIR European Group of FAIR Champions to share information on the progress of their FAIR-oriented activities and to discuss commonalities and priorities.













The report addresses the EOSC Executive Board and Governing Board and their successors, as well as the European Commission's EOSC programme (together called "the EOSC Governance" in this report), in addition to the participants and other EOSC-related projects.

The following table summarises the amount of activity with regards to the 27 recommendations from the *Turning FAIR into Reality* report (TFiR). It is a snapshot in time and the observations and analysis in the report express an interpretation of the situation - confirmed by the workshop participants.

Legend:

-  many activities support this recommendation
-  some activities support this recommendation
-  hardly any or no activities support this recommendation

Concepts for FAIR implementation	FAIR culture	FAIR ecosystem	Skills for FAIR	Incentives and metrics for FAIR data & services	Investment in FAIR
1: Define FAIR for implementation 	4: Develop interoperability frameworks 	7: Support semantic technologies 	10: Professionalise data science & stewardship roles 	12: Develop metrics for FAIR digital output 	14: Provide strategic and coordinated funding 
2: Implement a model for FAIR digital objects 	5: Ensure data management via DMPs 	8: Facilitate automated processing 	11: Implement curriculum frameworks and training 	13: Develop metrics to certify FAIR services 	15: Provide sustainable funding 
3: Develop components of a FAIR ecosystem 	6: Recognise & reward FAIR data & stewardship 	9: Certify FAIR services 			

Priority recommendations are above this line; supporting recommendations are below this line.					
16: Apply FAIR broadly 	18: Cost data management 	22: Use information held in DMPs 		25: Implement and monitor metrics 	27: Open EOSC to all providers but ensure services are FAIR 
17: Align and harmonise FAIR and Open data policy 	19: Select and prioritise FAIR digital objects 	23: Develop components to meet research needs 		26: Support data citation and next generation metrics 	
	20: Deposit in Trusted Digital Repositories 	24: Incentivise research infrastructures to support FAIR data 			
	21: Incentivise reuse of FAIR outputs 				

The overall conclusion of the workshop series and this review of project activities is that the implementation of the *Turning FAIR into Reality* recommendations is clearly being addressed across the range of projects and activities surveyed.

The EOSC Governance should look at the less well covered TFIR Recommendations 6, 8, 11 and 13 (coded “some activities support this recommendation”), determine whether extra activity is needed and which could be provided through EOSC co-creation activities, through the Horizon Europe funding initiative or through other means. Workshop participants also felt that supporting recommendation 23 should be reclassified as a priority recommendation.

Finally, this report proposes additional actions that address gaps in the *Turning FAIR into Reality* Action Plan that were identified by the workshop discussions.

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## 1. Introduction to the FAIRsFAIR Synchronisation Force workshops

The FAIRsFAIR project aims to supply practical solutions for the use of the FAIR data principles throughout the research data lifecycle with an emphasis on fostering a FAIR data culture and the uptake of good practices in making data FAIR, in particular in the context of the European Open Science Cloud (EOSC).

A key challenge for FAIRsFAIR is to ensure that project activities dovetail with work carried out by the Working Groups of the EOSC Executive Board, and feed into and complement the work that is being done by other projects in the research data and FAIR space. For this reason, the FAIRsFAIR project set up the **Synchronisation Force**, a team tasked with establishing a dialogue among the various projects and actors in both the EOSC and FAIR ecosystems whose work touches on FAIR in order to:

- Maximise coordination and minimise unnecessary overlap or duplication;
- Encourage the dovetailing of projects' and actors' activities with those of the EOSC Governance Boards;
- Promote mechanisms to support collaboration on turning FAIR into reality.

The key activity of the Synchronisation Force (SF) is to run three dedicated workshops that bring together the various projects and actors. Workshops were chosen as the best platform to create a dialogue between the key stakeholders working in the dynamic landscape of FAIR activities in relation to EOSC. Although the workshops were planned to be held as face-to-face meetings, we had to restructure the second workshop as a virtual workshop due to the COVID-19 restrictions at the time. Each of the three workshops will result in a report and the collection of all three reports will form the basis of a FAIRsFAIR White Paper. The White Paper will provide a set of prospective recommendations for how to encourage ongoing alignment and synchronisation around FAIR, Open Science and EOSC. The White Paper will also provide information about progress on turning FAIR into reality.

The **first Synchronisation Force workshop**, held in Budapest, 25 November 2019, explored interaction between FAIRsFAIR and the five EOSC Working Groups<sup>1</sup> that were established at that time<sup>2</sup>. The first workshop highlighted the difficulty around coordination and collaboration of activities as a key challenge. Furthermore, it was concluded that the importance of clustering activities and outputs around recommendations from the *Turning FAIR into Reality* report was underemphasized in the workshop and that more stakeholders should have a seat at the table. These three issues have been addressed in the second Synchronisation Force workshop. First, the *Turning FAIR into Reality* recommendations were the linking pin of the sessions (see Sections 2-3). Second, the workshop itself was instrumental in bringing stakeholders together to share information about their respective activities. To better enable discussion around FAIR themes, eight sessions were held instead of one workshop where discussions would have to remain at a higher level. Third, for the second workshop

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<sup>1</sup> <https://www.eoscsecretariat.eu/eosc-working-groups>

<sup>2</sup> The report on the First FAIRsFAIR Synchronisation Force workshop (D5.3) is available at <https://doi.org/10.5281/zenodo.3629159>.



we invited a wider group of stakeholders and encouraged participants to choose the sessions that best reflected their areas of activity.

**FAIRsFAIR’s primary stakeholders** within the EOSC ecosystem are the Working Groups of the EOSC Executive Board, the INFRAEOSC-5a-c projects, which collaborate in Task Forces under a Cross-Project Collaboration Board, domain-related ESFRI cluster projects, and generic or “horizontal” e-Infrastructure projects. In addition to the Synchronisation Force, FAIRsFAIR has initiated the European Group of FAIR Champions (EGFC)<sup>3</sup> to work as FAIR ambassadors. Finally, there are many other FAIR-related initiatives. The landscape of our primary stakeholders is illustrated in Figure 1.

Figure 1. FAIRsFAIR primary stakeholders within the EOSC ecosystem



The stakeholders that were actually represented in the second Synchronisation Force workshop and the workshop participants are listed in Appendix 1 and 2, respectively. For ease of reading of this report we will use the term “projects” to refer to the INFRAEOSC-5a-c and ESFRI cluster projects but also to the EOSC Working Groups and the FAIR Champions.

<sup>3</sup> <https://www.fairsfair.eu/advisory-board/egfc>

## 2. Turning FAIR into Reality: tracking progress for FAIR

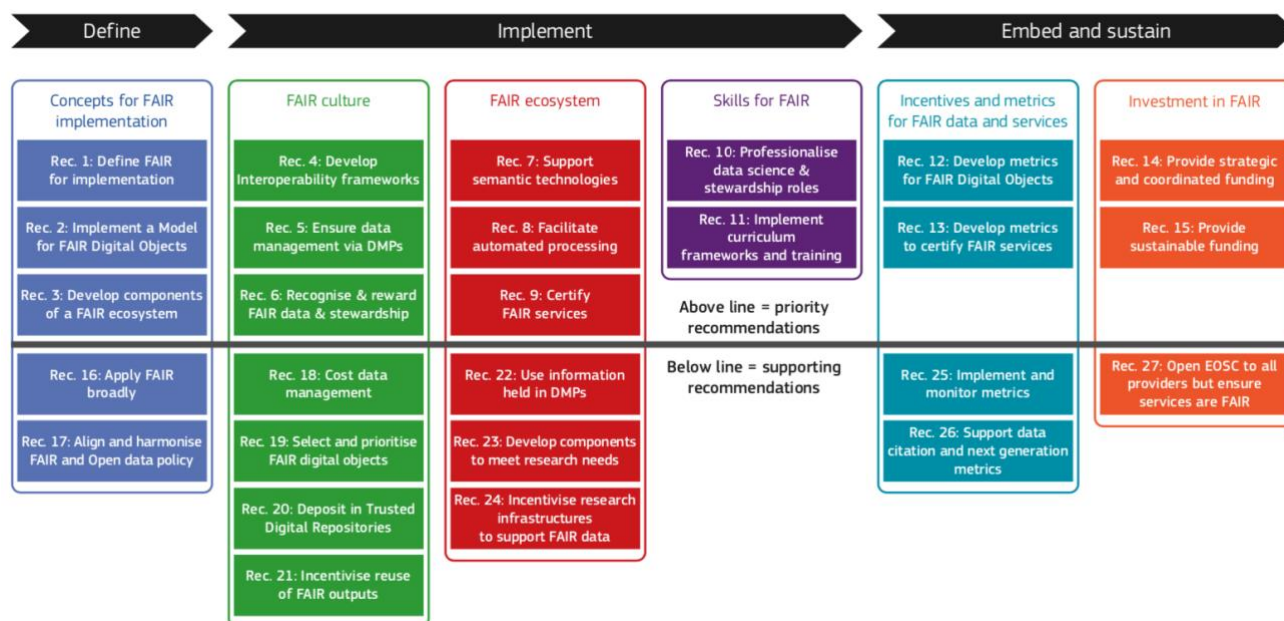
### 2.1 Introduction

The European Commission Expert Group report *Turning FAIR into Reality* (TFiR<sup>4</sup>) lays out an Action Plan for what is needed to implement FAIR. It recognises that in order for data and other research outputs to be Findable, Accessible, Interoperable and Reusable, a broader ecosystem of shared concepts, technologies, services, skills and culture is required. Furthermore, that ecosystem needs to be sustained by appropriate investment and sound governance.

To that end the TFiR report makes a series of structured recommendations, and an Action Plan for delivering FAIR data. In turn, the structure in which those recommendations are presented provides a useful and appropriate framework for discussing and comparing FAIR-oriented activities of a wide range of projects and initiatives across Europe. The recommendations are clustered under six pillars:

1. Core Concepts: FAIR Digital Objects and technical components of the FAIR ecosystem
2. FAIR Culture: agreements on data availability and description, data management plans, recognition and rewards
3. FAIR Ecosystem: key services, semantic technologies, trust and certification of services
4. Skills for FAIR: data science and data stewardship, curriculum frameworks
5. Incentives and Metrics for FAIR data and services: citation, metrics and monitoring
6. Investment in FAIR: investment, sustainability and governance

Figure 2. Turning FAIR into Reality priority and supporting recommendations (Source: TFiR, page 17)



<sup>4</sup> European Commission Expert Group on FAIR data, 2018. Turning FAIR into Reality: Final Report and Action Plan from the European Commission Expert Group on FAIR data. <https://doi.org/10.2777/1524>




In the Synchronisation Force workshops we try to understand how actors within the EOSC and FAIR ecosystems are addressing the TFIR recommendations and how they “answer” the *Turning FAIR into Reality* Action Plan.

In the current workshop series information from the projects was collected and discussed for each of the six pillars (see Figure 2), hence the term “pillar session”. In advance of the six pillar sessions the Synchronisation Force published a spreadsheet that lists all TFIR recommendations. For each recommendation - if relevant - the participants provided information about their project’s deliverables and ongoing activities that aim to address this recommendation: both “in place” and “planned” activities. During the sessions, participants were invited to flesh out this information. Furthermore, each pillar session discussed whether any significant FAIR-related activities were missing from the TFIR recommendations or deserved more attention or priority.

## 2.2 Mapping project activities to the TFIR recommendations

Informative as the six pillar sessions are, it should be recognised that this report can only provide a snapshot in time. It should also be emphasised that “gaps” in the spreadsheet don’t imply an omission on the side of the projects: it was not to be expected that each project or working group, let alone a FAIR Champion, would be addressing all TFIR recommendations. In addition, a number of recommendations target other stakeholders than those invited to attend the workshop, such as research funders. In light of these, the observations and analysis presented in the following sections should be considered impressionistic: they express an interpretation of the situation and do not pretend to offer a comprehensive or quantified list of all work being undertaken. Given these caveats, we did not attempt to assign any “weight” to pillars; each of them is important.

In the remainder of this section we describe per pillar the main findings for each TFIR recommendation. The project activities reported below are a selection of the information provided in the spreadsheet and during the sessions. In addition to the data presented in the spreadsheet, which refers to specific project deliverables for each TFIR recommendation, the extensive session notes are available for more details<sup>5</sup>. Where relevant, possible follow-up actions and/or missing elements are added. Furthermore, the following coding is used:

-  many activities (in place and/or planned) support this recommendation
-  some activities (in place and/or planned) support this recommendation
-  hardly or no activities (in place and/or planned) support this recommendation

## 2.3 Pillar 1: Concepts for FAIR implementation

***Turning FAIR into Reality Pillar 1: Concepts for FAIR implementation*** defines how the FAIR principles apply in the context of research communities - based on the data types, the nature of research and the level of existing support for data sharing. It also identifies points where the FAIR principles need to be supported with additional concepts and policies to be further expanded and unpacked.

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<sup>5</sup> The spreadsheet and the session notes are available from <https://doi.org/10.5281/zenodo.3953979>

The recommendations address the concept of “Defining” with a two-fold focus:

- **FAIR Digital Objects** - Defining what is needed for digital objects to be made FAIR.
- **FAIR Ecosystem** - Defining which components are needed in the FAIR ecosystem.



### Rec. 1: Define FAIR for implementation

*“To make FAIR data a reality it is necessary to incorporate and emphasise concepts that are implicit in the FAIR principles, namely: data selection, long-term stewardship, assessability, legal interoperability and the timeliness of sharing”. (TFiR, page 62)*

The definition of how the FAIR principles apply in the context of research communities is widely tackled by all of the EOSC initiatives and collaboration and cross-fertilisation is already in place, with many actors sharing analyses, reports and best practices and contributing to each other’s working groups.

FAIRSFAR WP3 addressed the principles in its draft policy enhancement recommendations<sup>6</sup> and draft recommendations on practice to support FAIR data principles<sup>7</sup>. WP2 also produced a first set of requirements for persistence and interoperability<sup>8</sup>. The FAIR Practice Task Force of the EOSC FAIR WG<sup>9</sup> examines FAIR practices in a variety of disciplinary fields, with a draft report available for consultation around July 2020 and a webinar planned. The Interoperability Task Force plans to examine legal interoperability aspects while the Metrics & Certification Task Force is working on recommendations for FAIR Metrics taking into account the recommendations from the RDA FAIR Data Maturity Model WG<sup>10</sup> and of FAIRSFAR WP2 and WP4. The definition of FAIR implementation is also being addressed by the EOSC Regional initiatives, with a few of them (EOSC Nordic<sup>11</sup>, NI4OS-Europe<sup>12</sup>, SSHOC<sup>13</sup> projects) basing their implementation of FAIR assessment on “Evaluating FAIR maturity through a scalable, automated, community-governed framework” (Wilkinson et al. 2019<sup>14</sup>) in terms of definitions and implementation guidelines. Finally, FAIRSFAR WP6 is setting up a single FAIR Data Stewardship Competence Centre. This centre will be shaped as a shared hub of expertise in implementing FAIR data stewardship principles, offering leadership, coordination and cataloguing

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<sup>6</sup> Davidson, J., Grootveld, M., Whyte, A., Herterich, P., Engelhardt, C., Stoy, L., & Proudman. (2020). D3.3 Policy Enhancement Recommendations (Version 1.0). <https://doi.org/10.5281/zenodo.3686900>

<sup>7</sup> Molloy, L., Nordling, J., Grootveld, M., van Horik, R., Whyte, A., Davidson, J., ... Asmi, A. (2020). D3.4 Recommendations on practice to support FAIR data principles (Version 1.1). Zenodo <https://doi.org/10.5281/zenodo.3924131>

<sup>8</sup> Lehvälaiho, H., Parland-von Essen, J.a, Behnke, C., Laine, H., Riungu-Kalliosaari, L. Le Franc, Y., & Staiger, C.. (2019). D2.1 Report on FAIR requirements for persistence and interoperability 2019 (Version v1.0 Draft). FAIRSFAR. <https://doi.org/10.5281/zenodo.3557380>

<sup>9</sup> <https://www.eoscsecretariat.eu/working-groups/fair-working-group>

<sup>10</sup> <https://www.rd-alliance.org/groups/fair-data-maturity-model-wg>

<sup>11</sup> <https://www.eosc-nordic.eu/>

<sup>12</sup> <https://ni4os.eu/>

<sup>13</sup> <https://www.sshopencloud.eu/>

<sup>14</sup> Wilkinson, M.D., Dumontier, M., Sansone, S. *et al.* Evaluating FAIR maturity through a scalable, automated, community-governed framework. *Sci Data* **6**, 174 (2019). <https://doi.org/10.1038>

services to connect relevant people, guidance, learning resources and curricula in different thematic areas.

The potential value of workshops, hackathons and Metadata for Machines (M4M)<sup>15</sup> events to support communities to implement FAIR practices has also been analysed and is in the pipeline of several projects. With regard to the **ESFRI Clusters**, ExPaNDS<sup>16</sup>/PaNOSC<sup>17 18</sup> are organising a joint workshop in September/October 2020 targeting facility scientists to promote the FAIR principles where they will address the revision of Research Infrastructure data policies to take FAIR principles into account. All clusters are adapting policy and practice frameworks to better reflect their user communities, proposing targeted definitions, schemas and solutions.

#### Possible follow-up actions:

- Different lines of collaboration can be opened with the work done/undergoing by FAIRsFAIR to draft policy and practice recommendations as well as with the FAIRsFAIR nascent Competence Centre.
- For implementing FAIR data assessment, Wilkinson et al. 2019 could be taken into consideration in terms of common definitions and implementation guidelines.



#### Rec. 2: Implement a model for FAIR Digital Objects

*“Implementing FAIR requires a model for FAIR Digital Objects. These, by definition, have a PID linked to different types of essential metadata including provenance and licencing. The use of community standards and sharing of rich documentation is fundamental for interoperability and reuse of all objects.”* (TFiR, page 62)

The EOSC Architecture Working Group<sup>19</sup> and the EOSC FAIR Working Group’s PID Task Force produced a second draft of PID Policy document<sup>20</sup> available for consultation.

All the initiatives represented in this pillar session directly or indirectly work on this recommendation. Some projects such as EOSC Pillar are working on **pilots using existing tools** (e.g. Cordra<sup>21</sup>) to test the FAIR Digital Object concept and which will deliver recommendations on integration of existing repositories. Different initiatives are working on **implementation plans and technical frameworks for FAIR digital objects** in domain specific contexts (SSHOC, EOSC Synergy<sup>22</sup>, ExPANDS). Others

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<sup>15</sup> <https://www.go-fair.org/resources/go-fair-workshop-series/metadata-for-machines-workshops/>

<sup>16</sup> <https://expands.eu/>

<sup>17</sup> <https://www.panosoc.eu/>

<sup>18</sup> ExPaNDS and PaNOSC cooperate on many topics, and where relevant this report takes them together.

<sup>19</sup> <https://www.eoscsecretariat.eu/working-groups/architecture-working-group>

<sup>20</sup> Hellström, M., Heughebaert, A., Kotarski, R., Manghi, P., Matthews, B., Ritz, R., ... Wittenburg, P. (2020, May 1). Second draft Persistent Identifier (PID) policy for the European Open Science Cloud (EOSC) (Version 2.0). Zenodo. <http://doi.org/10.5281/zenodo.3780423>

<sup>21</sup> <https://www.cordra.org/>

<sup>22</sup> <https://www.eosc-synergy.eu/>

highlight the training aspects needed and seem focused on **training activities for data producers and users on ontologies and interoperability** (ENVRI-FAIR<sup>23</sup>, ESCAPE<sup>24</sup>).

#### Missing elements:

- More work is needed on defining digital objects, for example on how to apply semantics of data.



#### Rec. 3: Develop components of a FAIR ecosystem

*“The realisation of FAIR data relies on, at minimum, the following essential components: policies, Data Management Plans, identifiers, standards and repositories. There need to be registries cataloguing each component of the ecosystem, and automated workflows between them.” (TFiR, page 63)*

The framework of this recommendation can be identified in the work ongoing at the Interoperability Task Force of the FAIR WG and the Architecture WG that have developed draft recommendations on the EOSC Interoperability framework, including discussion of technical, semantic, organisational and legal interoperability. In terms of components and workflows, many initiatives are undertaken, however, the entire “minimum set” mentioned above is not always considered / adopted.

**Tools and registries.** The EOSC Nordic project is working to develop and test the **FAIR Maturity Evaluator** on a 100+ data repository sample<sup>25</sup>. The test is mainly focused on machine actionability. **The FAIRsharing registry**<sup>26</sup> of standards and repositories also provides content that tools can use in support of automated workflows. FAIRsharing is already working to connect its content with DMPonline<sup>27</sup>, and FAIR evaluation tools to use the standards in the FAIR assessment. As a registry, it is already used and recommended by various EOSC reports and projects, as well as EC reports and guidelines to researchers, and also by publishers.

In **Austria**, a number of building blocks are being developed in the context of the digital transformation initiatives for the academic sector covering a number of the core components of the FAIR ecosystem and additional services. In **Spain**, the DIGITAL.CSIC research data policy<sup>28</sup> explicitly indicates the types of research data accepted, main data management issues and recommendations, and identifies priority data-related services including DOI minting, support/review of DMPs, compliance with journal data sharing policies, compliance with FAIR Data Principles and aggregation into broader research data infrastructures. (For DMPs see also recommendation 5.)

**Country-tailored systems of rewards and incentives.** NI4OS-Europe brought to the table the issue of incentives and rewards that can be employed to improve the uptake of Open RDM and FAIR in general as well as their integration in EOSC. EOSC Nordic will also work on this.

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<sup>23</sup> <https://envri.eu/home-envri-fair/>

<sup>24</sup> <https://projectescape.eu/>

<sup>25</sup> <https://www.eosc-nordic.eu/fair-maturity-evaluation-of-nordic-and-baltic-data-repositories/>

<sup>26</sup> <https://fairsharing.org/communities#activities>

<sup>27</sup> <https://dmponline.dcc.ac.uk/>

<sup>28</sup> <http://digital.csic.es/dc/politicas/politicaDatos.jsp>

**Missing elements:**

- There is more work to do on registries and a need for testbeds to continuously evolve and evaluate the functioning of the FAIR ecosystem.

**Rec. 16: Apply FAIR broadly**

*“FAIR should be applied broadly to all objects (including metadata, identifiers, software and DMPs) that are essential to the practice of research, and should inform metrics relating directly to these objects.” (TFiR, page 70)*

While FAIR should be applied broadly, there is a need to tailor the FAIR principles to the relevant context, in particular the research field. This particular aspect looks like it is still far from being a reality as only some communities have well defined definitions about what FAIR means for them while others are just getting started. The FAIR WG is gathering information on initiatives aimed at defining FAIR for other objects than data and its FAIR Practice TF is surveying the FAIR practices of different communities.

**Target collaborations.** An aspect worth highlighting relates to the few collaborations in place among projects to tackle specific challenges. EOSC-Synergy is working with FAIRSFair, as part of collaboration activities, to see where the overlap is between quality assurance of software and quality assurance of services and what that means for FAIR.

**Rec. 17: Align and harmonise FAIR and Open data policy**

*“Policies should be aligned and consolidated to ensure that publicly-funded research data are made FAIR and Open, except for legitimate restrictions. The maxim ‘as Open as possible, as closed as necessary’ should be applied proportionately with genuine best efforts to share.” (TFiR, page 70)*

Harmonising FAIR policies and FAIR incentives is on the agenda of the majority of the initiatives involved. FAIRSFair released D3.3 Policy enhancement recommendations. ENVRI-FAIR, PANOSC and ExPaNDS are working on data policy framework documents and position papers in support of better harmonisation.

**Regional approaches.** NI4OS-Europe WP2 works on building national Open Science Cloud initiatives aiming at stimulating discussions regarding national research settings and EOSC policies (including FAIR) taking stock of OpenAIRE NOAD’s<sup>29</sup> experience and resources that facilitate policy alignment while EOSC Nordic has similar activities planned during the last year of the project (2021-22). EOSC Synergy is looking in particular at the **Service Level Agreements in place** in the region<sup>30</sup> for service providers related to data sharing, storage and transfer - making sure DMPs are available; and at the **AAI (Authentication and Authorisation Infrastructure) policies in place** in the region and defining

<sup>29</sup> National Open Access Desks, see <https://www.openaire.eu/noads>

<sup>30</sup> Countries participating in EOSC Synergy: <https://www.eosc-synergy.eu/about/>

changes which might be recommended to improve/enable transnational data sharing by service providers.

**Legal regulations when dealing with sensitive data.** In terms of FAIR and Open data policy, an example of activity at TU WIEN was shared. While opening up access to “shareable” data is increasingly accepted, there remains the issue of the significant quantity of data that is sensitive due to privacy reasons or commercial interests. In the wake of COVID19, TU WIEN has set up a secure data infrastructure based entirely on open-source components that allows data owners to provide controlled access for researchers to subsets of their data, while maintaining full control of their data and preventing data download to the fullest extent possible via a combination of technical and legal mechanisms. TU WIEN’s infrastructure<sup>31</sup> is currently under review for broader adoption to **support the vision of data visiting instead of data sharing**, providing a pathway to accessing highly sensitive data, no matter whether this is due to privacy or commercial reasons. Activities are underway to identify necessary changes to legal regulations to support such access provisioning for sectors with sensitive data that should be opened up for research purposes.

## 2.4 Pillar 2: FAIR culture

**Turning FAIR into Reality Pillar 2: Creating a culture of FAIR data** defines how FAIR attitudes and workflows can be improved - by means of interoperability, data management planning, and better recognition for FAIR practice. This also relates to selecting which data to deposit in Trustworthy Digital Repositories, costing data management, and encouraging that FAIR data are actually reused.



Rec. 4: Develop interoperability frameworks for FAIR sharing within disciplines and for interdisciplinary research

*“Research communities need to be supported to develop interoperability frameworks that define their practices for data sharing, data formats, metadata standards, tools and infrastructure.” (TFiR, page 64)*

Several projects address interoperability issues, e.g. by making recommendations in their data policy or via FAIR metadata frameworks to be applied across the data lifecycle. ExPaNDS for instance is developing an ontology to provide a common syntax and common semantics for use by metadata catalogues and data analysis services. FAIRSFAR is also working to develop a proposal on integration of metadata catalogues to support cross-disciplinary FAIR uptake. During the session discussions, it was noted that many of the reported project activities are going on within specific research communities, whereas much current research work and future opportunity is cross-disciplinary. Therefore, research communities that apparently have nothing in common, like heritage and industry, will need data to be FAIR as well as sustainable, and FAIR-enabling tools that support collaboration. This is in line with the original TFiR recommendation 4: “within disciplines and interdisciplinary”. The SSHOC report<sup>32</sup> on SSHOC (meta)data interoperability problems provides

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<sup>31</sup> [http://www.ifs.tuwien.ac.at/~andi/secure\\_data\\_infrastructure.html](http://www.ifs.tuwien.ac.at/~andi/secure_data_infrastructure.html)

<sup>32</sup> Broeder, D., Trippel, T., Degl'Innocenti, E., Giacomi, R., Sanesi, M., Kleemola, M., ... Đurčo, M. (2019). SSHOC D3.1 Report on SSHOC (meta)data interoperability problems (Version v1.0). <https://doi.org/10.5281/zenodo.3569868>



examples of challenges that are being encountered. Participants agreed that there is a need to develop use cases to better understand the challenges and opportunities for FAIR data production and use across communities.

#### Possible follow-up actions:

- Projects should share information on repositories that will be involved in metadata catalogue work and testing, in order to avoid overlap and get better representation across domains and Research Performing Organisation types.
- Exchange formats for documenting use cases and implementation stories, and coordinate sharing of these.



#### Rec. 5: Ensure Data Management via DMPs

*“Any research project producing or collecting research data must include data management as a core element necessary for the delivery of its scientific objectives, and should address this in a Data Management Plan. The DMP should include all the relevant project outputs and be regularly updated to provide a hub of information on FAIR Digital Objects.” (TFiR, p. 65)*

DMPs, including machine-actionable DMPs (maDMPs), play a role in all stages of the data lifecycle and provide an important instrument to improve the quality of data management. Next to the more overarching guidelines, many aspects of data management are in practice defined at the level of the scientific (sub)domains. Therefore, support is needed to better reflect these domain specific contexts. PaNOSC presents an interesting example here: photon and neutron facility users have to apply for beam time, and they need to understand the volume of data they will produce. These facilities produce a lot of data, and users are not necessarily accustomed to managing large volumes, or working with DMPs. A machine-actionable DMP tool is being implemented to access the beam time proposal mechanism and ask users targeted questions (e.g. what volume of data will be created). This will assist in identifying services that can be made available from the facility to better manage the data from the outset. It will help facility managers in provisioning the resources to curate the data and analyse it. The maDMP “follows the user through the lifecycle”, as it was expressed in the discussion.

Various projects explore maDMPs. In some cases, DMPs are linked to service level agreements for service providers. At TU WIEN cost estimation is an element of the maDMP infrastructure. DMPonline<sup>33</sup> and Argos<sup>34</sup> are used as components in the ecosystem.

#### Possible follow-up actions:

- Research Infrastructures should develop and implement the “domain protocol” approach for DMPs that was initiated by Science Europe<sup>35</sup> (TFiR Action 5.3). FAIRSFAR WP3 is developing some work around DMPs with different communities and it might be useful to join forces.

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<sup>33</sup> <https://dmponline.dcc.ac.uk/>

<sup>34</sup> <https://argos.openaire.eu/>

<sup>35</sup> Science Europe: Science Europe Guidance Document Presenting a Framework for Discipline-specific Research Data Management. [https://www.scienceeurope.org/media/nsxdyvqn/se\\_guidance\\_document\\_rdmps.pdf](https://www.scienceeurope.org/media/nsxdyvqn/se_guidance_document_rdmps.pdf)



## Rec. 6: Recognise and reward FAIR data and data stewardship

*“FAIR data should be recognised as a core research output and included in the assessment of research contributions and career progression. The provision of infrastructure and services that enable FAIR data must also be recognised and rewarded accordingly.” (TFiR, page 65)*

Currently there aren't many mechanisms for recognising and rewarding FAIRness, but a couple of projects have started work, or plan to work, on incentives (NI4OS, ESCAPE, SSHOC) or are including it in institutional or domain policies (CSIC<sup>36</sup>/EGFC).

**Badging** could play a role (TFiR Action 6.3) but raises several questions about the governance, process and quality of any badging scheme. For example, who issues the badges, how are changes of the “badged” content handled, how to choose from different - i.e. competing - “flavours” of FAIR badges, how to ascertain their credibility? EOSC Synergy is carrying out work related to badging. However, their focus is on quality assurance and not primarily on FAIR. The potential role of the various EOSC working groups in developing and governing badging schemes was noted during the session.

### Possible follow-up actions:

- Exchange/publish policy examples of recognising and rewarding FAIRness (TFiR Action 6.1).
- The EOSC WG on Skills and Training could take the topic of badges for individual skills forward.
- The EOSC WG Rules of Participation could address badging that focusses on services.



## Rec. 18: Cost data management

*“Research funders should require data management costs and other relevant costs to be considered and included in grant applications where relevant. To support this, detailed guidelines and worked examples of eligible costs for FAIR data should be provided.” (TFiR, page 71)*

Research funders weren't represented in the workshop. Nevertheless, the topic of costs is being addressed in a few of the projects represented. NI4OS training on Open and FAIR RDM addresses how researchers can calculate costs to cover the steps needed across the data lifecycle, and how institutions/providers can calculate the costs of building curation services. Cost estimation is a key component in the maDMP infrastructure developed at TU WIEN. In the tinman report<sup>37</sup> the EOSC Sustainability WG presents a funding model for a Minimum Viable EOSC, which provides a good reference for institutions and projects in relation to costing the potential trade-off between increased automation and manual processes. FAIRsFAIR WP3 plans to work with data stewards and research software engineers to see how costs associated with making data FAIR are calculated, covered and communicated to researchers.

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<sup>36</sup> CSIC Open Access Mandate <https://digital.csic.es/handle/10261/179077>

<sup>37</sup> [https://www.scienceeurope.org/media/nsxdyvqn/se\\_guidance\\_document\\_rdmps.pdf](https://www.scienceeurope.org/media/nsxdyvqn/se_guidance_document_rdmps.pdf)



### Rec. 19: Select and prioritise FAIR Digital Objects

*“Research communities and data stewards should develop and implement processes to assist the appraisal and selection of outputs that will be retained for a significant period of time and made FAIR.” (TFiR, page 71)*

Selecting and prioritising FAIR digital objects appears to be a topic that is underrepresented among the participating projects. The FAIR Practice Task Force of the EOSG FAIR Working Group collects practices of different communities including some information on selecting data. The topic of this recommendation will also be addressed to some extent through guidance and training developed in FAIRsFAIR WP3. One of the FAIR Champions remarked that selection policies should be related to the long-term preservation strategies of data repositories.

#### Missing elements:

- In particular research communities and Research Infrastructures can play a larger role in defining and refining policies about what to keep and make FAIR and what not to keep. Ideally this relates to data management planning, addressing FAIRness and the level of data curation at each stage of the data lifecycle.



### Rec. 20: Deposit in Trusted Digital Repositories

*“Research data should be made available by means of Trusted Digital Repositories, and where possible in those with a mission and expertise to support a specific discipline or interdisciplinary research community.” (TFiR, page 72)*

Several projects are working with certified repositories or supporting the certification of repositories (EOSC Nordic, FAIRsFAIR, SSHOC) via the CoreTrustSeal Requirements. FAIRsFAIR is developing a maturity model linking certification guidelines and FAIR. Work is also being done on APIs (ExPaNDS/PANOSC) and on certifying certain RDM processes (NI4OS). It was remarked that putting too much strain on repositories to achieve several types of certification may be counterproductive and ineffective. Also, there is the issue that when repositories partner with other data services, these must also be trusted.

#### Possible follow-up actions:

- Next to the above-mentioned actions, mainly aimed at the repositories themselves, there is a need to provide outreach to and concrete support for researchers, e.g. on how to select TDRs for data deposit.



### Rec. 21: Encourage and incentivise reuse of FAIR outputs

*“Funders should incentivise the reuse of FAIR outputs when appropriate by promoting this in funding calls and requiring research communities to seek and build on existing content wherever possible.” (TFiR, page 72)*

Incentivising the reuse of FAIR output may not be felt to be a role that the projects can play.

The ongoing and planned activities within the different projects focus on the definition of incentives and policies to support high quality RDM and FAIR and result in recommendations for stakeholders, such as funders.

## 2.5 Pillar 3: FAIR ecosystem

**Turning FAIR into Reality Pillar 3: Creating a technical ecosystem for FAIR data** centers around FAIR Data Objects. It addresses semantic technologies and automated processing, as well certification of FAIR services and incentives for research infrastructures. Ecosystem components should meet research needs and information in DMPs should be used.



### Rec. 7: Support semantic technologies

*“Semantic technologies are essential for interoperability and need to be developed, expanded and applied both within and across disciplines.” (TFIR, page 66)*

The EOSC FAIR and Architecture Working Groups have developed a draft Interoperability Framework<sup>38</sup>; semantic interoperability is one layer of the Framework. All projects have the importance of supporting semantic technologies on their radar. About half of the INFRAEOSC-5b projects and ESFRI cluster projects focus their work on the support, promotion and use of standards, vocabularies and ontologies, and/or standard metadata schemes. Some projects have a specific focus in this area on their own domains; for example, SSHOC concentrates on their own interoperability hub. In the concluding discussion it was remarked that maintaining common vocabularies and application profiles as well as mappings between vocabularies and metadata schemes is important.

ESCAPE supports the International Virtual Observatory Alliance (IVOA) Semantics standards as part of general support of IVOA standards for Astronomy/Astroparticle ESFRIs. The IVOA has a Semantics Working Group that has produced four standards that are used for interoperability of astronomy data and services<sup>39</sup>. This includes content descriptors and a framework for vocabularies, as well as a standard on units that is not limited to astronomy. These semantics standards are implemented at some level in all services in the IVOA registry (and via the B2FIND service offered by EUDAT<sup>40</sup>). ExPaNDS/PANOSC are developing ontologies for the main application domains of Photon and Neutron science, with the aim of standardising the metadata used in facility metadata catalogues. These catalogues will then be federated through EOSC. A key point is that the use of standard ontologies will ensure that the federated EOSC metadata catalogues are based not only on common syntax, but also on common semantics.

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<sup>38</sup> <https://www.eoscsecretariat.eu/eosc-liaison-platform/post/eosc-interoperability-framework-out-comment>

<sup>39</sup> <http://ivoa.net/documents/>

<sup>40</sup> <http://b2find.eudat.eu/>

FAIRSFair has published a first set of recommendations for FAIR semantics<sup>41</sup>. The project also collaborates with repositories on semantic interoperability and common metadata interfaces. FAIRSFair will also carry out work on integration of metadata catalogues.

### Possible follow-up actions:

- FAIRSFair, SSHOC, ExPaNDs and PANOSC to explore potential synergies on metadata catalogue activity



#### Rec. 8: Facilitate automated processing

*“Automated processing should be supported and facilitated by FAIR components. This means that machines should be able to interact with each other through the system, as well as with other components of the system, at multiple levels and across disciplines.” (TFIR, page 66)*

The EOSC FAIR and Architecture Working Groups have developed a second draft of a Persistent Identifier policy for the EOSC<sup>42</sup>. The EOSC Interoperability Framework (see Rec. 7) is based on FAIR digital objects with PID references to common machine-readable semantic artefacts. Some of the projects foresee the evaluation and testing of recommendations in this area. For one or two domain-specific projects like ESCAPE the processing of large amounts of data is so fundamental to the research that the recommendation is already practice. For the majority of the domains the situation is different. EOSC-Nordic is testing machine-actionable metadata and EOSC Synergy plans automated pipelines for adding software and services to the EOSC. ExPaNDs/PANOSC focus on integrating data analysis services into EOSC. FAIRSFair is looking at the potential role of machine-actionable DMPs in supporting FAIR practice. (Machine-actionability and interoperability were also discussed in the context of other TFIR recommendations, such as recommendation 17 on DMPs.)

### Possible follow-on actions:

- FAIRSFair, EOSC Nordic, ExPaNDs and PANOSC to explore potential synergies on machine-actionable metadata and DMPs



#### Rec. 9: Develop assessment frameworks to certify FAIR services

*“Data services must be encouraged and supported to obtain certification, as frameworks to assess FAIR services emerge. Existing community-endorsed methods to assess data services, in particular CoreTrustSeal (CTS) for trusted digital repositories, should be used as a starting point to develop assessment frameworks for FAIR services. Repositories that steward data for a substantial period of time should be encouraged and supported to achieve CTS certification.” (TFIR, page 67)*

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<sup>41</sup> Le Franc, Y., Parland-von Essen, J., Bonino, L., Lehv slaiho, H., Coen, G., & Staiger, C. (2020). D2.2 FAIR Semantics: First recommendations (Version 1.0). FAIRSFair. <https://doi.org/10.5281/zenodo.3707984>

<sup>42</sup> Hellstr m, M., Heughebaert, A., Kotarski, R., Manghi, P., Matthews, B., Ritz, R., ... Wittenburg, P. (2020, May 1). Second draft Persistent Identifier (PID) policy for the European Open Science Cloud (EOSC) (Version 2.0). Zenodo. <http://doi.org/10.5281/zenodo.3780423>

The large majority of the projects foresee activities that will contribute to the implementation of this recommendation. Some of the projects still need to start up these activities. The FAIR Working Group is gathering information about the activities aiming at FAIR service certification.

There are several important elements to note here:

- First of all, it is clear that the focus is almost solely on repositories and certainly not on a large variety of services. Work is also done in the area of the FAIR assessment of data.
- Secondly, the FAIRsFAIR project plays an important linking (and in some cases guiding) role between the projects.
- Thirdly, and this is relevant for several other TFiR recommendations as well, the term “FAIR-enabling services” may be preferable to “FAIR services”<sup>43</sup>.
- Fourthly, any assessment of services depends on clearly scoped and defined services and services providers, and well-defined criteria for each.

#### **Possible follow-up actions:**

- Explore for what type of data services FAIR-enabling assessment and certification is valuable and feasible, in addition to repositories. This will also require assessors and/or certification bodies



#### **Rec. 22: Use information held in Data Management Plans**

*“DMPs hold valuable information on the data and related outputs, which should be structured in a machine-actionable way to enhance reuse. Investment should be made in DMP standards and tools that adopt common standards and support ‘active’ DMPs to enable information exchange across the FAIR data ecosystem.” (TFiR, page 72)*

Four projects mention work in this area. ExPaNDS/PaNOSC aim to develop and trial an approach to active DMPs, which integrates with the experimental lifecycle and the metadata collection that happens (e.g. automatically) throughout this lifecycle. FAIRsFAIR plans to use the RDA Common Standard for DMPs<sup>44</sup> to expose DMP metadata and content from DMPonline to support integration use cases. EOSC Synergy provides some process guidance for developing DMPs for services joining the EOSC.



#### **Rec. 23: Develop FAIR components to meet research needs**

*“While there is much existing infrastructure to build on, the further development and extension of FAIR components is required. These tools and services should fulfil the needs of data producers and users, and be easy to adopt.” (TFiR, page 73)*

In addition to activities mentioned under recommendation 9, EOSC-Pillar is developing a FAIR RDM tool set. A few other activities were mentioned that focus on research communities and inclusiveness. SSHOC wrote a report on specific challenges that users from the Social Sciences and

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<sup>43</sup> Bangert, D., Hermans, E., van Horik, R., de Jong, M., Koers, H., Mokrane, M. (2019). Recommendations for Services in a FAIR data ecosystem. <https://doi.org/10.5281/zenodo.3585742>

<sup>44</sup> Miksa, T., Walk, P., & Neish, P. (2019). RDA DMP Common Standard for Machine-actionable Data Management Plans. <https://doi.org/10.15497/rda00039>

Humanities communities face when attempting to contribute to EOSC. Task Forces of the EOSC WG FAIR have surveyed a variety of disciplinary fields on their FAIR practice, as well as interviewed many disciplines regarding interoperability.



#### Rec. 24: Incentivise research infrastructures and other services to support FAIR data

*“Research facilities, in particular those of the ESFRI and national Roadmaps, should be incentivised to provide FAIR data by including it as a criterion in the initial and continuous evaluation process. Investments should be made strategically and consider data service sustainability.” (TFiR, page 73)*

Activities relating to incentives were mentioned by just a small number of participants. EOSC Nordic will map and identify effective incentives for the uptake of FAIR practices for various stakeholders. EOSC-Pillar<sup>45</sup> mentions a federated data space incentivising the uptake of additional data spaces, which will connect data islands. Incentivising research infrastructures to support the production and use of FAIR data will also require involvement and commitment from other stakeholders than projects.

#### Missing elements:

- Machine-actionable certification assessment, which is critical since there is a need to ensure scalability, as well as transparency of the assessment process to enable correct interpretation of the outcomes. This assessment in turn depends on the implementation of TFiR recommendation 8, “facilitate automated processing”.
- Certification of services other than repositories (see also Rec. 9).

## 2.6 Pillar 4: Skills for FAIR

**Turning FAIR into Reality Pillar 4: Skills and capacity building** identifies the need for professionalising roles and curricula in data science and data stewardship.



#### Rec. 10: Professionalise data science and data stewardship roles and train researchers

*“Steps need to be taken to develop two cohorts of professionals to support FAIR data: data scientists embedded in research projects, and data stewards who will ensure the management and curation of FAIR data. All researchers also need a foundational level of data skills.” (TFiR, page 67)*

Most projects organise and provide training: for data stewards, open science officers, library and archiving staff, and partners. Sometimes this follows on from a gap analysis (ENVRI-FAIR). Training for researchers is offered within the research domain(s) of the project, or domain-independently like the RDA-CODATA-FAIRsFAIR data science/data steward school. The EOSC Skills & Training WG is charting a minimal skill set for target users of a Minimum Viable EOSC and working on recommendations for a training catalogue. Examples of collaboration are courses leveraging GO FAIR trainers (EOSC Nordic) and ENVRI-FAIR joining the EOSC-Life<sup>46</sup> school. Training formats mentioned include courses, schools (EOSC-Life), hackathons (ESCAPE, EOSC Nordic), and webinars (SSHOC).

<sup>45</sup> <https://www.eosc-pillar.eu/>

<sup>46</sup> <https://www.eosc-life.eu/>

SSHOC also developed an inventory of existing training materials. FAIRSFair is creating a competence framework that addresses both data science and data management. It also plans to work with the proposed RDA IG on Professionalising data stewardship to transfer lessons from the RSE community in establishing the Society of Research Software Engineers (RSE).

It is considered very important that training is not seen as a “one off” activity, but should be part of continuing professional development, as in any working environment.

#### Missing elements:

- Activities around establishing professional bodies or accreditation of training (TFiR Action 10.3).



#### Rec. 11: Implement curriculum frameworks and training

*“A concerted effort should be made to coordinate and accelerate the pedagogy for professional data roles. To support uptake, skills transfer schemes, fellowships, staff exchanges and informal training opportunities are needed, as well as formal curricula.” (TFiR, page 68)*

FAIRSFair works on a competence framework for FAIR for use in higher education and a competence center for knowledge materials. EOSC-Pillar is preparing a catalogue of resources aimed at the data stewards’ team/RDM support staff. ESFRI cluster projects ENVRI-FAIR and SSHOC are carrying out inventories and gap analyses of FAIR training materials. FAIRSFair, EOSC Synergy and NI4OS support and/or deliver train-the-trainer activities. NI4OS follows up their efforts by delivering training activity in the national settings.

#### Missing elements:

- Concerted efforts to coordinate the pedagogy for professional data roles.
- Fellowships and staff exchanges (TFiR Action 11.3)
- Certification and endorsement (TFiR Action 11.4). These elements are probably missing because they target activities that are on a longer timescale than the projects and stakeholders that are not well represented by the projects. Even so, for project partners who are affiliated with universities, like FAIRSFair, the university would be a route for progress.

## 2.7 Pillar 5: Incentives and metrics for FAIR data and services

**Pillar 5: Incentives and metrics for FAIR data and services** identifies the need to develop metrics to certify FAIR objects and services and their implementation.



#### Rec. 12: Develop metrics for FAIR Digital Objects

*“A set of metrics for FAIR Digital Objects should be developed and implemented, starting from the basic common core of descriptive metadata, PIDs and access. The design of these metrics needs to be guided by research community practices and they should be regularly reviewed and updated.” (TFiR, page 68)*



With a dedicated “metrics and certification taskforce” in the EOSC FAIR Working Group, the topic was well discussed. Several projects are using, testing and assessing FAIR metrics. FAIRsFAIR developed Object assessment metrics and pilots will be run to help the assessment of individual datasets within repositories that focus on researchers (manual awareness raising tool) and repositories (automated FAIR data assessment). The RDA FAIR Data Maturity evaluation guidelines<sup>47</sup> have been tested by different projects (FAIRsFAIR, EOSC Nordic, ESCAPE) while work is still ongoing on the definition of FAIR software by the recently proposed RDA/Force11 WG “FAIR for research software”<sup>48</sup>. In terms of community practice, the ENVRI-FAIR project is implementing the result of an assessment activity of metrics into a common system for the environmental research infrastructures.

In the discussion about metrics - of objects and services - it is remarked that these may change or have to change over time, when the understanding and the level of implementation of FAIRness develop. There is concern in the EOSC WG FAIR about drawing conclusions from metrics which haven't been fully tested in the context in which they are applied.

#### Missing elements to both Recommendations 12 and 13:

- Developing a governance process for the maintenance and revision of metrics and associated assessment processes is important.



#### Rec. 13: Develop metrics to certify FAIR services

*“Certification schemes are needed to assess all components of the ecosystem as FAIR services. Existing frameworks like CoreTrustSeal (CTS) for repository certification should be used and adapted rather than initiating new schemes based solely on FAIR, which is articulated for data rather than services.” (TFiR, page 68)*

Similarly, to Recommendation 12, this recommendation is also being tackled by different initiatives but it looks like the majority of the work is done around repositories. The EOSC-Nordic project seems to be the only one working on a “surface maturity framework” to evaluate services other than repositories (though not with the intention to certify them). The EOSC FAIR WG Metrics and Certification Task Force works on a recommendation on certification for FAIR-enabling services in collaboration with FAIRsFAIR WP2 & 4. SSHOC and ENVRI-FAIR are working on tackling community practice repositories.

#### Missing elements to both Recommendations 12 and 13:

- Developing a governance process for the maintenance and revision of metrics and associated assessment processes is important.

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<sup>47</sup> RDA FAIR Data Maturity Model Working Group (2020). FAIR Data Maturity Model: specification and guidelines. Research Data Alliance. DOI: 10.15497/RDA00050

<sup>48</sup> <https://www.rd-alliance.org/groups/fair-4-research-software-fair4rs-wg>

### Possible follow-up actions:

- Effectiveness of metrics: because metrics are not yet robust nor substantially applied, one should not place too much emphasis on metrics and also be cautious when applying them automatically. They should be used constructively to improve services, complementary to for instance maturity evaluation and self-assessments.
- Quantitative metrics are important but qualitative metrics are also useful and necessary. Human mediated assessments based on community-agreed best practices are an important step towards identifying quantifiable approaches. Metrics should be clearly (reproducibly) measurable if they are to be used for auditing/certifying repositories, particularly if this process is to scale.



#### Rec. 25: Implement and monitor metrics

*“Agreed sets of metrics should be implemented and monitored to track changes in the FAIRness of data sets or data-related resources over time. Funders should report annually on the outcomes of their investments in FAIR and track how the landscape matures.” (TFiR, page 74)*

This recommendation is seen as quite difficult to achieve since there is no consensus yet on tools, metrics and badges. It also depends on the development of Recommendations 12 and 13. It is also seen as quite challenging to measure FAIR with evolving tools and evolving metrics.

### Possible follow-up actions:

- Organise assessment and comparisons of metrics tools: are the outcomes of competing tools comparable, when applied to the same data set or repository? Do users - potential FAIRness auditors included - apply them in the same way?



#### Rec. 26: Support data citation and next generation metrics

*“Systems providing citation, reuse and impact metrics for FAIR Digital Objects and other research outputs should be provided. In parallel, next generation metrics that reinforce and enrich citation-centric metrics for evaluation should be developed.” (TFiR, page 74)*

Apparently the SSHOC project is the only one working on developing citation practices, namely on an inventory of citation practices in the field of social sciences and humanities, and it is planning to integrate these into SSH catalogues.<sup>49</sup>

## 2.8 Pillar 6: Investment in FAIR

In **Turning FAIR into Reality Pillar 6: Investment in FAIR** the overall questions for the projects in the context of this pillar would be:

- How are they contributing to a view of coordination and strategic funding?

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<sup>49</sup> One of the reviewers commented: “To develop next generation metrics was somehow seen as a longer-term recommendation by the TFiR authors (but it may not be said explicitly in TFiR)”.

- What are they saying that contributes to a view of the strategically important parts of the FAIR ecosystem and how funding can be coordinated to meet these objectives?



#### Rec. 14: Provide strategic and coordinated funding

*“Funders should adopt a coordinated approach to supporting core infrastructure and services, building on existing investments where appropriate. Funding should be tied to certification schemes, sustainable business models and other community-vetted indicators that demonstrate viability.” (TFiR, page 69)*

This recommendation is specifically focused on the funders as the primary stakeholders. However, other organisations have a role in contributing to the coordinated and strategic approach to sustain a FAIR ecosystem.

The EOSC FAIR Working Group has a metrics and certification taskforce and emphasises that these topics are important for funders, because of the need to make choices and funding decisions, which relate to quality and trust. This, however, should be done carefully, taking into account the needs of users. The EOSC Landscape Working Group is creating an inventory of national Open Science and FAIR data policy and practice.

The discussion of this recommendation showed that almost none of the projects are actually implementing this specific recommendation. Nevertheless, topics like the sustainability of project outputs and DMPs are in the work plans of projects. In some projects more general work is done in the area of policy recommendations that could be useful in the context of this recommendation. The FAIRsFAIR project, for example, recommends clarification on eligible RDM and data sharing and more equitable business models to ensure that the costs of making and keeping data FAIR over time is split more equally between stakeholders.

The ESCAPE project expressed the view that strategic and coordinated funding should be connected to scientific bodies, physical infrastructures and networks that have knowledge of and an influence on the domain. These are important in considerations of funding and sustainability.

There was also broad support for the statement that helping large infrastructures to get on board EOSC and linking and interoperating with EOSC is one pathway to improve sustainability of infrastructure and services. Activities will be combined with the other infrastructures and in the EOSC sustainability model. The success of the cluster and other projects will furthermore improve the sustainability of large infrastructures in particular domains.



#### Rec. 15: Provide sustainable funding

*“Funders who issue requirements on FAIR must provide support to ensure the components of the FAIR ecosystem are maintained at a professional service level with sustainable funding. Service providers should explore multiple business models and diverse income streams.” (TFiR, page 69)*

This recommendation is also specifically focused on the funders as the primary stakeholders.

Again, with respect to sustainable funding and business models, the activities in the projects are mostly limited to the sustainability of the project outcomes. Still it was acknowledged that the projects do have a role to play in terms of informing funders' strategies for sustainable funding and on the FAIR guidelines and requirements that are needed to ensure a FAIR ecosystem. One example is the FAIR certification of data services and data objects. These mechanisms include requirements and assessment methods, being tested in the project with the community.

There was general agreement that it is essential for the business models to be sustainable and transparent so that the purchasers of services can make informed decisions. It was also noted that we need to make sure that (domain-specific) infrastructure components that have already been built are also sustained.



#### Rec. 27: Open EOSC to all providers but ensure services are FAIR

*“The Rules of Participation for EOSC must be based on the diverse mix of infrastructure and tools currently in use to enable service providers from all sectors to be part of EOSC. The Rules should ensure that services are FAIR-compliant and use open APIs and interchange standards.” (TFiR, page 75)*

The Rules of Participation are developed in the context of the EOSC governance with a wide stakeholder input. This work is not directly within the remit of the projects; one project remarked that what is expected to “ensure that services are FAIR-compliant” is not very clear. However, a couple of projects work on this topic, e.g. the FAIR Working Group, which also addresses inclusiveness of different community practices. Migration of regional services towards EOSC (NI4OS) and integration into EOSC are mentioned, as is a “Handbook” on how to integrate national clouds, thematic resources, and data repositories conformant to common quality standards, and harmonised in terms of technological, policy, and legal aspects (EOSC Synergy).

### 3. Findings and recommendations




This report presents the outcomes of the second FAIRsFAIR Synchronisation Force workshop, which was organised online as a series of eight sessions from 29th of April 2020 until 11th of June 2020. In this workshop representatives of EOSC-related projects and working groups - though several participants wore more than one hat - exchanged information about their FAIR-related activities.













The report addresses the EOSC Executive Board and Governing Board and their successors, as well as the European Commission’s EOSC programme (together called “the EOSC Governance” in this report), in addition to the participants and other EOSC-related initiatives.

#### 3.1 Overview of workshop findings

With the proviso that this is a snapshot in time which is based on input from many but obviously not all EOSC-related initiatives, the following table summarises the amount of activity with regards to the 27 recommendations from the *Turning FAIR into Reality* report. When asked in the final session, the participants mostly agreed that the coding of each pillar is an accurate representation of progress<sup>50</sup>.

Legend:

-  many activities support this recommendation
-  some activities support this recommendation
-  hardly any or no activities support this recommendation

Concepts for FAIR implementation	FAIR culture	FAIR ecosystem	Skills for FAIR	Incentives and metrics for FAIR data & services	Investment in FAIR
1: Define FAIR for implementation 	4: Develop interoperability frameworks 	7: Support semantic technologies 	10: Professionalise data science & stewardship roles 	12: Develop metrics for FAIR digital output 	14: Provide strategic and coordinated funding 
2: Implement a model for FAIR digital objects 	5: Ensure data management via DMPs 	8: Facilitate automated processing 	11: Implement curriculum frameworks and training 	13: Develop metrics to certify FAIR services 	15: Provide sustainable funding 

<sup>50</sup> At that moment, we used a three-way colour coding. The question in a Mentimeter live polling was “Is the colour coding an accurate representation of progress in relation to this pillar?”, with options “Accurate/Too negative/Too positive”. The response was: Pillar 1: 21/4/3. Pillar 2: 19/2/4. Pillar 3: 19/2/4. Pillar 4: 17/1/4. Pillar 5: 17/5/1. Pillar 6: 21/2/0. (The number of responses varies between 22 and 28.) In response to feedback, we replaced the colour coding with the circle segment icons used in the current report.

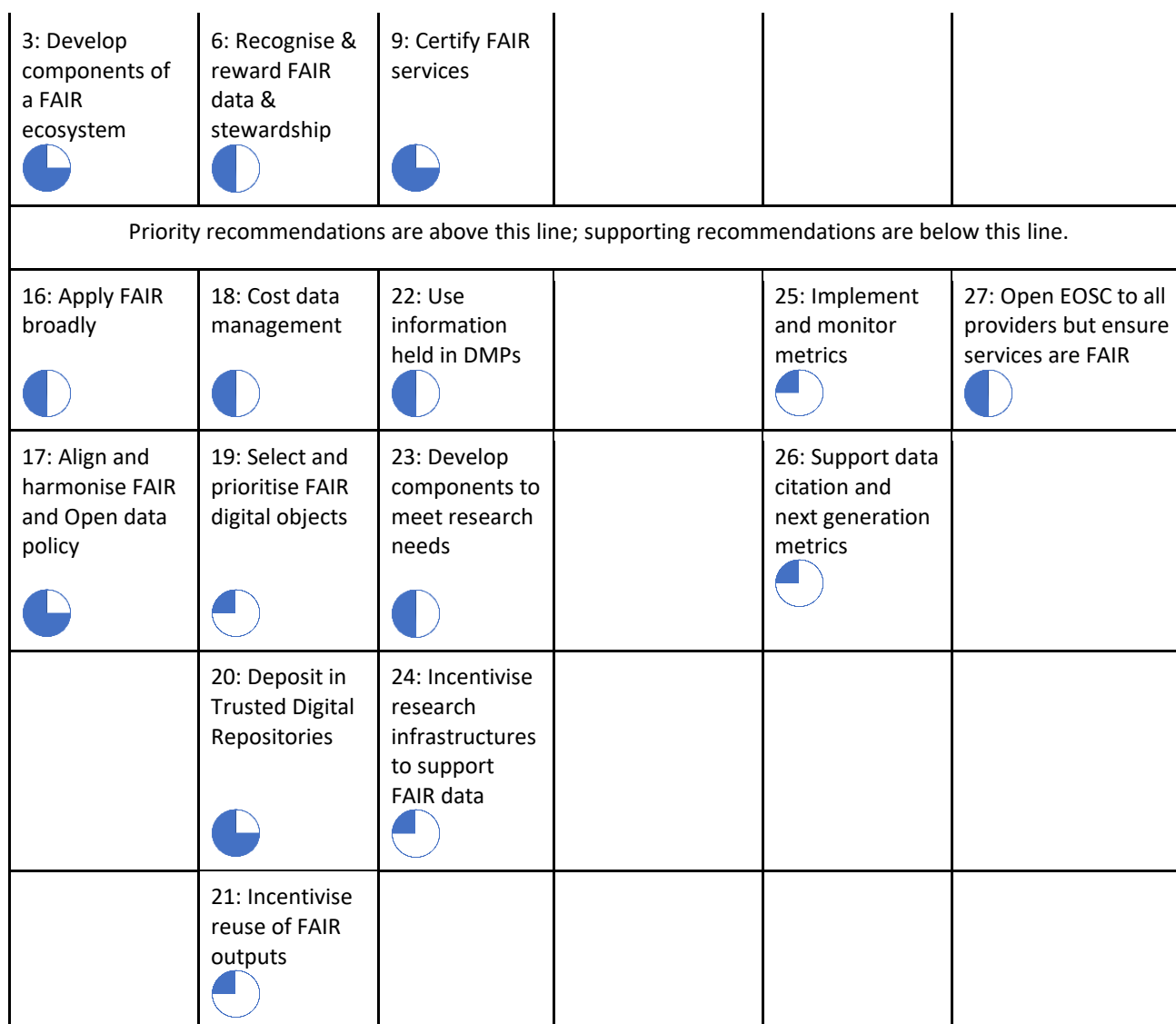


Figure 3. Extent of project activities per TFiR recommendation

### 3.2 Overall conclusion and recommendation

The series of eight workshop sessions resulted in a number of overall findings that can be summarised as follows:

- the EOSC-related projects, working groups, and FAIR Champions involved in the workshop are contributing to varying degrees towards the implementation of all but one of the TFiR pillars;
- the projects show less activity in relation to the pillar 6 recommendations on the investment in FAIR and sustainability. This is understandable given the temporary nature of the projects and the fact that these recommendations on funding and sustainability primarily aim at other stakeholder groups.
- Overall, the focus of the activities within the projects is on the TFiR priority recommendations.

The overall recommendation is that **the EOSC Governance should look at the TFiR recommendations 6, 8, 11, and 13** (coded as “some activities support this recommendation”) **and determine whether**

**extra activity is needed and whether some of these could be provided through EOSC co-creation activities, through HorizonEurope funding or through other means.**

We also recommend that the **EOSC Governance should analyse why there is little activity regarding the TFiR recommendations 14, 15, 19, 21, 24, 25, and 26** (coded as “hardly any or no activities support this recommendation”) - for instance because of the projects’ scope, the suggested stakeholders, or recommendations depending on progress made in other areas - and which actions could remedy this.

A mitigating circumstance that should be noted here is the mismatch in timing between the definition of the work in the different projects (the proposal-writing phase) and the start of the planning and work of the EOSC Governance and the Working Groups. This made it impossible to achieve optimal alignment between the work in the projects and the agendas of the WGs. In addition, not all relevant stakeholders participated in the workshop (see Section “Next steps”).

### 3.3 TFiR-related conclusions and recommendations

The original 27 TFiR recommendations, clustered in six pillars, are still very relevant and constitute a useful benchmark for measuring how projects and EOSC Working Groups progress towards turning FAIR into reality. Having said this, in TFiR, a lot of the crucial detail for implementation is expressed in the actions associated with each recommendation. The TFiR Action Plan was too large and detailed to be used as a tool in a workshop like this, which obliged us to focus discussion on the recommendations rather than the actions. Even so, the workshop findings allow us to propose additional actions that address some gaps in the TFiR Action Plan that were identified by the workshop discussions.

#### **Pillar 1: Concepts for FAIR Implementation**

##### **Define PID services**

In Recommendation 2 ‘Implement a model for FAIR Digital Objects’, the TFiR report argues that FAIR Digital Objects ‘by definition, have a PID linked to different types of essential metadata including provenance and licencing.’ Action 2.1 calls for the ‘universal use of appropriate PIDs for FAIR Digital Objects needs to be facilitated and implemented.’ Unspecified in the TFiR recommendations and actions (and therefore a useful addition) would be the need to develop policies and guidance for PID services, including the precise functions they need to fulfil and criteria for assessment. Any such policies and guidance should recognise that PIDs are possibly the most mature part of the FAIR ecosystem, witness the information in the PID Forum<sup>51</sup>. Work on this is underway in the EOSC Architecture and FAIR Working Groups.

*This could be added to the TFiR structure as Action 3.1bis<sup>52</sup>.*

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<sup>51</sup> <https://www.pidforum.org/c/knowledge-hub>

<sup>52</sup> “bis” here is an indication that the new action should logically follow 3.1 and come before 3.2. It doesn't necessarily depend on the preceding action.

## Pillar 2: FAIR Culture

### **Support the application of FAIR for data that needs to be protected**

Data from publicly funded research should be as open as possible, as closed (protected) as necessary. There are legitimate reasons for restricting access to data, for protecting data, and various proportionate means of doing so (embargoes, data safe havens et cetera). It can be argued that the implementation of FAIR for protected data should be better addressed. It should be underlined that the potential open sharing of data or other outputs is not the only driver for FAIR. More support and guidelines should be provided for researchers and research institutions to make data and other outputs FAIR even if for legitimate reasons they cannot be openly shared. Work on 'FAIR for data that needs to be protected' would be extremely valuable. Important components include leveraging existing ethics expertise, frameworks and processes, community agreements and guidelines, clear expression of legal and ethical frameworks, and the provision of training in FAIR for protected data. A useful starting point is also early lifecycle attention to FAIR for pre-shared data. FAIR will benefit research groups' data stewardship, whether or not the data can ultimately be open. Research communities that work with data that needs to be protected and is accessible only under strict conditions, need to be reassured that FAIR is relevant to them.

*This could be added to the TFiR structure as Recommendation 4bis or Action 4.6.*

## Pillar 3: FAIR Ecosystem

### **Ensure the purpose and effectiveness of automated assessment is regularly reviewed**

Automated assessment of FAIR services will likely be necessary in order for such assessment to scale, so this could be added as a recommendation or action. Nevertheless, caution is necessary. The development of criteria and their application through algorithms can be gamed and entrench biases. No technology is neutral. So, any automation requires thorough consultation and testing, and for the feedback to be treated seriously and taken into account.

*This could be added to the TFiR structure as Action 9.4bis.*

### **Prepare a priority list of services that would benefit from FAIR assessment and certification**

As observed in TFiR Recommendation 9, certification and other forms of assessment of FAIR services are important and extend beyond repositories. A useful additional recommendation would be a priority list of services which would benefit from such assessment. Any such statement should clearly articulate the purpose and need for such assessment and propose draft criteria.

*This could be added to the TFiR structure as Action 9.2bis.*

### **Develop guidelines (and where useful) metrics for FAIR software**

FAIR software and the application of FAIR principles to software is important, and sometimes neglected. Software plays an important role in the research and the FAIR ecosystem. The way in



which FAIR is applied to software, and the development of any related guidelines and metrics, needs further work and clear recommendations (cf. RDA-FORCE11-ReSA Working Group<sup>53</sup>).

*This could be added to the TFiR structure as Action 9.3bis.*

### **Rec. 23: Develop FAIR components to meet research needs**

It was observed a number of times during the virtual workshops that the position of Recommendation 23 ‘Develop FAIR components to meet research needs’ as a supporting recommendation rather than a priority recommendation was not ideal and gave the wrong impression. It is necessary to prioritise recommendations, but it was agreed that the involvement of research communities in the development of components of the FAIR ecosystem should be a priority. These discussions included a number of members of the Expert Group that authored the TFiR report, as well as members of current EOSC GB WGs, all of whom supported this argument. We recommend, therefore, that Rec. 23 should be considered a priority recommendation and presented as such in future iterations of the TFiR Action Plan.

*Rec.23 to be positioned as a priority recommendation in the column on the FAIR Ecosystem.*

## **Pillar 4: Skills for FAIR**

### **Professionalise FAIR training for all support staff**

The FAIR and data related training needs of all personnel involved in research projects (beyond researchers *sensu stricto*, data scientists and data stewards) should be addressed and professionalised. This includes, but is not limited to, laboratory personnel, research/university libraries staff, technicians, research software engineers and similar support roles. This requires the adaptation of data related curricula for the needs of these roles.

*This could be added to the TFiR structure as Action 10.5*

## **Pillar 5: Incentives and Metrics**

### **The purpose and effects of FAIR metrics should be regularly reviewed with active input from research communities.**

TFiR Action 12.3 states that ‘Metrics need to be regularly reviewed and updated to ensure they remain fit-for-purpose.’ This cannot be sufficiently emphasised. Of paramount importance is **to define clearly and to review the purpose of the metric and whether the implementation of the metric is achieving that purpose**. Research communities need to be intrinsically involved with such reviews. Additionally, there needs to be continual interaction between an evolving map and catalogue of the FAIR ecosystem and the criteria by which any metrics and incentives are devised.

*This could be added to the TFiR structure as Action 12.4*

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<sup>53</sup> <https://www.rd-alliance.org/groups/fair-4-research-software-fair4rs-wg>

### Governance of the FAIR principles?

The argument was made during the virtual workshops, that there should be some process to govern and revise the FAIR principles. The case for this was as follows: the FAIR principles are being used to develop metrics, assessments and certification. They may need to be modified if it is found they do not correspond to or promote good practice, in some details. An example given was that the FAIR principles state that both the data and the related metadata should each be assigned a (distinct) globally unique and persistent identifier. A logical and technical case may be made in favour of this: the data and the metadata are not the same thing and a distinct PID can facilitate machine actionability. On the other hand, this has not generally been the practice of many extremely professional and longstanding repository services. One good (if not completely overwhelming) reason for this, is that metadata are often further enriched. Should these repositories' rating and certification be downgraded if it is felt contrary to existing practice and unnecessary to assign a distinct PID to the metadata? Finally, it should be observed that the original presentation of the FAIR principles underlines their 'modularity' and stresses the notion that they represent a continuum towards improved machine actionability. As examples of good practice, a number of repositories and data services are listed in the Scientific Data article,<sup>54</sup> which do not use distinct PIDs for data and metadata.

Ultimately, it is not our recommendation that a governance process should be established to update and modify the FAIR guiding principles. They are what they are and, in any case, should serve as a guide, not as articles of faith from which nothing can deviate in any circumstances. Metrics for EOSC, for repositories and the FAIR ecosystem, should not *necessarily* feel bound to follow a strict interpretation of the existing FAIR principles. If there are issues which for pragmatic reasons or for accepted practice do not follow the apparent letter of the principles as published, then resultant guidelines and metrics - and the TFiR Action Plan or subsequent document - should be adjusted in a reasoned and transparent way. Effort would be better expended ensuring that metrics and certification are implemented with appropriate judgement, with transparency and feedback, and do not do an unnecessary disservice to good established practice.

### Pillar 6: Investment in FAIR

#### Strategic investment needs to consider the whole FAIR ecosystem

In order to provide sustainable and strategic funding of the FAIR ecosystem, there needs to be some process to identify priorities and to express the needs of research communities. A real challenge is that some parts of the FAIR ecosystem (including semantics, stewardship, software) are frequently neglected and their cost and importance underestimated. Many of these components, furthermore,

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<sup>54</sup> Wilkinson, M., Dumontier, M., Aalbersberg, I. et al. The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* 3, 160018 (2016). <https://doi.org/10.1038/sdata.2016.18>

rely on the efforts of research communities, which need support in developing and maintaining these things. Evidence and expertise need to be mobilised in support of such neglected parts of the FAIR ecosystem.

*This could be added to the TFiR structure as Action 14.4*

### **Sustain funding models for distributed services as well as for centralised facilities**

Centralised and distributed infrastructures each have vulnerabilities from the perspective of sustainability. From a funding perspective centralised facilities are often secure while prioritised but have a single point of failure. Distributed services are vulnerable to attrition, neglect and unequal provision. The sustainability strategy (and robust business models and funding mechanisms) need to address a variety of models.

*This could be added to the TFiR structure as Action 15.4*

## **4. Next steps: the third workshop**

From the high level of participation in the second FAIRsFAIR Synchronisation Force workshop we can conclude that this workshop was a very valuable initiative to bring people together who may not meet otherwise. It was an occasion for the projects to learn what the other projects are doing, and to share good practices, concerns, et cetera. The workshop also informs the EOSC Working Groups. The organisers were pleasantly surprised that several participants made time to contribute to all or nearly all of the eight virtual sessions, spanning from late April to mid-June. Many of them also involved colleagues who had more experience with specific topics.

The evaluation in the final session confirms that the value for the participants, as intended, lies in getting an overview of the landscape, as can be seen from responses like “Coming from one cluster project, the workshop was very valuable to get a better picture of the wider landscape of stakeholders” and “To have a status update on where we stand with TFiR. It’s encouraging, but still a long way to go”. 9 out of 22 participants responding to the live evaluation poll indicate that they will reach out to other projects or working groups, 8 others will take a look at other projects’ deliverables or tools, and 4 will carry out follow-up actions suggested in this report.

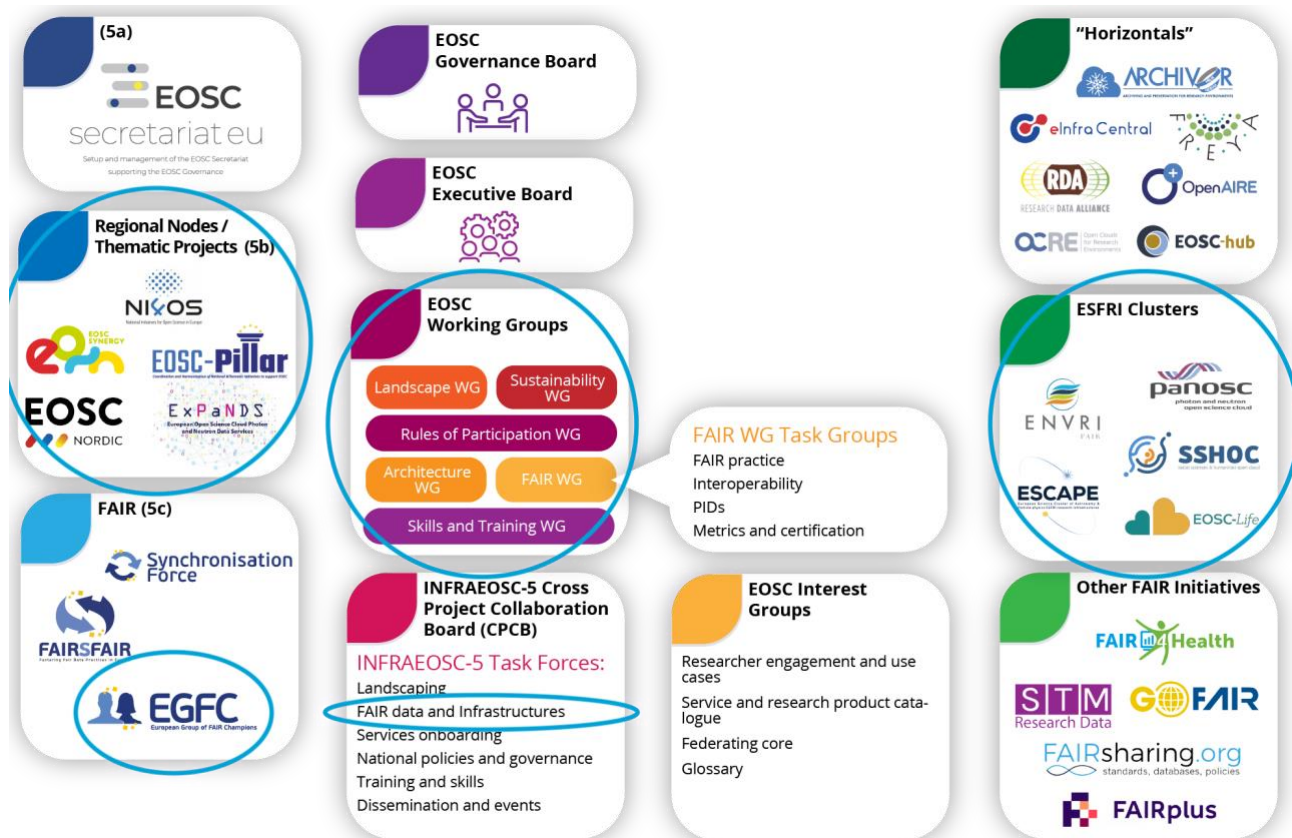
However, not all invited stakeholders were able to join the workshop. We didn’t fully succeed in involving the ESFRI cluster projects, with their large span of projects and domains. Also, not all EOSC Working Groups were represented. This probably impacts the findings reported in this report. In addition, the horizontal e-infrastructure projects had not been invited to the current workshop.

The e-infrastructure projects will be invited to the third Workshop of the Synchronisation Force in the first half of 2021, when we will take another and final snapshot of the status of the implementation of the recommendations from the *Turning FAIR into Reality* report. FAIRsFAIR will also consider how better to engage the ESFRI cluster projects and (successors of) the EOSC Working Groups in the preparation of that workshop.

## Annex 1 - Stakeholders invited to the second workshop

The stakeholders marked in Figure 4 were invited to participate in the second Synchronisation Force workshop.

Figure 4. FAIRsFAIR primary stakeholders within the EOSC ecosystem; invitees highlighted



**EOSC Working Groups:** EOSC Working Groups<sup>55</sup> (2019-2020) form an official part of the EOSC Governance structure that will ensure a community-sourced approach to the current challenges of the EOSC. There are six Working Groups: on FAIR<sup>56</sup>, Landscape<sup>57</sup>, Architecture<sup>58</sup>, Rules of Practice<sup>59</sup>, Skills and Training<sup>60</sup>, and Sustainability<sup>61</sup>. Several Working Groups have topical Task Forces.

**INFRAEOSC-5 projects:** alongside the EOSC Secretariat<sup>62</sup> and FAIRsFAIR, five regional nodes or thematic projects receive funding in the Horizon INFRAEOSC-5 call. These are EOSC Nordic<sup>63</sup> (Nordic

<sup>55</sup> <https://www.eoscsecretariat.eu/eosc-working-groups>

<sup>56</sup> <https://www.eoscsecretariat.eu/working-groups/fair-working-group>

<sup>57</sup> <https://www.eoscsecretariat.eu/working-groups/landscape-working-group>

<sup>58</sup> <https://www.eoscsecretariat.eu/working-groups/architecture-working-group>

<sup>59</sup> <https://www.eoscsecretariat.eu/working-groups/rules-participation-working-group>

<sup>60</sup> <https://www.eoscsecretariat.eu/working-groups/skills-training-working-group>

<sup>61</sup> <https://www.eoscsecretariat.eu/working-groups/sustainability-working-group>

<sup>62</sup> <https://www.eoscsecretariat.eu/>

<sup>63</sup> <https://www.eosc-nordic.eu/>

and Baltic countries), EOSC Pillar<sup>64</sup> (Open Science across Austria, Belgium, France, Germany and Italy), EOSC Synergy<sup>65</sup> (national publicly-funded digital infrastructures), ExPands<sup>66</sup> (EOSC Photon and Neutron Data Service), and NI4OS-Europe<sup>67</sup> (National Initiatives 4 Open Science in Europe). All INFRAEOSC-5 projects collaborate in topical Task Forces. For this workshop the members of the Task Force FAIR data and infrastructure have been invited.

**FAIR Champions:** the European Group of FAIR Champions (EGFC)<sup>68</sup> was initiated by FAIRSFair and is composed of scientific experts and “doers” in the field of FAIR data, who work as ambassadors.

**ESFRI Cluster projects:** five cluster projects were launched in early 2019, namely ESCAPE<sup>69</sup>, ENVRI-FAIR<sup>70</sup>, SSHOC<sup>71</sup>, PaNOSC<sup>72</sup> and EOSC-Life<sup>73</sup>. These five initiatives gather projects from the European Strategy Forum on Research Infrastructures (ESFRI)<sup>74</sup> and European Landmarks, to cover the scientific domains of Astronomy and particle physics, Environmental research, Social Sciences and Humanities, Photon and Neutron research, and Life sciences, respectively.

In addition to these stakeholders, also Project officers from the European Commission have been invited to the workshop.

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<sup>64</sup> <https://www.eosc-pillar.eu/>

<sup>65</sup> <https://www.eosc-synergy.eu/>

<sup>66</sup> <https://expands.eu/>

<sup>67</sup> <https://ni4os.eu/>

<sup>68</sup> <https://www.fairsfair.eu/advisory-board/egfc>

<sup>69</sup> <https://projectescape.eu/>

<sup>70</sup> <https://envri.eu/home-envri-fair/>

<sup>71</sup> <https://www.sshopencloud.eu/>

<sup>72</sup> <https://www.panosc.eu/>

<sup>73</sup> <https://www.eosc-life.eu/>

<sup>74</sup> <https://www.esfri.eu/>

## Annex 2 - List of participants

	Name	Surname	Organization Type	Affiliation	Country	Stakeholder
1	Mark	Allen	Research Infrastructures & e-Infrastructures	Strasbourg Astronomical Data Centre (CDS)	France	FAIRsFAIR Champion , ESCAPE
2	Andreas	Athenodorou	Universities and Research Performing Organisations	The Cyprus Institute & University of Pisa	Cyprus	(5b) EOSC-NI4OS
3	Rossella	Aversa	Research Infrastructures & e-Infrastructures	Karlsruher Institut für Technologie (KIT)	Germany	
4	Daniel	Bangert	Universities and Research Performing Organisations	University of Göttingen	Germany	FAIRsFAIR
5	Lisana	Berberi	Universities and Research Performing Organisations	KIT	Germany	(5b) EOSC-Pillar
6	Isabel	Bernal	Universities and Research Performing Organisations	CSIC	Spain	FAIRsFAIR Champion
7	Tracey	Biller	Small-Medium Enterprises (SMEs)	Trust-IT Services	Italy	FAIRsFAIR
8	Carlos	Casorran	Research Funding Organisations & National Agencies	European Commission	Belgium	European Commission
9	Neil	Chue Hong	Universities and Research Performing Organisations	Software Sustainability Institute / University of Edinburgh	United Kingdom	EOSC WG - FAIR
10	Gerard	Coen	Research Infrastructures & e-Infrastructures	Data Archiving & Networked Services	Netherlands	(5b) EOSC-Synergy
11	Joy	Davidson	Universities and Research Performing Organisations	Digital Curation Centre, University of Glasgow	United Kingdom	FAIRsFAIR

12	Anusuriya	Devaraju	Research Infrastructures & e-Infrastructures	MARUM_PANGAEA	Germany	FAIRsFAIR
13	Ingrid	Dillo	Research Infrastructures & e-Infrastructures	Data Archiving & Networked Services	Netherlands	FAIRsFAIR
14	Claudia	Engelhardt	Universities and Research Performing Organisations	UGOE	Germany	FAIRsFAIR
15	Vinciane	Gaillard	Other	European University Association	Belgium	EOSC WG - Skills and Training
16	Francoise	Genova	Universities and Research Performing Organisations	CDS/Observatoire Astronomique de Strasbourg	France	EOSC WG - FAIR
17	Alejandra	Gonzalez-Beltran	Universities and Research Performing Organisations	Science and Technology Facilities Council	United Kingdom	(5b) EOSC-ExPaNDS
18	Carole	Goble	Universities and Research Performing Organisations	The University of Manchester	United Kingdom	ESFRI ELIXIR, EOSC-Life
19	Heike	Görzig	Research Infrastructures & e-Infrastructures	Helmholtz-Zentrum Berlin (HZB)	Germany	(5b) EOSC-PaNOSC
20	Marjan	Grootveld	Specialised Service Providers	Data Archiving & Networked Services	Netherlands	FAIRsFAIR
21	Natalie	Harrower	Research Infrastructures & e-Infrastructures	Digital Repository of Ireland	Ireland {Republic }	EOSC FAIR working group
22	Simon	Hodson	Other	CODATA	France	FAIRsFAIR
23	Andreas	Jaunsen	Research Infrastructures & e-Infrastructures	Nordforsk	Norway	(5b) EOSC-Nordic
24	Maria	Johnsson	Universities and Research Performing Organisations	Lund University	Sweden	FAIRsFAIR Champion
25	Nick	Juty	Universities and Research	The University of Manchester	United Kingdom	FAIRplus, EOSC-

			Performing Organisations			Enhance, ESFRI EOSC-Life
26	Fotis	Karayannis	Research Infrastructures & e-Infrastructures	STFC	United Kingdom	n.a.
27	Gabin	Kayumbi	Research Infrastructures & e-Infrastructures	STFC	United Kingdom	FAIRsFAIR
28	Mari	Kleemola	Research Infrastructures & e-Infrastructures	Finnish Social Science Data Archive	Finland	(5b) EOSC-Nordic
29	Hervé	L'Hours	Research Infrastructures & e-Infrastructures	UK Data Archive, UK Data Service, University of Essex	United Kingdom	FAIRsFAIR
30	Monica	Lassi	Universities and Research Performing Organisations	Lund University, EOSC Nordic	Sweden	(5b) EOSC-Nordic
31	Oonagh	Mannix	Universities and Research Performing Organisations	HZB	France	n.a.
32	Branko	Marović	Universities and Research Performing Organisations	University of Belgrade Computer Center	Serbia	(5b) NI4OS
33	Paula	Martinez	Universities and Research Performing Organisations	National Imaging Facility, The University of Queensland	Australia	n.a.
34	Abigail	McBirnie	Research Funding Organisations & National Agencies	UKRI/STFC	United Kingdom	(5b) EOSC-ExPaNDS
35	Rita	Meneses	Small-Medium Enterprises (SMEs)	TRUST-IT Services	Italy	FAIRsFAIR
36	Mustapha	Mokrane	Research Infrastructures & e-Infrastructures	DANS	Netherlands	FAIRsFAIR
37	Elizabeth	Newbold	Research Infrastructures & e-Infrastructures	STFC	United Kingdom	FAIRsFAIR



38	Josefine	Nordling	Research Infrastructures & e-Infrastructures	CSC	Finland	FAIRsFAIR
39	Pilar	Ocon	Policy Making Organisations	European Commission	Belgium	European Commission
40	Milan	Ojsteršek	Universities and Research Performing Organisations	University of Maribor	Slovenia	EOSC WG - FAIR
41	Elli	Papadopoulou	Universities and Research Performing Organisations	Athena Research Center	Greece	(5b) NI4OS
42	Jessica	Parland-von Essen	Research Infrastructures & e-Infrastructures	CSC	Finland	FAIRsFAIR
43	Sara	Pittonet Gaiarin	Small-Medium Enterprises (SMEs)	Trust-IT Services	Italy	FAIRsFAIR
44	Vanessa	Proudman	Other	SPARC Europe	Netherlands	FAIRsFAIR
45	Silvia	Ramos	Universities and Research Performing Organisations	Diamond Light Source	United Kingdom	(5b) EOSC-ExPaNDS
46	Andreas	Rauber	Universities and Research Performing Organisations	TU Wien	Austria	FAIRsFAIR Champion
47	Kostas	Repanas	Policy Making Organisations	European Commission	Belgium	European Commission
48	Olivier	Rouchon	Universities and Research Performing Organisations	CINES	France	(5b) EOSC-Pillar
49	Bregt	Saenen	Policy Making Organisations	European University Association	Belgium	FAIRsFAIR
50	Susanna-Assunta	Sansone	Universities and Research Performing Organisations	University of Oxford	United Kingdom	FAIRsFAIR Champion

51	Birgit	Schmidt	Universities and Research Performing Organisations	University of Göttingen	Germany	FAIRsFAIR
52	Hugh	Shanahan	Universities and Research Performing Organisations	Royal Holloway, University of London	United Kingdom	FAIRsFAIR
53	Barbara	Sierman	Universities and Research Performing Organisations	KB National Library of the Netherlands	Netherlands	FAIRsFAIR Champion
54	Eefke	Smit	Other	International Association of STM Publishers	Netherlands	FAIRsFAIR Champion
55	Emanuel	Soeding	Universities and Research Performing Organisations	GEOMAR Computer Center	Germany	GO-FAIR
56	Lennart	Stoy	Policy Making Organisations	EUA	Belgium	FAIRsFAIR
57	Jonathan	Taylor	Research Infrastructures & e-Infrastructures	European Spallation Source ERIC	Sweden	ESFRI-PaNOSC
58	Marta	Teperek	Universities and Research Performing Organisations	TU Delft	Netherlands	EOSC Working Group FAIR
59	Erzsébet	Tóth-Czifra	Research Infrastructures & e-Infrastructures	DARIAH-EU	Germany	ESFRI DARIAH
60	Sadia	Vancauwenbergh	Universities and Research Performing Organisations	ECOOM UHasselt euroCRIS	Belgium	EOSC WG - Landscape
61	Ilona	von Stein	Policy Making Organisations	Data Archiving & Networked Services	Netherlands	FAIRsFAIR
62	Andrey	Vukolov	Research Infrastructures & e-Infrastructures	ELETTRA Sincrotrone Trieste	Italy	EOSC Working Groups: ExPaNDs
63	Angus	Whyte	Universities and Research	Digital Curation Centre	United Kingdom	EOSC WG - Skills and Training

		Performing Organisations			
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## Annex 3 - Notes from the pillar sessions

In advance of the six pillar sessions the Synchronisation Force published a spreadsheet that lists all TFIR recommendations. Per recommendation - if relevant - the participants provided information about their project's deliverables and activities that address this recommendation: both "in place" and "planned". In the sessions they were invited to flesh out this information. Furthermore, the question was discussed whether any FAIR-related activities were missing from the TFIR recommendations or deserved more attention or priority.

This spreadsheet and the session notes are available from Zenodo<sup>75</sup> as data underlying the current report. As mentioned before, it should be recognised that the data and the report can only be a snapshot in time. It should also be noted that "gaps" in the spreadsheet don't imply an omission on the side of the projects: it was not to be expected that each project or working group has planned deliverables to address each of the TFIR recommendations. In addition, a number of recommendations target other stakeholders than those attending the workshop, such as research funders.

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<sup>75</sup> The spreadsheet and the session notes are available from <https://doi.org/10.5281/zenodo.3953979>