White Paper 1: Open Science and Open Scholarship

Supporting Document to D3.3 Draft Policy Recommendations

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1. INTRODUCTION

The European Open Science Cloud is proposed as a trusted environment based on a federation of digital infrastructures which makes it possible to store, move, share and re-use data seamlessly across borders, among institutions and research disciplines. Current work aims to identify requirements and devise solutions for the architecture, service, governance and business models which can best bring the EOSC to fruition. However, such range of service may only lead to a coherent and unified research area, if common policies are adopted, which are then translated into concrete Rules of Participation (RoP) for those that are part of the EOSC ecosystem.

Encouraging and supporting the practice of Open Science is a key part of achieving the aims of the EOSC and it is only through coherent policies, that such an effort could be achieved. This White Paper focuses on examining barriers and constraints to Open Science and Open Scholarship and makes some initial policy recommendations aimed at encouraging the establishment of open science activities and outputs through the EOSC.

Open Science (OS) is an umbrella term[1] declaring elements of "open" in the way that research is performed, connected and disseminated in a research lifecycle to facilitate re-use. Many have attempted to unfold these components but results vary in correlation to the approach that is followed. However, there is common ground between the majority of such approaches, regardless of the way in which they are interpreted, including Open Access to publications, Open and FAIR Research data, Open Educational Resources, Research Collaboration artefacts (open peer review, open data citation, open workflows, open methodologies, etc.) and Citizen Science activities.

Besides Member State-level and EU-level adaptation, public sector organisations and even SMEs have developed and put in place their own organisational/institutional policies in their pursuit of Open Science, as well as in alignment and response to the respective hard regulations. We refer to such policies as micro-policies.[2] Stakeholders which proactively moved in that direction were mostly those directly affected by this action, who had an immediate role to play in the broader context of Public Sector Information and were also actively involved in the research process itself: ministries, agencies and other public sector bodies, as well as universities, libraries, research centres and funders of research and excellence.

The topics examined in this White Paper are pertinent to openness in terms not only of the content/ data themselves, but also of the infrastructures and services necessary to create, process, analyse or store such data. In addition, the White Paper covers management practices of scientific data and other research outputs relating to knowledge sharing and research reproducibility.

The structure of this paper reflects the main areas where policy interventions are necessary in order to establish and sustain open science practices in the context of the EOSC. These are expressed in a "matrix of openness", where we investigate different constraints and drivers in the context of Infrastructures, Research Outputs and practices of monitoring open access respectively. For each of these areas we suggest a set of draft policy recommendations which address features of the specific area, while contributing to the establishment of a common set of policies supporting Open Science.

This document is a supporting document to Deliverable D3.3, Draft Policy Recommendations, which proposes a wider set of draft recommendations covering also the areas of Ethics, Data Protection and Public Procurement.

[1] http://book.openingscience.org/basics_background/open_science_one_term_five_schools_of_thought.html

[2] We use the term "micro-policy" in order to denote policies applied on a micro scale, particularly that of the organisational level, i.e. RPO or Funder, as opposed to National or European macro policies.

2. METHODOLOGY

This paper presents a set of draft policies, as responses to respective drivers and constraints regarding the areas of Open Science and Open Scholarship.

In addition to exhaustive desk research, all insights presented in this document drew variously on the activities conducted by EOSCpilot Task 3.1 with the objective of collecting relevant information[3].

These activities included:

- policy landscape review via desk research into the micro-policy landscape and to identify drivers and constraints, as being in need of further exploration and development in the context of the EOSC, namely policies for data/information, skills, services and infrastructures
- the Policy Landscape Review (D3.1) conducted in the context of the EOSCpilot project, which provides a clearer view of specific EU rules and regulations that are connected leading to the EOSC, a mechanism which is envisioned to become the ultimate driver of Open Science in the Open Innovation, Open Science, Open to the World vision[4]
- face-to-face policy workshops at the first EOSC Stakeholders Forum, 28-29 November 2017 in Brussels, and at the EOSCpilot All Hands event, 8-9 March 2018 in Pisa
- structured interviews with Science Demonstrator representatives and policy experts from ministries and research infrastructures
- liaison with EOSCpilot related tasks: Governance and Rules of Participation (WP2), services (WP5), interoperability (WP6) and Training & Skills (WP7)
- and several freeform interviews with individuals to gather input on particular topics or aspects of the work.

Thorough examination of drivers and constraints has led to the compilation of draft recommendations, presented in Chapter 4, addressing policy issues to be enforced and implemented by Funders/Ministries, Research Performing Organisations and Research Infrastructures as well as the EOSC governance and Rules of Participation.

Next steps of the EOSCpilot policy work involve more communication with stakeholders and consultation activities with experts to assess the proposed draft recommendations and prioritise issues leading to the last deliverable of D3.6 Final Policy Recommendations.

[3] For more information see Annex A “Review of Scholarly Communications Policy and Practice during the EOSCpilot”

[4] See D3.1 Policy Landscape Review

3. A MATRIX OF OPENNESS: DRIVERS AND CONSTRAINTS

To devise a set of policies in the EOSC with the capacity to support and sustain Open Science and Scholarship, it is necessary to identify the key drivers and constraints to the free flow of data throughout the entire life-cycle of the research process. These drivers and constraints are positioned and examined in the context of three main categories:

(a) policies for infrastructures and services: these have primarily a technical interoperability and procedural focus

(b) policies for research outputs: these include policies for Open Access, FAIR Research Data Management, Intellectual Property Rights (IPR)

(c) policies for monitoring research impact and Open Science practices, trends and uptake: these are mostly related to different forms of metrics used by funders, policy makers and RPOs to measure and assess the progress and impact of Open Science policies.

In the rest of this section we present drivers and constraints as identified in each of the three categories.

3.1. Infrastructures and Services

Services are key components in the development and uptake of EOSC. They facilitate and often drive research lifecycle activities. Together with supporting infrastructures that are connected to the EOSC, either as service suppliers or service consumers, they effectively become the vehicle for converging technical and legal requirements for resources/data exchange and interoperability and have the capability to significantly improve the uptake of open science.

3.1.1. Constraints

Open Science constraints related to infrastructures and services are mostly the result of three types of factors:

- Knowledge-related issues ranging from lack of awareness of the existence of certain infrastructures to the lack of expertise required for using such infrastructures, especially when coming from different disciplines. This *siloed* knowledge effectively hinders free access to infrastructures across borders, sectoral or geographical.
- Fragmentation in technology, such as the lack of a single access point for all digital infrastructures or the lack of interoperability between infrastructures.
- Inconsistency in access, rules and conditions which unnecessarily increases the access costs and subsequently curtails open access use of infrastructures.

Infrastructures and Services: Constraints
Lack of awareness of the existence of infrastructures. Infrastructures are unknown outside the research community that uses them This is primarily due to “vertical” or discipline specific digital Infrastructure services. Awareness of their existence outside of their immediate user community is low. Information often spreads in the research community amongst groups of collaborators, often by word of mouth, but as it is not formalised and made more widely available this presents a barrier to those outside the group.
Infrastructure use requires expertise that does not exist outside the specific community Use of many services requires a level of expertise which users do not possess, presenting a further barrier to their use. The need for users to have a relatively high level of expertise in order to successfully use a service - or alternatively, for services to be more user-friendly - is a recognised issue which on the one

hand is being addressed by efforts to tackle the critical skills gap as described in the first report of the EOSC High-level Expert Group, including the work in Work Package 7 (Skills) of the EOSCpilot project, and on the other hand will be addressed to a degree by efforts to deliver a more service-oriented approach towards RIs and e-Infrastructures.

Lack of a single access point where multiple infrastructures services are available

"e-Infrastructures services are currently too often developed as stand-alone systems by individual RI … One of the most recurrent comments collected during the consultation concerns the need to bridge the gap between RI and the providers and operators of [horizontal] e-Infrastructures and associated core services"[5].

The lack of a global, efficient, authentication and authorisation infrastructure (AAI) was identified as the single most important issue preventing exploitation and usage of existing e-infrastructures and distributed resources[6]. This was recognised as an organisational challenge as well as a technical challenge, for which the recommendations to be produced by the AARC2 project[7] for enabling federated AAI whilst maintaining an acceptable level of assurance, should be adopted.

Limited access due to absence of permissions for using the infrastructure or due to scarcity of resources

This is primarily due to the principles on which usage permission is granted, with scarcity of resources being an important factor behind the need to regulate access. Limited access to infrastructures may stem from Ethics or Personal Data rules, especially when the infrastructures are incorporating services and data for which there are no adequate access rights/ permissions.

Permissions are again reflected on the authentication and authorisation infrastructure, which plays a key role in permitting access to individual services, or services across infrastructures.

Ethics and Data protection rules, when the infrastructure is offered as a service and incorporates data that contain personal information or other related information restrained by Ethics rules

In making services, infrastructures and resources as usable as possible, the familiar restraints on usage should be noted ("as open as possible, as closed as necessary"), including adherence to ethical principles around reasons for access to and usage of particular services or data, for example sensitive medical or personal data.

Other kinds of access or usage limitations are as listed in the Charter for Access to RIs: "national security and defence; − privacy and confidentiality; − commercial sensitivity and intellectual property rights; − ethical considerations in accordance with applicable laws and regulations", while they could also be derivatives of Access Units configurations[8].

Lack of interoperability between infrastructures (per discipline or between national infrastructures)

This is the result either of domain specific infrastructures that have their own standardisation rules or national infrastructures that have not been interoperated with each other as of today. Apart from

[5] Sustainable European Research Infrastructures - A Call for Action SWD(2017) 323 final http://ec.europa.eu/research/infrastructures/pdf/ri_policy_swd-infrastructures_2017.pdf, referencing the EC's 2016 consultation on Long-Term Sustainability of Research Infrastructures

[6] e-Infrastructures gap analysis performed for EOSCpilot Deliverable D6.1, see https://www.eoscpilot.eu/content/d61-e-infrastructure-gap-analysis

[7] https://aarc-project.eu/

[8] mainly referring to measurements like hours and sessions of processing time or gigabytes and quotations. For more information see: https://ec.europa.eu/research/infrastructures/pdf/2016_charterforaccessto-ris.pdf

technical and data specific issues, lack of interoperability in this case is crucial for service operation and provisioning, as this impacts on organisational and legal issues.

Diversity of policies for access to infrastructures

Diversity of access policies is clearly shown as one of the most important issues preventing exploitation and usage of existing e-Infrastructures and distributed resources[9].

EGI for example uses different access modes depending on the resources of services being rival or non-rival[10]. For the former, computing capacity and storage space fall under policy-based or market-driven access policies whereas the latter are defined by wide access policies to software packages or scientific data. However, that division is not inclusively followed by and applied to all of EGI's relevant services.

3.1.2. Drivers

A substantial proportion of the drivers contributing to openness in terms of infrastructures and services are found in the form of central policies, both at the Member State and the EU level.

Such initiatives may be seen as top-down. However, there is a consistent effort for them to reflect user needs, wider cultural and societal needs as well as other considerations such as cost/ benefit ratio and the rise of citizen science. Research infrastructures, e-Infrastructures and other services and resources have developed access policies and data procedures and policies as part of the technical, legal and organisational frameworks within which they operate. Particularly for Research Infrastructures, the European Charter for Access to Research Infrastructures[11] defines three different access modes: excellence-driven, market-driven and wide, and recommends that access to any RI may be regulated according to one of these or any combination of them.

The vision for the European Open Science Cloud includes supporting and furthering Open Science, the ongoing transition to collaborative working in research, and the achievement of substantial and sustainable knowledge sharing. The EOSC is envisaged as a federated environment for scientific data sharing and re-use, based on existing and emerging elements in the member states, to accelerate and support the transition to more effective open science and open innovation[12]. This naturally provides a driver towards harmonisation in the policies and rules of infrastructures, services and other resources participating in the EOSC, particularly those infrastructures which are accessed virtually, access to which is likely in future to be through the EOSC.

Infrastructures and Services: Drivers

EU funding policies

Transnational access to Research Infrastructures receives significant EU funding to open up key national and regional research infrastructures to all European researchers[13]. In a broader context, the Global Research Council's 2013 Annual Meeting focused on the development of an "Action Plan towards Open Access to Publications"[14].

EU/ Member State roadmaps and research infrastructure strategies

[9] https://eoscpilot.eu/content/d61-e-infrastructure-gap-analysis
[10] https://www.egi.eu/access-policy/
[11] https://ec.europa.eu/research/infrastructures/pdf/2016_charterforaccessto-ris.pdf#view=fit&pagemode=none
[12] Realising the European Open Science Cloud - First report of the EOSC High Level Expert Group http://ec.europa.eu/research/openscience/pdf/realising_the_european_open_science_cloud_2016.pdf#view=fit&pagemode=none
[13] For a list of those RIs currently providing free access with EU support, see https://ec.europa.eu/research/infrastructures/pdf/infrastructure_offering_tna.pdf#view=fit&pagemode=none
[14] http://www.scienceeurope.org/wp-content/uploads/2014/05/GRC_action_plan_open_access.pdf

The existence of specific research infrastructures strategies implemented through roadmaps, either at the Member State or EU level provides a sound basis for the support of open science through infrastructures, especially when policies contain specific guidelines regarding the development of open interfaces and open access to services and infrastructures.
Open data portals, services and infrastructures (PSI and INSPIRE) Open data portals and infrastructures, either of public sector information or geodata-specific mandated by the PSI[15] and the INSPIRE[16] directives respectively constitute major drivers for the opening up of infrastructures since they include open technologies, such as CKAN,[17] which may be adapted and reused in a research environment. Note: the new proposal for the PSI revision[18] considers research data (article 10) to be within the remit of the directive.
Transparency of access to RI policies & Terms of Use (in line with the EU Charter for access to RIs) In 2016 the European Commission published the Charter for Access to Research Infrastructures[19], fulfilling a commitment of its 2012 ERA Communication[20] as a result of consultation with stakeholder organisations. The Charter sets out principles and guidelines for RIs to use as a reference when defining access policies, helping to drive open access to RIs. Its preamble observes that "Research Infrastructures are also crucial in helping Europe lead a global movement towards open, interconnected, data-driven and computer-intensive research…". The Charter recognises the need to optimise the use of scarce resources for increasingly expensive facilities and to overcome fragmented Research Infrastructure spending, to address pressing global societal challenges and drive innovation. The Charter is non-binding, and enquiries with the European Commission in March 2018 showed that apparently information on its adoption is not so far available, but applicants to the INFRAIA call in the Research Infrastructures part of the 2018-2020 Work Programme of Horizon 2020[21] are asked to apply the Charter, which may be expected to boost its adoption.
Adoption of the excellence driven model for access to RIs Promoting the "excellence-driven access mode", as defined by the Access Charter, as a requirement for funding the access to RIs is a key enabler of open science. The results of the consultation on long-term sustainability of research infrastructures[22] show that the majority of RIs use the excellence-driven access mode, and that scientific excellence is widely acknowledged as the most important pre-condition for long-term sustainability of RIs. It is also a model that may encourage and sustain open access to science and developed through such infrastructures. Moreover, HPC access traditionally relies on scientific excellence, while on the other hand networking sets and applies eligibility criteria to give access to services and interfaces.
Transnational access to research. Business models for sharing national RIs

[15] http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32003L0098, http://eur-lex.europa.eu/legal-content/FR/ALL/?uri=CELEX:32013L0037

[16] https://inspire.ec.europa.eu/

[17] https://ckan.org/

[18] https://ec.europa.eu/digital-single-market/en/news/proposal-revision-directive-200398ec-reuse-public-sector-information

[19] https://ec.europa.eu/research/infrastructures/pdf/2016_charterforaccessto-ris.pdf#view=fit&pagemode=none

[20] A Reinforced European Research Area Partnership for Excellence and Growth, COM(2012)392 final http://ec.europa.eu/research/era/pdf/era-communication/era-communication_en.pdf

[21] http://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-infrastructures_en.pdf

[22] https://ec.europa.eu/research/infrastructures/pdf/lts_report_062016_final.pdf#view=fit&pagemode=none

A very important issue for research infrastructures, often the recipients of large amounts of research funding at a national level, is provision of access to their resources for users from other countries. While member states understandably wish the benefits of their investment to flow to users in their own countries, the EU fosters transnational access to Research Infrastructures through significant EU funding to open up key national and regional research infrastructures to all European researchers. In a broader context, the Global Research Council's 2013 Annual Meeting focused on the development of an "Action Plan towards Open Access to Publications"[23].

Policy supporting services for infrastructures

There are services which support interoperability and provide information on policy compliance to help drive interoperability. Among the most prominent of these are the Jisc SHERPA suite for open access policy compliance (on the national level) and the OpenAIRE and DataCite metadata schemata (on the EU and global levels) supporting interoperability between infrastructures and repositories and assisting information exchange and text and data mining.

Understanding of the possibilities in using different types of RIs and e-Infras

An appreciation of the different types of RIs/e-Infras and the ways in which their services may be reused by other disciplines and fields is an essential driver for the opening of science not only to different fields of scientific inquiry but also to citizens who would like to get involved in citizen science projects.

Standardisation of the information of services

A key driver in open science is the so-called *FAIRness* of services: how to discover, understand, access and use them. The eInfraCentral project[24] is developing a common catalogue of e-Infrastructure services which will help to address the issue of lack of user awareness by helping a broader and more varied set of users, including industry and SMEs, to discover and access the existing and developing e-Infrastructure capacity. The project also aims to put a focus on services' availability and quality and on user satisfaction by enhancing the monitoring of relevant KPIs.

The recently launched EOSC-hub project[25] specifically aims to understand the state-of-the-art of service management and provision. Working with more than twelve RIs and 3 e-Infrastructures, it aims at building a marketplace using standardised approaches, i.e. the FitSM IT Service Management framework, also adopted by the eInfraCentral project and being used in the EOSCpilot project.

The EOSC Rules of Participation, currently in development within the EOSCpilot project, are expected to include a minimum set of required information which all services provided through the EOSC must make available.

Service citation: measuring service usage

In the EOSC, it is expected that consistent and transparent presentation of information about services, along with the development of metrics and reporting on their usage, will provide some impetus towards improving services' usability if for no other reason than to improve their utilisation statistics in a bid for sustainability.

Open interfaces and protocols

OAI-PMH[26] has been facilitating information exchange in information management systems of RPOs and Libraries since the 1990's when it was developed and even today remains the preferred choice of protocols for metadata exchange by repository managers. Resource Sync[27] is another framework that is widely used

[23] http://www.scienceeurope.org/wp-content/uploads/2014/05/GRC_action_plan_open_access.pdf

[24] The eInfraCentral service catalogue portal is currently available in pilot mode: http://beta.einfracentral.eu/home

[25] https://www.eosc-hub.eu/

[26] https://www.openarchives.org/pmh/

[27] http://www.openarchives.org/rs/toc

for synchronisation of resources on the web. The Research Data Alliance[28] (RDA) has endorsed groups to work with registries in standardising activities of the research lifecycle and encouraging open approaches in the recommendations produced as RDA research outputs, e.g. for data types to assist data models' definition, for metadata standards to assist metadata exchange etc.

Approaches of this kind are encouraging signs that there are protocols and tools allowing the harvesting, aggregation and publishing of open data across platforms and repositories. Such standards and protocols allow the creation of the critical mass of content and users necessary for the success of the open science model.

European Interoperability Framework

In a broader context, the EC's new European Interoperability Framework[29] (EIF), adopted in 2017, provides guidance on setting up interoperable digital public services. The EIF is part of the Digital Single Market initiative and is aimed at public administrations rather than specifically at the research sector, however the EOSC is intended to include the wider public sector within its scope in due course, and the new EIF has been updated (the first version of the EIF was adopted in 2010) to take account of EU policies including the European Cloud Initiative[30]. The EIF conceptual model includes principles addressing legal, organisational, semantic and technical aspects of interoperability, providing a clear impetus to member states to develop interoperable digital public services. Key drivers of the EIF include improving the transparency and quality of public services to citizens and businesses.

The wider ISA2 programme[31] of which the EIF is part includes an action called IMAPS (Interoperability Maturity Assessment of a Public Service) to assess progress being made towards interoperability of public services[32]. IMAPS provides information on the maturity of public services' interoperability, and also assists with assessing activities required to improve services' maturity levels, which could be used as an example for a similar initiative in the context of the EOSC. A similar exercise has been developed as part of the Finnish Open Science Initiative[33].

Standard and global core services for cloud storage, AAI and PID

Global services for cloud storage/processing (mostly from commercial providers) and standards on AAI and PIDs are core drivers for the interoperability of infrastructures. They provide a global set of identifiers that allow persons and assets to be uniquely identified and thus be portable between different infrastructures, thus removing a major obstacle to the free flow of research and researchers between infrastructures.

Global partnerships for repository networks. Adoption of Next Generation Repository technologies

COAR – the Coalition of OA repositories[34] has undertaken the task of aligning repository networks, whether these are thematic, national and regional, in order to create a seamless global repository network. The alignment is focusing on strategic, technical/semantic interoperability, and services, and initial results have enabled the interconnection of European (OpenAIRE) and Latin American infrastructures (La Referencia[35]).

Furthermore, open source repository platforms (Dataverse, DSpace, EPrints, Fedora, Invenio, Islandora, Samvera) have expressed interest in the implementation of technical recommendations as provided in

[28] https://rd-alliance.org/
[29] https://ec.europa.eu/isa2/eif_en
[30] https://ec.europa.eu/digital-single-market/en/%20european-cloud-initiative
[31] https://ec.europa.eu/isa2/home_en
[32] https://ec.europa.eu/isa2/actions/imaps_en
[33] http://openscience.fi/open-science-and-research-roadmap-2014-2017
[34] https://www.coar-repositories.org
[35] http://www.lareferencia.info/joomla/en/

the COAR Next Generation Repositories Report[36], towards an out-of-the-box interoperability for Resource Sync and Signposting.

Trend for Open Education infrastructures

During the years, valuable sources of information on Open Educational Resources (OER) have been compiled. A key report from UNESCO[37] presented the outcome of a working group that explored "the Impact of Open Courseware for Higher Education in Developing Countries", addressing the areas of software, connectivity and standards as those in need of new technology precautions[38].

Even though OER and services are not yet visible in EOSC, the EC FOSTER project[39] has made a first attempt to gather OER and courses for issues related to open science, as well as the Open Science MOOC[40] (a community initiative). EOSCpilot tackled this issue by identifying OS skills and training but has not provided details on how these are expected to be integrated within and provided through EOSC.

3.2. Research Outputs

The sharing of research outputs is perhaps the point where Open Science is manifested with the greatest possible intensity. Hence, in this section the main focus is on the drivers and constraints that involve Research Outputs and, more specifically, Scholarly Communication, FAIR data principles, Data Stewardship and IPR issues. This section explores how different stakeholder groups are affected, focusing on how specific issues have to be addressed or how successful existing practices need to be highlighted and further supported.

3.2.1. Scholarly Communication and FAIR Data

Scholarly communication is mostly performed within the context of Research Performing Organisations (RPOs). RPOs - libraries in particular - are key facilitators of open science, as they instruct students, young researchers and faculty in their research conduct and contribute to researcher empowerment through information handling and digital literacy. Researchers, especially early career researchers, have quite quickly recognised the benefits of un-paywalled research as an important contribution to their primary goals of research excellence and impact. FAIR developments imposing adoption of DOI/PIDs services and systematic review of research data enable re-use by providing infrastructure (repositories, linked data, interfaces, identifiers, etc.) which enhances monitoring and sharing of data-sets.

Public funding bodies and Ministries (as second-level funding bodies for Open Science), together with other funders such as research councils or even private organisations interested in contributing to scientific growth, play a key role in the way scholarly communication is performed and in how it evolves over time. The desire of policy makers and funders to realise the full potential of open and FAIR research data and other outputs of the research process by facilitating adoption and re-use has been recognised.

3.2.1.1 Constraints

A service or data(set) being FAIR (i.e. Findable, Accessible, Interoperable, Reusable) does not directly imply that it is also open. In this regard there is also some discussion about "levels" of legal openness[41], which

[36] https://www.coar-repositories.org/news-media/recommendations-for-next-generation-repositories-now-available-on-github/

[37] http://unesdoc.unesco.org/images/0012/001285/128515e.pdf

[38] "...to the extent possible, the core part of the software should be technology / implementation independent. The technology should be designed to allow the use of a variety of appropriate tools, with a minimum of integration problems." from the Forum on the Impact of Open Courseware for Higher Education in Developing Countries, UNESCO

[39] https://www.fosteropenscience.eu/

[40] https://opensciencemooc.eu/

[41] These issues are treated extensively under the IPR section.

relate to IPR ownership and licensing, confidentiality issues, trade secrets etc. Similarly, Open does not necessarily mean FAIR. Many datasets, trainings and services are open without being FAIR[42].

This OPENness vs. FAIRness discussion has introduced some ambiguity on the (technical) features that need to be added to FAIR data/services/infrastructures. Furthermore, proper metadata, citation and accessibility of accompanying software are necessary to make data useful to prospective users. This is often encountered in the medical field when accessing patient health history (unstructured, undocumented records) or in humanities where working on already existing data constitutes a large part of the research itself.

Research Outputs – Scholarly Communication and FAIR Data: Constraints
Technical limitations to the reuse of data. Lack of standardised data citation Technical aspects that prohibit the full exploitation of re-use of data have been well-known for years. They relate to obsolete data types and formats which are not robust and to lack of documentation in how to use data for reproducibility purposes. Technologies that enable reuse, i.e., shared/standard metadata models, aligning of domain-specific ontologies, data exchangeability, linked data[43], are not effectively used within or across infrastructures.
Costs for: open publishing, management of research data (FAIR), sustainable repositories **Publications:** Attempts to assess and "standardise" OA publication costs have mainly targeted Article Processing Costs (APCs). Initiatives to increase transparency and help achieve standardisation of expenditure include the OA2020 initiative[44], OpenAPC[45] , OpenAPC-de[46], OpenAIRE FP7 OA pilot[47], and institutional e-publishing part of it being the emerging funder publishing platforms, e.g. WT Open Research[48]. On top of the *big deal* approaches, which also seek practical solutions for costing decisions among the research library consortiums, global mobilisation is important if standardisation is to be achieved. **Data:** Costs of stewardship, management and publishing of research data are still not clear, and neither are the relevant regulations for researchers. The return on investment is yet to be determined, especially when we consider indirect socio-economic externalities. In particular, costs breakdown related to soft or hard services, volume of data stored, user access have not been exhaustively calculated, adding to the lack of long-term commitment from institutions. The OECD report on "Business models for sustainable research data repositories"[49] is an example that touches upon the repository-service component.
Heterogeneous technical environments in different scientific domains Heterogeneous technical environments are a common phenomenon observed when merging scientific domain databases and software, mainly due to the diversity in the trajectory and history of their developments prior to the OA movement or development of OS standards. This heterogeneity is also seen

[42] The FORCE11 scholarly communications group uses the term "open, FAIR and citable" for scholarly objects https://www.force11.org/scholarly-commons/principles

[43] Research Data Reusability: Conceptual Foundations, Barriers and Enabling Technologies https://pdfs.semanticscholar.org/64a9/ec97fa879aed397cc5852997f73429e70f29.pdf

[44] https://oa2020.org/

[45] https://treemaps.intact-project.org/apcdata/openapc/#journal/

[46] https://github.com/OpenAPC/openapc-de

[47] https://postgrantoapilot.openaire.eu

[48] https://wellcomeopenresearch.org/

[49] http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/STP/GSF(2017)1/FINAL&docLanguage=En

in derivatives of scientific activities performed in those domain environments, for example arbitrary approaches in FAIR implementation and application (data, infrastructure or services).
Lack of a FAIR infrastructure to accommodate FAIR needs in a standardised way FAIRness can be viewed at many levels, e.g. not only at the level of (data) repositories or (meta)data but also at the level of dataset, software, service etc. An overall FAIR environment is therefore essential to motivate and encourage good FAIR practices. The potential of a FAIR infrastructure in which research output is stored and preserved, needs to be recognised for its benefits in achieving transparency, increasing efficiency or even - in terms of the EOSC - providing its users with the ability to work with a large-scale, dynamic infrastructure that spans multiple scientific domains.
No clear definition of a "user" in the context of the EOSC A "user" in the EOSC context is not a standard term as there are different types of organisations with specific, often overlapping responsibilities involved, and it is a rather loose and customisable interpretation arguable to given needs.
Absence of data stewards. Lack of or limited training of data stewards. Lack of certification or standards for Data Stewardship at the RI level With increasing reliance on data experts, especially in academia where they are most severely undervalued, a lack of data-related core expertise is among the risks for Europe losing a leading position in science[50]. Data stewardship, data science and data management are interchangeably used terms. Lack of a clear definition is a consequence of the diversity of the data processes and actors involved, but data scientist skills need to be combined with traditional data management virtues to provide a solid knowledge of data architectures, metadata, data quality and correction processes, data stewardship and administration, master data management hubs, matching algorithms, and a host of other data-specific topics in order to pursue big data as a long-term strategic differentiator[51]. The FAIR principles implementation requires systematic training, both horizontal and domain-centric, reinforced by certification accrediting researchers and other practitioners for their data and open science skills.
Lack of coordination between various FAIR-related activities FAIR-related activities have contributed substantially to the improvement of researchers' and wider community understanding and practices of opening up research resources. However, since they include specific rules regarding the ways in which data are stored, identified, accessed, documented and monitored, the absence of a common framework with interoperable standards and techniques between different activities supporting FAIR data could easily lead to inconsistent approaches and to a fragmentation of the scholarly commons.

3.2.1.2 Drivers

Open Access (OA) and **Research Data Management (RDM)** policies on the institutional level in Europe had been primarily developed as the result of the need to increase access to research and quality of scientific work but also as a direct outcome of public funders' mandates or response to specific regulatory and policy interventions such as EU Recommendations (Access to and Preservation of Scientific Information, 2012[52]),

[50] Realising the European Open Science Cloud, EC HLEG (1st) report https://ec.europa.eu/research/openscience/pdf/realising_the_european_open_science_cloud_2016.pdf

[51] Thomas H. Davenport, Jill Dyché, May 2013, Big Data in Big Companies, http://docs.media.bitpipe.com/io_10x/io_102267/item_725049/Big-Data-in-Big-Companies.pdf

[52] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012H0417&from=EN

Directives (PSI 2013[53], INSPIRE[54]), Regulations (GDPR[55], Regulation proposal for the free flow of non-personal data[56]) and/or guidelines/prerequisites of specific financial programmes. These policies have as a clear goal the increase of free flow of knowledge, also known as the 5th Freedom, across the European Union and reflect core European concerns involving a combination of issues, such as re-use of Public Sector Information, ethics and data protection, intellectual property rights.

Similar considerations have been at the heart of the strategy and operations of public funders (both ministries and funding agencies) as well as private entities which fund research and support excellence.

However, these categories of stakeholders require additional guidance and support regarding more detailed aspects of implementing Open Access, such as costs related to managing, opening access to and preserving research outputs (e.g., Article Publishing charges - APCs or storage fees[57]). Another crucial aspect involves the ways in which acknowledgment to the funder may be provided, as well as how compliance with funding conditions - particularly regarding open science - is monitored and implemented.

Research Outputs – Scholarly Communication and FAIR Data: Drivers
Existence of top-down mandate included in hard law (Directives/ Regulations) or soft law (Recommendations, funding instruments) The European Commission has recently updated its Recommendation on Access to and Preservation of Scientific Information[58] which includes "measures at national level that should enable proper functioning and use of the EOSC". Moreover, and in accordance also to the EOSC declaration, recommendations go beyond OA to publications and include provisions for research data to all publicly funded research/projects, not only to H2020 or the Open Research Data Pilot which was the case previously. The recommendations involve provisions for infrastructures, skills and competences, incentives and rewards and mark the next phase of policy making and adaptation by stakeholders which, similarly to the 2012 Recommendation on Access and Preservation which led to OA policies development, and may be expected to eventually conclude in the realisation and development of Open Science policies in Europe.
National Open Access Policies. Open access by default In 2012 the European Commission's "Recommendation on access to and preservation of scientific information" invited all Member States to develop national OA policies[59]. A year later amendments to the Public Sector Information Directive (2003/98/EC) included specific provisions for the re-use of public sector information in order to encourage open government data and include cultural heritage information (Museums, Libraries and Archives) within the target contents[60].
Adopting common principles of openness. Standardisation of policies

[53] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013L0037&from=FR
[54] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0002&from=EN
[55] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679&from=EN
[56] http://europa.eu/rapid/press-release_IP-18-4227_en.htm
[57] Most of the data repositories limit free storage of researchers' datasets to a certain amount of bytes which they have predefined (e.g., Zenodo or Dryad). Check also: https://www.nature.com/sdata/policies/repositories
[58] https://ec.europa.eu/digital-single-market/en/news/recommendation-access-and-preservation-scientific-information
[59] https://ec.europa.eu/research/science-society/document_library/pdf_06/recommendation-access-and-preservation-scientific-information_en.pdf
[60] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013L0037&from=EN

Organisational Open Access Policies have been better understood as a result of templates providing policy modeling schemas [61] mainly to support RPOs' and research funders' OA policy adoption and implementation activities. Common areas were identified from these activities (informing about the time of deposit or publication, i.e. immediate or embargoed; indicating a locus of deposit or publication (national repository, institutional repository, data repository etc); including copyright and licensing information facilitating sharing and re-use, etc) and initiatives, such as FORCE11 and OpenAIRE, are working towards realising the means of achieving a scholarly commons ecosystem under the guiding principles of Open, FAIR and Citable.

Publishers attempted to normalise sharing policies and practices as expressed in the Transparency and Openness Promotion (TOP) Guidelines[62] and further implemented a schema of standardised policy types. That schema was established and adopted by Springer Nature journals[63] and is being considered for adoption by a wider publishing community within the context of the Research Data Alliance (RDA) Data policy standardisation Interest Group[64].

Existence of Research Data Management Plans

Research Data Management Plans were initially included in research activities as a trial for the purposes of the Open Research Data Pilot, but their benefits in providing clear documentation for all stages of a research and data lifecycle, especially for enabling data reuse, have made them one of funders' recent demands. The EOSC Declaration[65], FAIR HLEG[66] and the new draft Framework Programme "Horizon Europe" proposals[67], mandate DMP deposit in pursuit of good data management and stewardship practices.

RPOs targeting open and FAIR data awareness

Many institutions[68,69] in their attempt to spread awareness about research data and engage more researchers into making their research and research outputs open and FAIR, have launched programmes following a "champions" notion.

Open access as a key part of Responsible Research and Innovation (RRI)

An updated version of the European Code of Conduct for Research Integrity[70] which is aimed at promoting the responsible conduct of research, was published in March 2017. Developed by the All European Academies (ALLEA) federation and the European Commission, the code has been updated to take account of developments in Open Science including the growing importance of data quality and management. In the UK, the Concordat to Support Research Integrity[71] was developed and adopted jointly by a group of major research funding councils and Universities UK, the representative body of UK universities.

[61] Such as deliverables of PASTEUR4OA (http://pasteur4oa.eu/); the RECODE project (http://recodeproject.eu/) or the LEARN Toolkit (http://learn-rdm.eu/wp-content/uploads/RDMToolkit.pdf)

[62] https://osf.io/ud578/?_ga=2.209061201.298400614.1525769058-1403095727.1525769058

[63] https://group.springernature.com/gp/authors/research-data-policy/data-policy-types/12327096

[64] https://docs.google.com/document/d/1DTAfOKkE1a2n2f_1hGcrXlrw-5Tq_AL5tk-ju8B82_E/edit#heading=h.lx2xs5vf6emf

[65] https://ec.europa.eu/research/openscience/pdf/eosc_declaration-action_list.pdf

[66] http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=3464

[67] https://ec.europa.eu/info/designing-next-research-and-innovation-framework-programme/what-shapes-next-framework-programme_en

[68] Data Champions programme of the University of Cambridge https://www.data.cam.ac.uk/intro-data-champions

[69] Data Stewardship programme by TU Delft https://openworking.wordpress.com/2017/08/29/data-stewardship-addressing-disciplinary-data-management-needs/

[70] http://ec.europa.eu/research/index.cfm?&na=na-240317-1&pg=newsalert&year=2017

[71] http://www.universitiesuk.ac.uk/policy-and-analysis/reports/Pages/research-concordat.aspx

Use of minimal and rigorous global standards for research data
Efforts to standardize metadata are in progress to ensure best practices and services for sharing data are in place. Work in RDA has illustrated the potential for global, inter-disciplinary collaboration on registries and standards, e.g., the Data Description Registry Interoperability, domain specific standards (e.g., Wheat, Rice, Agro Semantics, Fisheries, Linguistics), horizontal standards (e.g., Scholix[72]). Moreover, DataCite Schema and OpenAIRE Guidelines provide a solid framework for minimal, cross-domain metadata exchange, adopted by organisations around the globe.
Use accreditation and certification schemes to advance open data use
As expressed by the EOSC Declaration, scientists should get recognition for their efforts in using European and national scientific research infrastructures to deposit and access data for those infrastructures conforming to clear rules and criteria regarding OS and for assisting FAIR data compliance matters.

3.2.2. Intellectual Property Rights (IPR)

IPR policies are a crucial component of the Open Science and Open Scholarship ecosystem: they set the key rules for the ownership of most of the digital assets and they regulate the flow of such assets both within the organisations producing the research and between RPOs and other stakeholders (government, business, general audience). In that sense, they may constitute major drivers, but also key constraints in the development of Open Science.

IPR policies are deployed to address issues in relation to the acquisition, management and exploitation of intangible assets on which IPR subsists, and to produce value, either in monetary or non-monetary terms.

Policy makers set the broader environment in which the other stakeholders operate. Issues related to IPR that are relevant to the Open Science environment include the boundaries of the public domain, the setting up of limitations and exceptions that are clear and easy to follow, and the removal of any barriers in the use of open licensing. In addition, policy makers set out specific guidelines for the IPR conditions for funding and promoting research. Some such rules tend to be soft rules - i.e. incentives rather than strict norms - including obligations on RPOs regarding the formulation of comprehensive IPR policies, suggested licensing, encouragement of licence pools etc.

Research Infrastructures and e-Infrastructures operate as platforms, where RPOs and individual researchers share IP. For this, they need to have policy frameworks that allow the assets which circulate over such platforms to be shared in a way that minimises transaction costs and fulfils the objectives of the specific platforms.

Funders deploy IPR policies to support the goals of specific action lines or programmes in line with their long-term funding policies. For instance, they could be supporting open access to research results, while also supporting the exploitation of IPRs, e.g. through the registration and licensing of patents. Such exploitation policies are not necessarily antithetical to, but rather are complementary to, open access and open science policies.

[72] SCHOLIX: A framework for SCHOlarly Link eXchange http://www.scholix.org/

The EC positions IPR policies as an integral part of the EU Single Market Strategy[73] [74], Digital Agenda for Europe Policies[75] and more specifically the Innovation Union[76] and Digital Single Market policies[77] [78]. The key elements of the EU policies in relation to IPR may be summarised as follows:

- Overall the objective is to create an EU-wide policy framework and regulatory environment that may support the production and flow of IPR in Europe
- In the context of the Digital Single Market, this overall objective emphasises the need to support the provision of digital services across the Single Market with the minimum possible frictions, improving enforcement in the digital environment and supporting all possible licensing models (open and all rights reserved)
- In the context of the Innovation Union, the objective is to provide a unified framework, particularly for industrial property, in order to support SMEs in terms of collaboration (through Open Innovation licensing arrangements), dissemination and exploitation of their IP. In the same context it is important to also allow the collaboration between academia and the private sector, particularly in relation to the creation of innovative start-ups or the scaling-up of existing organisations.

3.2.2.1 Constraints

Constraints for Open Science regarding the use of IPR are mainly due to fragmentation of policies and misconception of IPR usage.

Research Outputs – IPR: Constraints
Lack of comprehensive IPR policies covering copyright, open access, patents and trademarks at all levels (RPOs, Funders, RIs, Policy Makers) RPOs frequently lack IPR policies that contain comprehensive rules for all types of IPR or do not have such policies formed in a transparent and coherent fashion. For instance, exploitation policies mostly focus on patent filing and licensing, whereas Open Access policies focus on the release of content under open licences. The separation of these two policies is very likely to lead to conflicts or unnecessarily hinder the opening of content. Similarly, funders may require both patenting and opening material without any comprehensive explanation or guidance as to how this is possible, thus creating confusion for RPOs. This

[73] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions, Upgrading the Single Market: more opportunities for people and business Brussels, 28.10.2015 COM(2015) 550 final, Section 3.3 Consolidating Europe's intellectual property framework https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0550&from=EN

[74] Commission Staff Working Document, A Single Market Strategy for Europe - Analysis and Evidence Accompanying the document Upgrading the Single Market: more opportunities for people and business, Brussels, 6.5.2015 SWD(2015) 100 final, Section 3.3 Consolidating Europe's intellectual property framework https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015SC0100&from=EN

[75] Communication From The Commission, EUROPE 2020 A strategy for smart, sustainable and inclusive growth Brussels, 3.3.2010 COM(2010) 2020 final https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52010DC2020&from=EN

[76] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions, Europe 2020 Flagship Initiative Innovation Union SEC(2010) 1161 Brussels, 6.10.2010 COM(2010) 546 final http://ec.europa.eu/research/innovation-union/pdf/innovation-union-communication_en.pdf pgs 18-20, 27-28

[77] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions, A Digital Single Market Strategy for Europe Brussels, 6.5.2015 COM(2015) 192 final. http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52015DC0192&from=EN

[78] Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions on the Mid-Term Review on the implementation of the Digital Single Market Strategy A Connected Digital Single Market for All Brussels, 10.5.2017 COM(2017) 228 final http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52017DC0228&from=EN

lack of coordination is often reflected in the structure of the units within RPOs supporting innovation (exploitation) and openness, the former being within Technology Transfer Offices (TTOs), and the latter within the scope of the work of libraries. The lack of coordination between the two creates unnecessary conflicts in the IPR strategy of an RPO.

No comprehensive IPR documentation of resources

A great number of resources that exist on research institution repositories or RIs do not contain proper documentation of their IPR status, mostly IP ownership and relevant licence. As a result, it is impossible to reuse them or verify that their open access status is valid.

Lack of uniform, standard and harmonised licensing policies

Licensing policies for RPOs or RIs tend to be fragmented both at the national and EU levels. As a result, it is difficult to have truly interoperable licensing regimes and low transaction cost reuse of content (particularly data).

Lack of comprehensive response on the infringement of open licences

The absence of policies for responding to open licences infringement undermines trust in the use of open licences for the release of material and reduces their appeal to researchers.

Lack of clearance policies

Rights clearance includes all activities necessary for identifying the existence of third party rights in a particular resource and for obtaining the necessary permissions for its re-use.

The increasing use of third party resources in the research and academic context renders such clearance of rights necessary for opening up resources. To ensure that open access to resources is possible, it is necessary to have obtained all licences and rights necessary to release such data in the most open fashion. This may be reflected in the acquisition policies of RPOs, the funding conditions, or policy makers' key directions.

Lack of awareness of different IPR types and their operation

Different forms of IPR have different protection goals, conditions of registration and protection and modes of licensing. For instance, copyright has no registration requirements, it protects original expression and is licensed for use, whereas patents have a formal registration system, protect novelty and are licensed mostly for manufacturing. Accordingly, patents are easier to measure, both in terms of numbers and economic output, since we have a formal registration system, and are frequently used as an innovation measure. On the other hand, copyright is the obvious and automatic form of protecting research output and the question related to it is not one of registration but rather of licence choice.

Better understanding of IPR policies contributes to the formation of better quality policies. In addition, it adds to the motivation of researchers to contribute to open resources.

Misconceptions about patents, copyright and their use

The interrelationship between patents and copyright might confuse researchers who, most of the time, lack clear guidance and explanation of the differences between patents and copyright.

The moment in patent and copyright life-cycles requiring the greatest attention is that before the registration of the patent: the research results on which a patent is based need to remain unpublished (regardless of whether using the open or all rights reserved mode) if a patent is to be filed at all.

It is essential to have the agreements in place that ensure that (a) patent filing is possible and (b) the choice between an open and an all rights reserved licensing model is possible. This means that there is need for

a set of Non Disclosure Agreements (NDAs) to be put in place to allow the members of a research team or a research consortium to collaborate and share information and data without any disclosure taking place.

3.2.2.2 Drivers

Drivers regarding the use of IPR mostly concern understanding of the operation and use of IPR, the proper documentation of IPR assets, the collaboration between IPR-related institutions and the use of standard and innovative licensing tools.

Research Outputs – IPR: Drivers
Harmonization of IPR regimes across Europe, especially in the area of limitations and exceptions Digital Single Market policies aiming at the harmonization of IPR policies, particularly TDM limitations and exception, may substantially contribute to the reduction of friction in the reuse and opening of resources. Copyright exceptions allowing lawful text and data mining (TDM) constitute a driver for open science in Europe. TDM exceptions, although still limited, are introduced into the EU policy and legal framework in the form of a copyright exception for research purposes and non-commercial re-use). Transposition in different Member States is expected to be diverse, however, and to raise issues of policy fragmentation running contrary to the objective of the DSM policies [79].
Coordination between different IPR agencies (e.g. national IPR offices) and the research policy makers Collaborative programmes such as the European Patent Academy or programmes that encourage the collaboration between RPOs, funders and National IPR Agencies allow the development of sound and usable IPR policies both at the national and institutional level.
Licence choice and compatibility tools The existence of tools that allow a better choice of licences or the resolution of open licence incompatibilities contributes to the reusability of resources as well as the choice of licences that reflect the value models of the RPOs and individual researchers. The Policy Framework developed by FutureTDM[80] and the matrix of licenses' compatibility for content and software by OpenMinTeD[81] overcome compatibility issues and limitations characterising the current legal framework to enable TDM-related research.
Open patents and license pools models The use of open patents, i.e. the opening of industrial property rights or the use of cross-licensing schemes for sharing IP within trusted environments supports open innovation and allows the development of commercial application on the top of a common layer of IP. Of great importance is the movement of open patents which has two followers already: in Denmark with Aarhus University and in the UK with the Structural Genomics Consortium[82]. The prior has adopted a policy which is patent-free[83]. The Open Patents movement facilitates the sharing of basic research knowledge without precluding subsequent patenting of inventions that may arise from the deployment of such knowledge. In collaboration with Industry and SMEs they have developed an Open Science Platform, free of patents and with no charge for use for research purposes. Open access to knowledge generates new

[79] http://www.europarl.europa.eu/RegData/etudes/IDAN/2018/604941/IPOL_IDA(2018)604941_EN.pdf

[80] https://www.futuretdm.eu/policy-framework/

[81] https://openminted.github.io/releases/license-matrix/

[82] www.thesgc.org

[83] http://scitech.au.dk/en/about-science-and-technology/current-affairs/news/show/artikel/aarhus-universitet-og-industrien-aabner-patentfri-legeplads/

knowledge while encouraging interdisciplinary approaches and has a lot of benefits, among them being able to patent and re-license new intellectual property issues. A similar attempt has been made by the Structural Genomics Consortium. It is also a patent-free initiative aiming to build a communication channel between Open Science and Open Innovation.

The Open Patent Office which was established by two researchers of the Vrije Universiteit Brussel in Belgium provide a concise comparison between patents and open patents[84]. The idea of the Open Patent Office is to provide a facility of quasi-patent registration that will operate as a defence mechanism against potential patent abuses.

3.3. Research Impact Assessment and Open Science Monitoring

Research assessment is at the core of Open Science, as it shapes researchers' behaviours, and guides them on how to communicate-disseminate-share their work. At the European level, the European Open Science Policy Platform (OSPP)[85], recognising that researchers are the key agent of change toward Open Science, together with the HLEG on Altmetrics [86] have undertaken the task of defining high-level policy recommendations for research assessment practices which involve the areas of Next Generation Metrics and Rewards for Open Science practices. Their recommendations, based on the evaluation of researchers' careers and their attitudes while sharing and promoting their work in non-traditional academic platforms such as social media streams, targeted policy makers on the future approaches for career assessment and promotion as well as monitoring of research impact at the institutional level.

Policy monitoring is effectively a compliance measure. In the Open Access movement, there have been mechanisms showing the benefits of OA publishing and current state-of-the-art in following OA principles. With current policy moves embracing Open Science, the need to develop a mechanism which supports national OS uptake, trends and compliance with OS policies has already been recognised and addressed in national European Research Area (ERA) strategies.

The EOSCpilot Open Science Monitor concentrated primarily on understanding the Open Science environment and its dimensions, focusing on the more mature efforts in measuring Openness and FAIRness. Taking into consideration that it is possible for a digital object to be FAIR but not open and the other way round, an exercise to find commonalities and differences between those two aspects eventually formed the outline of the Open Science Monitor Framework and the indicators which correspond to its Monitoring Targets.

[84] http://www.openpatentoffice.org/

[85] Evaluation of Research Careers fully acknowledging Open Science Practices https://ec.europa.eu/research/openscience/pdf/os_rewards_wgreport_final.pdf

[86] "Next-generation Metrics: Responsible metrics and evaluation for open science" https://ec.europa.eu/research/openscience/pdf/report.pdf

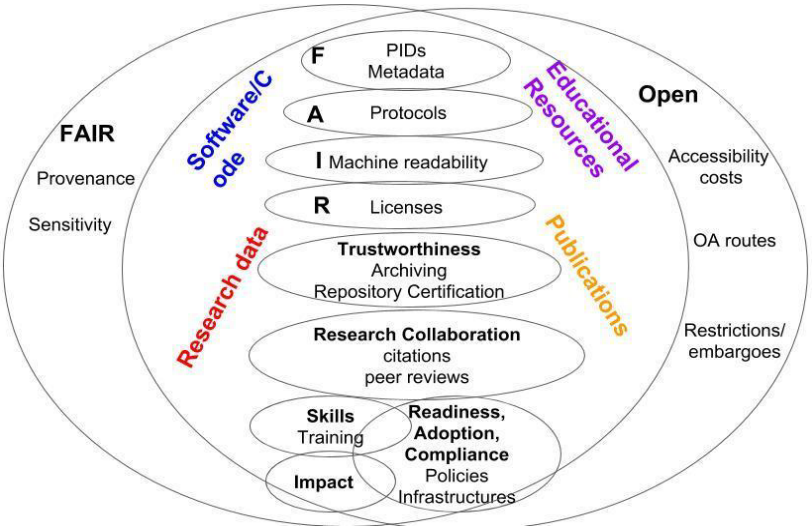

Figure 1 – EOSCpilot OS Monitoring Targets Framework

The ambition of the European Open Science Cloud is to contribute to leveraging open and FAIR practices and build the infrastructure to allow a step change in the practice of Open Science in Europe.

3.3.1. Constraints

Metrics are being used and often misused in an increasingly pervasive way in the evaluation of research. Universities' global ranking is in some respects based on inaccurate data and arbitrary indicators[87]. Promotions and career progress within universities are often based on h-index and the number of a researcher's articles in high-impact factor journals. Overall there is a bias on the use of quantitative metrics to evaluate research, which significantly affects researchers' careers, blurring the discussion on indicators and metrics with the discussion on career incentives and rewards.

Measuring of open science currently targets organisations (funders, RPOs, projects) and it is about practices and compliance to policy. The lack of an agreed framework including indicators, processes, services/APIs and trusted data sources has been a key limitation for systematic adoption.

Research Outputs – Monitoring Research Impact and Open Science: Constraints

Use of pre-web era metrics in evaluating research performance and impact

Metrics for assessing research performance are not always deployed in a way that promotes open science, and neither are they used in a uniform and consistent fashion. Most common types of metrics that fall under this category are Bibliometrics. Indicators like the Journal Impact Factor (JIF) and h-index have been inhibiting researchers from realising the benefits of open access, constraining them from following open practices. JIF was initially developed and used by librarians to guide their choices when buying scientific journals to add to their collections. Today, JIF is used to declare researchers' prestige. Similarly, the h-index has also been misinterpreted and used throughout the years. Promotions and career progress within universities are often based on h-index values and the number of a scientist's articles in high-impact factor journals. Efforts to change this culture have already been done in the Netherlands, at the UMC Utrecht where CVs have been replaced with portfolios which are more user-centric than publications-centric[88].

[87] The Leiden Manifesto for Research Metrics
https://www.nature.com/polopoly_fs/1.17351!/menu/main/topColumns/topLeftColumn/pdf/520429a.pdf
[88] https://openworking.wordpress.com/2018/06/24/changing-the-academic-reward-system-the-umc-utrecht-perspective/

Different metrics measured through different services (with potential bias involved)

The lack of a global infrastructure for research impact metrics is a barrier in aggregating, collecting and analysing information and data drawn from heterogeneous environments and limits comparison between similar sources or metrics. The need for Open and FAIR metrics has already been addressed in initiatives such as FAIR metrics[89], however the merits of having an infrastructure to facilitate such processes for all is apparently not currently being discussed.

Universities' global ranking is in some respects based on inaccurate data and arbitrary indicators[74]

University ranking providers like Times Higher Education[90] or the QS World University Ranking[91] base their results on indicators and data which are not always openly available to everyone. Opening such data and analytical processes to the wider academic and research community as well as to citizens, will automatically make them more transparent and result in greater impact.

Lack of qualitative metrics to evaluate research

The use of quantitative metrics is common and can be more easily provided and understood both by humans and computers. However, their use is not applicable to every occasion, especially when the target is quality-based practices. The need for more qualitative metrics has also been addressed in the Next Generation Metrics report of the EC Expert Group on Altmetrics[92].

Lack of a consistent definition of Open Science

The term Open Science is not used in a consistent manner resulting in misunderstandings and policy tools that do not necessarily reflect needs and practices of the research community.[93]

Lack of a unique and consistent framework for indicators on the different aspects of Open Science

The first attempt to measure and monitor Open Science elements and characteristics was the DG RTD Open Science Monitor (OSM) by RAND followed by an updated version coordinated by the Lisbon Council[94]. The EOSCpilot Open Science Monitor[95] and the OpenAIRE Open Science Observatory (in progress) are further examples of efforts to standardise monitoring approaches and provide a common Framework for indicators, something that is still missing from the OS ecosystem.

Biased monitoring. Use of non-open data sources (no reproducibility)

Reproducibility of monitoring, in its technicalities as a mechanism but also in data collection, analysis and statistics production, is key. To conform to Open Science principles: (a) there needs to be an open and FAIR monitoring mechanism which can be reproduced by others if needed, and (b) data collected for analysis should be made available from open sources and with open means for everyone to use for their needs, without producing different results or having to pay to gain access to commercial providers datasets (e.g. SCOPUS[96], Web of Science[97]).

[89] http://fairmetrics.org/

[90] https://www.timeshighereducation.com/policy/private-providers

[91] https://www.topuniversities.com/university-rankings

[92] https://ec.europa.eu/research/openscience/pdf/report.pdf

[93] https://im2punt0.wordpress.com/2017/03/27/defining-open-science-definitions/, http://book.openingscience.org/basics_background/open_science_one_term_five_schools_of_thought.html

[94] https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor_en

[95] https://www.eoscpilot.eu/content/d32-eosc-open-science-monitor-specifications

[96] https://www.scopus.com/search/form.uri?display=basic

[97] http://apps.webofknowledge.com/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=D1TejNtt2vh9n1I6v31&preferencesSaved=

Lack of registries for policies
Policies are traditionally non-structured, non-machine-readable documents generated by use of online or desktop text editors. A variety of policies related to Open Science are made public in a non-standardised way, hence, efforts of different groups to achieve standardisation of publishers' policies and data policies[98], or model policy templates produced in alignment with EU policy developments. Tools or services to overcome such issues and enhance visibility and findability of policy documents include the ROARmap registry of policies[99], JISC RoMEO and Juliet[100], and the FAIRsharing Policy Database[101] which rely on institutional efforts (manual, non-structured data).

3.3.2. Drivers

Drivers for effective monitoring of research impact and open science centre around the understanding of the environment (e.g., new indicators, new ways to measure them), their adoption at various decision-making levels (funding, RPO), and the definition of an interoperable framework of trusted services and data

Research Outputs – Monitoring Research Impact and Open Science: Drivers
The European OSPP – Open Science Policy Platform – as a coordinator of effort and channel to the communities Expertise of the OSPP members and intensive work on the OS policy areas performed in close, dedicated working groups is a great policy enabler for OS, and an outreach to many stakeholders including policymakers for guiding their activities
Initiatives such as Leiden Manifesto and DORA In changing current misconceptions, the OSPP group supports The Leiden Manifesto and The San Francisco Declaration on Research Assessment: DORA. The Leiden Manifesto is a set of statements which identifies ten principles to guide research evaluation while DORA is known for the "fight against the misuse of Journal Impact Factor (JIF)", for eliminating equivalent research assessments and assisting the exploration/examination of alternative methods. Many have signed DORA and recently some good practices following these guidelines have been shared on their website[102].
Research institutions and research performing organisations include Open Science practices in the evaluation of performance and career development It is important that research institutions and research performing organisations are encouraged to include Open Science practices in the evaluation of performance and career development. Funders should be encouraged to include Open Science practices in grant evaluation criteria and as part of the assessment of the researchers. The Open Science Policy Platform Working Group on Rewards/Recognition was mandated to make recommendations in this direction. The report delivered practical recommendations to be adopted by policy makers, funding agencies and institutions to promote the practice of Open Science.
Open Science criteria in funding mechanisms. Open Science a key pillar in Horizon Europe

[98] RDA WG https://www.rd-alliance.org/groups/data-policy-standardisation-and-implementation
[99] http://roarmap.eprints.org/
[100] https://www.jisc.ac.uk/sherpa
[101] https://fairsharing.org/policies/
[102] Good Practices of DORA signatories https://sfdora.org/good-practices/funders/

Horizon Europe, the draft new Research and Innovation Framework Programme to follow Horizon2020, includes Open Science practices in grant evaluation criteria and as part of the assessment of researchers, making the leap to Open Science a responsible decision.

OS-CAM as a tool to support open access

The OSPP Working Group on Rewards proposed a comprehensive approach to evaluating researchers: the Career Assessment Matrix (OS-CAM). The OS-CAM develops a number of evaluation dimensions and associated assessment criteria, looking at research outputs, research process, service and leadership, research impact, teaching and supervision. The OS-CAM proposal enhances the range of metrics which could be used to assess research output and research behaviour in relation to Open Science. By offering a sophisticated evaluation system, it provides insight and direction into more appropriate rewards and reward mechanisms.

Use of metrics and alt-metrics to make assessments for career development purposes

The new era of scholarly communication involves dissemination of research activities also to non-traditional channels where particularly the use of social media has been increased for scientific knowledge exchange, research promotion and networking to build collaborations. The motivation behind researchers' behaviours as well as how the result of such activities is perceived by other scientists requires further examination but there is increasing awareness of, and support for, the need to include this in the assessment of researchers.

Open protocols and (big data) infrastructures for measuring usage and citation

Popular measurements are citation and usage statistics. Initiatives such as WikiCite and the Initiative for Open Citations[103] provide open means and sources to measure citations uptake (in comparison to more closed ones, like CrossRef). Introduction of COCI[104], i.e. Crossref OpenCitations open Index of DOI-to-DOI references, tries to resolve the issue of Crossref's closed citations. Approaches for data are seen in RDA WGs for data citation and data metrics. Standards like the COUNTER[105] are used in IRUS-UK[106] and OpenAIRE analytics enabling aggregation of usage analytics inrepositories.

Services and tools to measure OS

RTD Open Science Monitor[107], OpenDataMonitor[108], FAIR assessors and OpenAIRE services[109] have been aggregating and collecting data in order to analyse them and eventually measure elements of Openness and FAIRness in open practices.

The EOSCpilot Open Science Monitor[110] (work in progress) proposes a framework for Monitoring Targets and indicators for measuring FAIR and Open: publications, research data, educational resources and software/code as well as trustworthiness of repositories and research collaboration (e.g. citations and peer reviews) and citizen science activities (e.g. blog posts, etc). Policy-wise, the measurements are threefold, and intend to capture the state of:

- preparedness of technical and legal infrastructure for policy adoption and implementation

[103] https://meta.wikimedia.org/wiki/WikiCite, https://i4oc.org/
[104] https://opencitations.wordpress.com/2018/07/12/coci/
[105] https://www.projectcounter.org/
[106] https://www.jisc.ac.uk/irus
[107] https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/open-science-monitor_en
[108] https://opendatamonitor.eu/frontend/web/index.php?r=dashboard%2Findex
[109] https://www.openaire.eu/
[110] D3.2 Open Science Monitor specifications (EOSCpilot repository)

- adoption of OS policies, to understand the bigger picture of how the policy is composed, under which regulation/policy it falls and the level of commitment that is required to comply with it

compliance of stakeholders' policies with the EOSC Rules of Participation.

4. DRAFT POLICY RECOMMENDATIONS

All policy recommendations assume a minimum capacity from the side of the stakeholder implementing them and are addressed to the key EOSC stakeholders who (i) need to produce and implement coherent and consistent Open Science and Open Scholarship policies, (ii) are part of the EOSC Governance, and (iii) are able to contribute to the EOSC's overall vision and mission.

The policy recommendations are addressed to all possible stakeholders, though we differentiate between **Research Performing Organisations**, **Funders/Ministries** and **Research/e-infrastructures,** when this is required. These stakeholders are key EOSC stakeholders which need to have produced coherent and consistent OS policies, able to contribute to the EOSC's overall vision and mission. Some recommendations are also directed at the EOSC governance and Rules of Participation.

4.1. Policy Recommendations for Infrastructures and Services in the EOSC

1. Develop a Charter for Access to EOSC Infrastructures, Services and Other Resources

A charter including ground rules, key principles and basic self-commitments would allow different stakeholders taking part in EOSC to have a clear understanding of their rights and obligations with respect to access.

2. Adopt the AARC framework for enabling an interoperable AAI infrastructure

Use of single sign on/login services (or interoperable ones) for the entirety of the spectrum of EOSC services is essential for reducing transaction costs and encouraging use of EOSC infrastructures and services. An AARC framework will provide an incentive both to users and service providers and thus aggregate offer (services) and demand (users) and increase the utility of EOSC.

3. Adopt a minimum metadata schema and limited number of APIs to be considered as standard for services, infrastructures and other resources in the EOSC Service Catalogue

A minimum metadata schema for services (e.g. as defined by eInfraCentral) and a limited number of APIs will allow to have a concise and manageable set of services and thus encourage the development of linked services to those of the EOSC Service Catalogue.

4. Adopt and measure user acknowledgement of use of or contribution to research results of EOSC services, infrastructures and other resources

Acknowledgement of use of or contribution to research results will provide incentives to researchers and at the same time provide a solid metric on which RPOs may build additional metrics, services and incentives schemes.

5. Develop an Evaluation and Ranking of Openness Maturity of EOSC services, infrastructures and other resources

The development of a maturity capability-like model for ranking and evaluating openness of EOSC services will provide a quick and easy-to-use way of assessing the openness of the EOSC ecosystem both for the individual researcher and a research performing organisation. Such system of evaluation and ranking could operate as a signal of openness for the researcher and as an incentive for the RPO, especially if different forms of funding are attached to such an evaluation system.

4.1.1. Implications and Implementation Recommendations for Different Stakeholders

ALL

Adopt the recommendations to be produced by the AARC2 project for enabling interoperable AAI to enable researchers to access the whole research and infrastructure service portfolio with one login

EOSC GOVERNANCE AND RULES OF PARTICIPATION

- Encourages openness and greater consistency in access policies of research infrastructures, services and other resources supplied through the EOSC
- Ensures AAI solutions in use by suppliers to and users of the EOSC will be interoperable
- Supports interoperability of services, infrastructures and other resources in the EOSC, based on widely recognised standards
- EOSC governance will need to develop monitoring of acknowledgements which will establish and develop practice of citation of EOSC services etc providing a metric for "usability" of services etc
- EOSC RoP should include requirement for users to acknowledge use/contribution of EOSC services, infrastructures and other resources
- EOSC governance will need to monitor adherence to the approved set of minimum metadata and APIs
- EOSC RoP should include requirements for EOSC providers to adhere to the approved set of APIs

FUNDERS

- Funders' requirement for greater openness and consistency of research infrastructures' access policies encourages their use
- Beneficiaries would be required to adopt/apply the AARC2 recommendations which will result in improved accessibility of infrastructures, services etc
- Encourage beneficiary services, infrastructure etc to adopt the EOSC-approved set of minimum metadata and APIs supporting interoperability of services, infrastructures etc and the EOSC, to ensure they meet the EOSC RoPs

RESEARCH PERFORMING ORGANISATIONS

- researchers will need to adopt the practice of citing EOSC services, infrastructures and other resources used in their research

E-INFRASTRUCTURES/ RESEARCH INFRASTRUCTURES

- Charter development may be expected to apply pressure for greater openness and harmonisation of access policies
- Evaluate and rank RIs' openness and recommend activities to encourage greater openness
- RIs should consider assigning open source licenses to the software comprising the core of the open infrastructure they are developing
- RIs will need to adopt the approved set of minimum metadata and APIs for greater interoperability of RIs and services, if they wish to participate in the EOSC
- use of research infrastructures for research outputs is recognised and cited, however RIs may feel under pressure to increase their usage

4.2. Policy Recommendations for Open Science Research Outputs in the EOSC

6. Adopt a minimal set of standards for data/metadata and exchange protocols

Such standards should be based, where possible, on existing global and widely adopted standards. For example, these could be standards for interoperability (e.g. protocols), for metadata exchange (machine readability), for vocabularies, for file formats etc.

7. Reduce regulatory complexity for researchers

In the course of their research activities researchers are frequently obliged to take into consideration an increasingly wide range of regulations (from copyright and data protection, to special data regimes, ethics rules etc). In this context, it is necessary that the regulatory complexity is reduced either through the

codification and simplification of the relevant legislation or through the use of tools and toolkits (including guides and training) to support them in their compliance work.

8. Develop and adopt a European Open Science Concordat

Provide leadership and clarity around openness-by-default by jointly detailing an Open Science code of conduct for every beneficiary involved in the research process, from authors to data stewards to repository managers, including the requirement for all research outputs to be appropriately open (as open as possible, as closed as necessary), FAIR and citable.

9. Encourage the development of an EOSC TDM (Text and Data mining) Policy Framework

TDM is becoming the basis for an increasing number of types of research activities, however the regulatory and policy framework surrounding its use remain unclear so we should create a comprehensive policy framework for TDM -based research output, covering commercial and non-commercial use and re-use.

10. Develop principles for long-term data stewardship enabling curation, provenance and quality

Long term stewardship is a composite and complex activity including a number of more specific activities, such as curation, provenance and quality assurance. It is necessary that best practices are developed, documented and then presented in a comprehensive form as a code of conduct including the most important principles and practices.

11. Use community accepted standards and conventions.

Best practices as developed and accepted by the relevant scientific communities are necessary to achieve the objectives of the EOSC. Hence it is necessary to describe, codify and disseminate such practices to reduce transaction costs and ensure EOSC is used by all involved communities.

12. Standardise costs types of Open Science (OA, RDM, Preservation, etc) at all levels

There is immediate need to standardize all types of costs ranging from subscriptions (eg big deals) and costs related to OA and RDM e.g., APCs (peer review process and data stewardship), to storage and services capabilities requirements (e.g., storage costs per Giga- or Tera- Bytes of datasets). Such standardisation will allow a better understanding of their operation (e.g. through meaningful comparisons), to the benefit of the individual researcher and the RPO.

13. Make DMPs a requirement and develop consistent (i.e. aligned) requirements for DMPs

Include machine-readability, versioning, linking to infrastructures and registries. Mandate DMP deposition in a certified repository or CRIS system, link with the research data to which they relate, and update during the lifetime of the research project so they are “live” documents.

14. Encourage the use of unique and persistent digital identifiers

Unique and persistent digital identifiers based on global, sustainable and community-governed solutions are necessary to support openness, FAIRness and citability of all research outputs and to provide the basis for mechanisms to assess compliance with Open Science policies.

15. Ensure that infrastructures, services and other resources supplied through the EOSC provide assurance, for example by developing accreditation or certification schemes

Such assurance is necessary to increase trust in the EOSC and encourage the open release of content by all involved stakeholders. Provide assurance:

- to users, that their research outputs are open, FAIR and citable;
- to the EOSC for the purposes of FAIR data governance and compliance monitoring.

16. Develop, support and promote an EOSC Skills and Capability Framework as a common reference point

Provision of the necessary skills to support and further advance open science is a necessary condition for the further development of the EOSC ecosystem. The description of the necessary competencies and skills for

RDM is a good first step in this direction and may be further complemented by additional specification of the skills necessary for ensuring that research outputs are appropriately open, FAIR and citable

4.2.1. Implications and Implementation Recommendations for Different Stakeholders

EOSC GOVERNANCE AND RULES OF PARTICIPATION

- Accepts or modifies the standardisation process across EOSC entities
- Supports EOSC RoP by stating principles around data stewardship
- European Open Science Concordat supports EOSC RoP by stating principles and expectations around openness, reflecting to users the standards of openness they need to seek in their research and to providers the baseline of openness they should provide
- Supports best practice in data management in the EOSC
- Supports all research outputs produced through the EOSC to have unique and persistent digital identifiers as well as to be open, FAIR and citable
- Provides the basis for mechanisms to monitor compliance with Open Science policies
- Accreditation or certification schemes for research outputs to be developed by EOSC governance; consider introduction of badging systems supporting specific rewards for data availability and for re-use
- provides a Skills and Capability Framework to offer RI, RPOs, and other service providers and users a common reference point for describing the necessary skills and competences for RDM, to ensure research outputs are appropriately open, FAIR and citable

FUNDERS

- Suggests or mandates the standardisation process across and beyond EOSC
- Requires cross-border coordination and cooperation between European states, RIs and RPOs and beyond
- Wider adherence to approved data stewardship practices by those involved in the research process
- Requires standardisation of costs around OA publishing and RDM eg APCs (peer review process and data stewardship)
- Supports research outputs to be open, FAIR and citable
- Provides basis for mechanisms to monitor compliance with Open Science policies
- Lowering the gap between supply and demand for ICT jobs

RESEARCH PERFORMING ORGANISATIONS

- Implement and evaluate standardisation within the research process
- Requires collaboration cross-border and with funders/ministries and RIs
- Collaborate with Industry to open up patents, for example piloting open patents in specific industry sectors with high R&D costs, a high regulatory burden or high equipment costs
- Expect guidance on standards to result in wider adherence to approved data stewardship practices by those involved in the research process
- Require standardisation of costs around subscriptions (eg big deals)
- Standardise requirements for DMPs; consistent processes to support implementation can be developed
- Support research outputs to be open, FAIR and citable
- Provide basis for mechanisms to monitor compliance with Open Science policies
- Use of EOSC development skills framework to create job profiles, describing the necessary skills and competences for RDM

E-INFRASTRUCTURES/ RESEARCH INFRASTRUCTURES

- Develop and deploy standardisation tools and testing processes
- Requires collaboration cross-border and with funders/ministries and RPOs
- RIs can support the principles and expectations around openness which RIs and users should meet
- RIs can support the data stewardship standards which RIs and users should meet
- Requires standardisation of costs around storage and services capabilities requirements (eg storage costs per Giga- or Tera- Bytes of datasets)
- Support all usage applications of DMPs
- Research outputs produced using RIs should be assigned unique and persistent digital identifiers
- Supports research outputs to be open, FAIR and citable
- Provides basis for mechanisms to monitor compliance with Open Science policies
- Mapping job profiles to EOSC services, validating the services with the feedback in the framework of skills & training

POLICY MAKERS

- Ensures all affected beneficiary groups are involved in developing the Concordat by providing principles and expectations around openness for beneficiaries and expecting increased levels of compliance to stated standards of openness
- Ensures all affected beneficiary groups are involved in developing the principles for Data Stewardship

4.3. Policy Recommendations for Intellectual Property Rights

This section provides an outline of the main policy themes and recommendations falling under the IPR umbrella. It aims at a comprehensive, yet concise, approach addressing the main challenges related to IPR that are identified in previous sections. The recommendations concern different types of IPR policies, that follow the life-cycle of an intangible asset (identification, clearance, sharing, management, dissemination). In the core of our approach is the reduction of any unnecessary transaction costs throughout the life cycle of the research process in a way that supports the vision and practice of open science.

17. Coordinate Open Access and IPR reutilisation in a comprehensive and coherent IPR framework

The issue of IPR and open science, particularly open access, are often presented as antithetical or incompatible. There is limited merit in such an approach. Different forms of IPR exploitation relate to open licensing in a limited fashion only and, mostly, have to do with the choice of time when the protected material is to be released, especially in relation to patents. In addition, IPR exploitation policies are closely related to questions of rights registration and enforcement.

18. Have proper IPR documentation when releasing or accessing a research resource

Rights documentation is a crucial part of any IPR policy, as it allows all involved stakeholders to have an accurate understanding of the rights status of different assets in different stages of their life-cycle (registration, sharing, licensing). Documentation should cover at least the (a) type of IPR, (b) ownership of rights, and (c) licensing of resources.

Such documentation should normally exist on the resource itself (e.g. ownership and copyright notices on a document), in the meta-data of the resource file (e.g. in the meta-data of .doc file), and in the repository metadata.

Where resources are offered through a web service (e.g. an API), the API documentation should also include the terms and conditions (TCs) or Terms of Service (ToS) under which they are offered.

Both licences and ToS/ TCs have to be stored in a permanent URI. They also have to follow a clear versioning system and contain a versioning history (versions/date). To the extent possible, a change of version shall be communicated to the recipients of the service (e.g. registered users) or made visible through a public website.

19. Clear IPRs before sharing them over e-Infrastructures/ Research Infrastructures

Rights clearance is a precondition for sharing any research output or resource and ensuring this happens before the introduction of the resource in a shared environment will substantially reduce research transaction costs and risks.

20. Provide coherent and consistent IPR ownership policies

One of the greatest challenges in comprehensive IPR policies for all types of organisations is the introduction of clear ownership and rights registration policies. Such policies allow all levels and types of participants in a research process to have a clear understanding of their rights regarding their contribution in a specific creative process.

21. Have a clear access and rights management regime

Rights management within a research environment, by and large, relates to the access rights that different levels and types of staff have on research results and services. This needs to be in accordance with all the aforementioned points and provide a coherent framework both for reducing potential risks and for ensuring no unnecessary exclusion of persons or institutes requiring access to resources is in place.

22. Ensure that licensing policies accommodate different types of value production

Licensing schemes are necessary both in relation to the establishment of any type of collaboration related to resources and services and in relation to exploitation of resources in a broader value chain including such resources. The relevant stakeholders should make provision to have in place policies both for collaboration and the exploitation/dissemination of resources.

23. Introduce Open Access enforcement policies and mechanisms

Enforcement policies should address three issues: first, how the organisation is to monitor the implementation/application of the licence agreements it grants in relation to its own assets; second, how it is to respond to infringements of its licences and/ or IPR in general; and third, how it is going to respond to infringements that take place through the services/assets it provides to third parties.

24. Devise and deploy open patent systems along the existing patent systems and support the use of open data for assessing the state of the art in a patent ecosystem.

Piloting open patents in specific industry sectors with high R&D costs, a high regulatory burden or high equipment costs could substantially contribute to the support of open science. In addition, the use of open data to improve state of the art searches and position research in the patent landscape will substantially increase the value return for RPOs and SMEs. Finally, collaboration between EOSC and the European Patent Academy to find and facilitate links between Open Science and increase access to the state of the art, could reduce patent costs allowing SMEs to take part in the innovation ecosystem on equal terms to bigger organisations.

4.3.1. Implications and Implementation Recommendations for Different Stakeholders

EOSC GOVERNANCE AND RULES OF PARTICIPATION

- Create an IPR registry containing all IPR policies of participating organisations
- Express IPR policies in a standard and – ideally - machine readable format
- Introduce obligatory IPR documentation as a ground rule for RoP. This includes at least ownership and licensing information
- Require rights clearance and documentation of the clearance process before any resource is uploaded on EOSC
- Create model collaboration agreements

- Record rights allocation rules in collaboration projects
- Record rights ownership in collaboration projects
- Provide model access policies (modular, standard and machine readable)
- Ensure that all resource providers have an access policy in place
- Produce EOSC wide modular and standardise model policy for scholarly communications and IPR
- Produce decision trees for the choice of open access policies in accordance to IPR policies
- Provide Licence compatibility charts, wizards and training
- Use standard and documented licences
- Create machine readable licensing policies
- Have an EOSC-wide enforcement policy
- Create SOPs for handling infringement of open licences and communicate it to the users

FUNDERS

- Require the existence of comprehensive IPR policies as a precondition for institutional funding
- Have IPR documentation of all research outcomes as a condition for funding a research project.
- Have clearance of rights as an eligible cost in their funding programmes
- Do not accept as deliverables any content/ research resources that remains uncleared
- Have clear allocation of IPR ownership as a funding condition
- Establish clear procedures with regards to allowed embargo periods and access limitations to maximise open access publications
- Condition funding upon the release of the research output, at a certain stage or certain degree, as open and FAIR content
- Request a justification, on the basis of a comprehensive IPR exploitation plan, of any decision not to openly release research output
- Require that individual researchers and RPOs have a clear exploitation plan along with an open scholarly communication plan. In case they fund consortia, they should provide model consortia agreements, and in all cases, make suggestions in relation to both open licences to be used (mostly those characterised as Free Cultural Work licences[111]), as well as model licensing frameworks[112]
- Require the existence of SOPs for the enforcement of open licences
- Undertake the funding of the whole or part of the litigation process, as well as encourage collaborations with civil society orgs (e.g. FSF).[113]

RESEARCH PERFORMING ORGANISATIONS

- Adopt a holistic IPR policy that covers all types of IPR, i.e. Copyright, Patents, Trademarks and Design Rights.
- Collaborate with National IPR Offices to create custom IPR awareness campaigns with an emphasis on the interaction between IPR and open access
- Increase the number and quality of IPR courses for non-lawyers focusing on interaction between open access and IPR utilisation
- Adopt minimum IPR documentation policies as a condition for the inclusion of resources in their institutional repositories.
- Ensure IPR documentation is standard and machine readable
- Introduce specific IPR ownership rules for the following instances:
    - regular research activities of the staff

[111] For the relevant definition, see https://creativecommons.org/share-your-work/public-domain/freeworks/

[112] E.g. the UK OpenGov Licensing Framework http://www.nationalarchives.gov.uk/information-management/re-using-public-sector-information/uk-government-licensing-framework/

[113] E.g. https://www.gnu.org/licenses/why-assign.html

  - research collaboration in the framework of projects funded by third parties
  - research collaborations with commercial parties
  - research conducted in collaboration with RPOs spin offs
  - research collaborations with the government
- Specify in clear terms the division of ownership between the RPOs and the individual researcher
- Establish clear access procedures in accordance to their IPR policies and ensure that such policies do not preclude neither open access publication of results nor the utilisation and exploitation of research output.
- Provide clear decision paths for making choices in relation to releasing research results under open licences and the exploitation of research results
- Provide training and support in relation to the different value production models and set open licensing as the default choice for the publication of research output
- Introduce model licensing agreements for open innovation networks
- Establish IPR policies in relation to different forms of exploitation. Such policies should contain at least the following elements:
  - have a patent or other industrial property assessment of research results
  - identify value in monetary and non-monetary terms -at least- in relation to core assets
  - identify possible embargos and specify how the scholarly communication of research results affects the exploitation possibilities of research results
  - specify a life-cycle or asset management plan for different assets contained in the research results
  - introduce model dual/multiple-licence agreements
- Establish standard operational procedures (SOPs) for responding to infringement, reporting to affected owners and limiting damage, including notice and take down procedures.
- Establish risk mitigation strategies, particularly through comprehensive rights clearance at the source of the information entry with a focus on:
  - violation of attribution terms
  - violation of copyleft terms
  - violation of the non-commercial clauses
- Introduce warning and mediation strategies before escalating legal action in case of infringement.

E-INFRASTRUCTURES/ RESEARCH INFRASTRUCTURES

- Condition RPOs participation to e-Infrastructures upon the existence of comprehensive IPR policies for the resources shared on the infrastructures
- Only host research content that contains IPR documentation
- Provide tools and guidelines for clearing content
- Ensure that IPR clearance takes place before any resource is shared through the infrastructure and only host IPR cleared material
- Ensure there is clear ownership of all resources entering an e-infrastructure
- Provide specific and clear rules for accessing research process and results
- Have very clear rules as to the kind of content they host and how they support scholarly communication and commercial exploitation accordingly
- Follow a coherent licence policy encouraging Free Cultural Work Licences[114]
- Follow a license compatibility framework, i.e. suggest a limited range of licences and ensure there are licence calculators in place to allow user to re-use and re-combine material[115]

[114] https://creativecommons.org/share-your-work/public-domain/freeworks/

[115] E.g. http://janelia-flyem.github.io/licenses.html

- Introduce Standard Operational Procedures (SOPs) for all kinds of infringements taking place over their network.

POLICY MAKERS

- Encourage collaboration between National IPR offices and RPOs
- Provide incentives for clear rules of ownership and the documentation of the ownership of research resources
- Provide rules specifying minimum embargo periods after which research results should become open
- Ensure that different access levels are based on predefined, rational and transparent parameters that may be monitored and enforced
- Clearly relate public funding to open access and commercial exploitation to state aid or financing from private sources. By identifying a series of different types of value (e.g. monetary and non-monetary), policy makers should opt for open scholarly communication that could be complemented with other types of protection, e.g. patent protection, especially if the disclosure obligations of a patent are fulfilled through the open access publication of the underpinning research
- Take all measures possible to reduce licence pollution by encouraging the use of standard and existing licences and also by linking funding and career development with the opening up of research results.
- Introduce policies linking the assessment of an RPO with the maturity of its enforcement mechanisms, particularly in relation to the violation of Open licences
- Provide guidance and training in relation to the types of liability related to different types of releasing research resources.

4.4. Policy Recommendations for Research Impact Assessment and Open Science Monitoring in the EOSC

25. Adopt the recommendation of the OSPP Working Group on Rewards and embed Open Science in the evaluation of researchers at all stages of their career

- Open Science must become part of recruitment criteria, career progression and grant assessment procedures for researchers
- ERA policies and roadmaps, as well as relevant national policies need a revision through the lens of Open Science and to be appropriately adapted to support Open Science
- Mechanisms should be put in place at the European level to encourage and incentivise researchers' participation in Open Science, primarily by funders
- Assessment of researchers should be structured to encompass all aspects of their achievements including Open Science. The OS-CAM multi-dimensional approach can be instrumental in this more structured evaluation of researchers.

26. Promote and support Open Next Generation Metrics infrastructure

As with the recommendation of the EC HLEG on Next Generation Metrics, «*Next generation metrics should be underpinned by an open, transparent and linked data infrastructure»* to address the collection and processing of underlying data. Develop and promote unique, unambiguous, persistent, verified, open, global identifiers; agreed standard data formats; and agreed standard data semantics.

27. Develop and operate Open Science Monitoring as an integral core service of EOSC

Develop an OS monitoring framework, indicators for measuring all aspects of OS, data to use, how to collect data, etc. This framework must meet the consensus of national infrastructures, RIs, EU as well as international bodies, who will have local monitoring instances. Moreover, the framework must be:

- **Open, Accessible and Interoperable.** Develop open, web-accessible and distributed instances with well-defined APIs and exchange formats for raw data, indicators and results
- **Reproducible.** Use of open data sources/resources to ensure transparency and reproducibility

- **Secure.** Provide appropriate security measures by defining and employing appropriate security policies around authorisation and authentication of research administrator actions, data protection and safe-guarding of the integrity of the data
- **Reliable.** Exhibit a reliable online presence, without down-time or undocumented changes
- **Extensible.** Account for dynamically changing application contexts, i.e., new types of data, new indicators
- **Scalable.** Handle very large amounts of requests, as well as simultaneous execution of tasks and processes such as monitoring, visualizing, exporting and so on.

28. Develop and maintain a machine-readable Open Science Registry for EOSC

Develop a set of OS policy models and accompanying structures.

4.4.1. Implications and Implementation Recommendations for Different Stakeholders

EOSC GOVERNANCE AND RULES OF PARTICIPATION

- EOSC must consider the Open Science Monitor (OSM) as one of its key core services
- All EOSC services must develop OS reporting mechanisms and exchange data with EOSC OSM
- The EOSC must be part of a global Open Metrics initiative where all types of next generation metrics are collected and processed. Use RDA as one of the venues for global collaboration on the specifications
- Ensure metrics are automatically collected from EOSC stakeholders who want to measure openness and FAIRness of their organization and research outputs
- Develop and introduce a badging system for all aspects of open science (e.g. OA publications and data, stewardship for FAIR data, links to software and methods, assisting citizen science) to intrinsically motivate researchers, boost their active participation in open science, increase public recognition and foster self-guided OS training
- Assist in the development of OS policy models to be used in EOSC and promote the use of machine-readable policy documents
- A federated EOSC should be supported by an Open Science registry.

FUNDERS/ MINISTRIES

- Define Open science, Data Science and relevant services and adjust grant policies by prioritising support for EOSC infrastructure and EOSC repositories
- Provide consistent policies for domain-specific Data Management Plans, the application of FAIR principles and rewards
- Provide financial incentives for researchers to make data openly available not only at the end of their project but also in other phases of the research process
- Provide the set of metrics specified by the OS Monitor for measuring Open Science Embed the framework into national infrastructures and services
- Adopt the OS policy model (preferably machine readable) and record OS policies at national level
- Establish and support national OS nodes to network with EU and global initiatives.

RESEARCH-PERFORMING ORGANISATIONS

- Provide the set of metrics specified by the OS Monitor for measuring Open Science
- Introduce the use of combined metrics in researcher career assessment. Use Journal Impact Factor, h-index and usage metrics wisely and only for the purpose each individual metric was initially introduced for
- Promote open peer review (including peer-review of DMPs and data) as a way of incentivising researchers and getting credit; include peer-review in recruitment and in promotion of researchers
- Encourage the establishment of Open Science Championships and other relevant initiatives promoting OS practices uptake.

E-INFRASTRUCTURES/ RESEARCH INFRASTRUCTURES

- Put in place the appropriate monitoring mechanisms and services (based on the agreed framework) and provide the set of metrics specified by the OS Monitor for measuring Open Science
- Define mechanisms to require the use of a standardised metrics system in line with those proposed by funder or specific domain communities
- Consider innovative ways of promoting the use of services, for instance by rewarding researchers with free storage space for sharing big datasets.

POLICY MAKERS

- Conform to the OS Monitor specs and provide data and indicators accordingly
- Provide citation and usage data in the Open Metrics Infrastructure

The table presented on the following pages summarises possible implications of the Open Science and Open Scholarship draft recommendations for each of the stakeholder groups.

Draft Policy Recommendation	EOSC Governance/Rules of Participation	Funders and Ministries	Research Producing Organisations	Research Infrastructures	Policymakers
OS1. Develop a Charter for Access to EOSC Infrastructures, Services and Other Resources OS2. Adopt the AARC framework for enabling an interoperable AAI infrastructure OS3. Adopt a minimum metadata schema and limited number of APIs to be considered as standard for services, infrastructures and other resources in the EOSC Service Catalogue OS4. Adopt and measure user acknowledgement of use of or contribution to research results of EOSC services, infrastructures and other resources OS5. Develop an Evaluation and Ranking of Openness Maturity of EOSC services, infrastructures and other resources	Encourages openness and greater consistency in access policies of research infrastructures, services and other resources supplied through the EOSC single login EOSC RoP should include requirements for EOSC providers to adhere to the approved set of APIs EOSC governance will need to monitor adherence to the approved set of minimum metadata and APIs Supports interoperability of services, infrastructures and other resources in the EOSC, based on widely recognised standards EOSC RoP should include requirement for users to acknowledge use/contribution of EOSC services,	Funders requirement for greater openness and consistency of research infrastructures' access policies encourages their use Beneficiaries would be required to adopt/apply the AARC2 recommendations which will result in improved accessibility of infrastructures, services etc Encourage beneficiary services, infrastructure etc to adopt the EOSC-approved set of minimum metadata and APIs supporting interoperability of services, infrastructures etc and the EOSC, to ensure they meet the EOSC RoPs	Researchers will need to adopt the practice of citing EOSC services, infrastructures and other resources used in their research	Charter development may be expected to apply pressure for greater openness and harmonisation of access policies Evaluation and Ranking of Openness Maturity will evaluate and rank RIs' openness and will recommend activities to encourage greater openness RIs should consider assigning open source licenses to the software comprising the core of the open infrastructure they are developing RIs will need to adopt the approved set of minimum metadata and APIs for greater interoperability of RIs and services, if they wish to participate in the EOSC - use of research infrastructures for research outputs is recognised and cited,	

	infrastructures and other resources - EOSC governance will need to develop monitoring of acknowledgements which will establish and develop practice of citation of EOSC services etc providing a metric for "usability" of services etc			however RIs may feel under pressure to increase their usage	

Draft Policy Recommendation	EOSC Governance/Rules of Participation	Funders and Ministries	Research Producing Organisations	Research Infrastructures	Policymakers
OS6. Adopt a minimal set of standards for data/metadata and exchange protocols	Accepts or modifies the standardisation process across EOSC entities European Open Science Concordat supports EOSC RoP by stating principles and expectations around openness reflecting to users the standards of openness they need to seek in their research and to providers the baseline of openness they should provide Supports EOSC RoP by stating principles around data stewardship Supports best practice in data management in the EOSC Supports all research outputs produced through the EOSC to have unique and persistent digital identifiers as well as to	Suggests or mandates the standardisation process across and beyond EOSC Requires cross-border coordination and cooperation between European states, RIs and RPOs and beyond increased rates of regulatory compliance by researchers; simpler to implement and monitor Ensures all affected beneficiary groups are involved in developing the Concordat by providing principles and expectations around openness for beneficiaries and expecting increased levels of compliance to stated standards of openness Ensures all affected beneficiary groups are	Implement and evaluate standardisation within the research process Requires collaboration cross-border and with funders/ministries and RIs Collaborate with Industry to open up patents, for example piloting open patents in specific industry sectors with high R&D costs, a high regulatory burden or high equipment costs Expect guidance on standards to result in wider adherence to approved data stewardship practices by those involved in the research process Require standardisation of costs around subscriptions (eg big deals)	Develop and deploy standardisation tools and testing processes Requires collaboration cross-border and with funders/ministries and RPOs RIs can support the principles and expectations around openness which RIs and users should meet RIs can support the data stewardship standards which RIs and users should meet Require tandardisation of costs around storage and services capabilities requirements (eg storage costs per Giga- or Tera- Bytes of datasets) Support all usage applications of DMPs Research outputs produced using RIs	
OS7. Reduce regulatory complexity for researchers					
OS8. Develop and adopt a European Open Science Concordat					
OS9. Encourage the development of an EOSC TDM (Text and Data mining) Policy Framework					
OS10. Develop principles for long-term data stewardship enabling curation, provenance and quality					
OS11. Use community accepted standards and conventions					
OS12. Standardise costs types of Open Science (OA, RDM, Preservation, etc) at all levels					
OS13. Make DMPs a requirement and develop consistent (i.e. aligned) requirements for DMPs					

OS14. Encourage the use of unique and persistent digital identifiers OS15. Ensure that infrastructures, services and other resources supplied through the EOSC provide assurance, for example by developing accreditation or certification schemes OS16. Develop, support and promote an EOSC Skills and Capability Framework as a common reference point	be open, FAIR and citable Provides the basis for mechanisms to monitor compliance with Open Science policies Accreditation or certification schemes for research outputs to be developed by EOSC governance; - consider introduction of badging systems supporting specific rewards for data availability and for re-use Provides a Skills and Capability Framework to offer RI, RPOs, and other service providers and users a common reference point for describing the necessary skills and competences for RDM, to ensure research outputs are appropriately open, FAIR and citable	involved in developing the principles for Data Stewardship Requires standardisation of costs around OA publishing and RDM eg APCs (peer review process and data stewardship) Supports research outputs to be open, FAIR and citable Provides basis for mechanisms to monitor compliance with Open Science policies - Lowering the gap between supply and demand for ICT jobs	Standardise requirements for DMPs; consistent processes to support implementation can be developed Support research outputs to be open, FAIR and citable Provide basis for mechanisms to monitor compliance with Open Science policies - Use of EOSC development skills framework to create job profiles, describing the necessary skills and competences for RDM	should be assigned unique and persistent digital identifiers Supports research outputs to be open, FAIR and citable Provides basis for mechanisms to monitor compliance with Open Science policies - Mapping job profiles to EOSC services, validating the services with the feedback in the framework of skills & training	

Draft Policy Recommendation	EOSC Governance/Rules of Participation	Funders and Ministries	Research Producing Organisations	Research Infrastructures	Policymakers
OS17. Coordinate Open Access and IPR reutilisation in a comprehensive and coherent IPR framework OS18. Have proper IPR documentation when releasing or accessing a research resource OS19. Clear IPRs before sharing them over e-Infras/ Research Infrastructures OS20. Provide coherent and consistent IPR ownership policies OS21. Have a clear access and rights management regime OS22. Ensure that licensing policies accommodate different types of value production OS23. Introduce Open Access enforcement policies and mechanisms	Create an IPR registry containing all IPR policies of participating organisations Express IPR policies in a standard and - ideally - machine readable format Introduce obligatory IPR documentation as a ground rule for RoP. This includes at least ownership and licensing information Require rights clearance and documentation of the clearance process before any resource is uploaded on EOSC Create model collaboration agreements Record rights allocation rules in collaboration projects Record rights ownership in collaboration projects Provide model access policies (modular,	Require the existence of comprehensive IPR policies as a precondition for institutional funding Have IPR documentation of all research outcomes as a condition for funding a research project. Have clearance of rights as an eligible cost in their funding programmes Do not accept as deliverables any content/ research resources that remains uncleared Have clear allocation of IPR ownership as a funding condition Establish clear procedures with regards to allowed embargo periods and access limitations to maximise open access publications	Adopt a holistic IPR policy that covers all types of IPR, i.e. Copyright, Patents, Trademarks and Design Rights. Collaborate with National IPR Offices to create custom IPR awareness campaigns with an emphasis on the interaction between IPR and open access Increase the number and quality of IPR courses for non-lawyers focusing on interaction between open access and IPR utilisation Adopt minimum IPR documentation policies as a condition for the inclusion of resources in their institutional repositories. Ensure IPR documentation is standard and machine readable	Condition RPOs participation to e-Infrastructures upon the existence of comprehensive IPR policies for the resources shared on the infrastructures Only host research content that contains IPR documentation Provide tools and guidelines for clearing content Ensure that IPR clearance takes place before any resource is shared through the infrastructure and only host IPR cleared material Ensure there is clear ownership of all resources entering an e-infrastructure Provide specific and clear rules for accessing research process and results	Encourage collaboration between National IPR offices and RPOs Provide incentives for clear rules of ownership and the documentation of the ownership of research resources Provide rules specifying minimum embargo periods after which research results should become open Ensure that different access levels are based on predefined, rational and transparent parameters that may be monitored and enforced Clearly relate public funding to open access and commercial exploitation to state aid or financing from private sources. By identifying a series of different types of value (e.g. monetary and non-monetary), policy makers should opt for open scholarly

	standard and machine readable) Ensure that all resource providers have an access policy in place Produce and EOSC wide modular and standardise model policy for scholarly communications and IPR Produce decision trees for the choice of open access policies in accordance to IPR policies Provide Licence compatibility charts, wizards and training Use standard and documented licences Create machine readable licensing policies Have an EOSC-wide enforcement policy Create SOPs for handling infringement of open licences and	Condition funding upon the release of the research output, at a certain stage or certain degree, as open and FAIR content Request a justification, on the basis of a comprehensive IPR exploitation plan of any decision not to openly release research output Require that individual researchers and RPOs have a clear exploitation plan along with an open scholarly communication plan. In case they fund consortia, they should provide model consortia agreements, and in all cases, make suggestions in relation to both open licences to be used (mostly those characterised as Free Cultural Work licences[116]), as well as	Introduce specific IPR ownership rules for the following instances: regular research activities of the staff research collaboration in the framework of projects funded by third parties research collaborations with commercial parties research conducted in collaboration with RPOs spin offs research collaborations with the government Specify in clear terms the division of ownership between the RPOs and the individual researcher Establish clear access procedures in accordance to their IPR policies and ensure that such policies do not preclude neither open access publication of	Have very clear rules as to the kind of content they host and how they support scholarly communication and commercial exploitation accordingly Follow a coherent licence policy encouraging Free Cultural Work Licences[119] Follow a license compatibility framework, i.e. suggest a limited range of licences and ensure there are licence calculators in place to allow user to re-use and re-combine material[120] Introduce Standard Operational Procedures (SOPs) for all kinds of infringements taking place over their network.	communication that could be complemented with other types of protection, e.g. patent protection, especially if the disclosure obligations of a patent are fulfilled through the open access publication of the underpinning research Take all measures possible to reduce licence pollution by encouraging the use of standard and existing licences and also by linking funding and career development with the opening up of research results. Introduce policies linking the assessment of an RPO with the maturity of its enforcement mechanisms, particularly in relation to the violation of Open licences Provide guidance and training in relation to

[116] For the relevant definition, see https://creativecommons.org/share-your-work/public-domain/freeworks/

[119] See https://creativecommons.org/share-your-work/public-domain/freeworks/

[120] E.g. http://janelia-flyem.github.io/licenses.html

	communicate it to the users	model licensing frameworks[117] Require the existence of SOPs for the enforcement of open licences Undertake the funding of the whole or part of the litigation process, as well as encourage collaborations with civil society orgs (e.g. FSF).[118]	results nor the utilisation and exploitation of research output. Provide clear decision paths for making choices in relation to releasing research results under open licences and the exploitation of research results Provide training and support in relation to the different value production models and set open licensing as the default choice for the publication of research output Introduce model licensing agreements for open innovation networks Establish IPR policies in relation to different forms of exploitation. Such policies should contain at least the following elements: have a patent or other industrial property		the types of liability related to different types of releasing research resources.

[117] E.g. the UK OpenGov Licensing Framework http://www.nationalarchives.gov.uk/information-management/re-using-public-sector-information/uk-government-licensing-framework/

[118] E.g. https://www.gnu.org/licenses/why-assign.html

			assessment of research results identify value in monetary and non-monetary terms -at least- in relation to core assets identify possible embargos and specify how the scholarly communication of research results affects the exploitation possibilities of research results specify a life-cycle or asset management plan for different assets contained in the research results introduce model dual/multiple-licence agreements Establish standard operational procedures (SOPs) for responding to infringement, reporting to affected owners and limiting damage, including notice and take down procedures. Establish risk mitigation strategies, particularly		

			through comprehensive rights clearance at the source of the information entry with a focus on: violation of attribution terms violation of copyleft terms violation of the non-commercial clauses Introduce warning and mediation strategies before escalating legal action in case of infringement.		

Draft Policy Recommendation	EOSC Governance/Rules of Participation	Funders and Ministries	Research Producing Organisations	Research Infrastructures	Policymakers
OS24. Adopt the recommendation of the OSPP Working Group on Rewards and embed Open Science in the evaluation of researchers at all stages of their career OS25. Promote and support Open Next Generation Metrics infrastructure OS26. Develop and operate Open Science Monitoring as an integral core service of EOSC OS27. Develop and maintain a machine-readable Open Science Registry for EOSC	EOSC must consider Open Science Monitor as one of its key core services All EOSC services must develop OS reporting mechanisms and exchange data with EOSC OSM EOSC must be part of a global an Open Metrics initiative where all types of next generation metrics are collected and processed. Use RDA as one of the venues for global collaboration on the specifications. Ensure metrics are automatically collected from EOSC stakeholders who want to measure openness and FAIRness of their organization and research outputs Develop and introduce a badging system for all aspects of open science (e.g., OA publications and data, stewardship for FAIR data, links to	Define Open science, Data Science and relevant services and adjust grant policies accordingly, by prioritising support for EOSC infrastructure and EOSC repositories Provide consistent policies for domain-specific Data Management Plan, the application of FAIR principles and rewards Provide financial incentives for researchers to make data openly available not only at the end of their project but also in other phases of the research process Provide the set of metrics specified by the OS Monitor for measuring Open Science. Embed the framework into national infrastructures and services	Provide the set of metrics specified by the OS Monitor for measuring Open Science Introduce the use of combined metrics in researcher career assessment. Use Journal Impact Factor, h-index and usage metrics wisely and only for the purpose each individual metric was initially introduced for Promote open peer review (including peer-review of DMPs and data) as a way of incentivising researchers and getting credit; include peer-review in recruitment and in promotion of researchers Encourage the establishment of Open Science Championships and other relevant initiatives promoting OS practices uptake	Put in place the appropriate monitoring mechanisms and services (based on the agreed framework) and provide the set of metrics specified by the OS Monitor for measuring Open Science Define mechanisms to require the use of a standardised metrics system in line with those proposed by funder or specific domain communities Consider innovative ways of promoting the use of services, for instance by rewarding researchers with free storage space for sharing big datasets	Conform to the OS Monitor specs and provide data and indicators accordingly - Provide citation and usage data in the Open Metrics Infrastructure

	software and methods, assisting citizen science) to intrinsically motivate researchers, boost their active participation in open science, increase public recognition and foster self-guided OS training. Assist in the development of OS policy models to be used in EOSC and promote the use of machine-readable policy documents A federated EOSC should be supported by an Open Science registry	Adopt the OS policy model (preferably machine readable) and record OS policies at national level Establish and support national OS nodes to network with EU and global initiatives			

5. NEXT STEPS

The next phase of work in T3.1 will consider recent policy proposals of relevance as well as reaching out to related initiatives as part of the exercise to validate the draft policy recommendations proposed here.

This consultation exercise will aim to provide more insight into a number of aspects that we consider that need to be more thoroughly addressed, including:

- gaining a greater understanding of possible models behind access modes of EOSC OS services
- opening access to training and consultancy and other categories of services which may be offered through the EOSC, as the conditions and concerns relating to these activities may be different from those discussed here
- the functionalities comprising a service and an interface, to understand the properties that make them Open Services or Open Interfaces
- determining whether the EOSC would benefit from the development of an EOSC tailored Altmetric Framework[121]. Collection of use cases and perceptions may provide clarity and new, combined metrics, helping to inform such a standardised attempt
- further examining the use of altmetrics in cases such as those suggested by the Next Generation Metrics report ("e.g. budget allocation or self-assessment and career development."). Currently, the EOSCpilot OS Monitor includes indicators relevant to career progression and promotion without however further exploring their potential use when there are budget allocation issues for example
- assessing practical considerations in the harmonisation of different types of IPR policies, particularly copyright and patents, when aiming at providing open access material
- investigating requirements for a minimum set of metadata for documenting assets in terms of IPR
- Creating tools for compliance with IPR regimes and policies
- Developing IPR clearance, licensing choice and interoperability tools.

[121] See: Access to global health research. Prevalence and cost of gold and hybrid open access: http://crc.ebsi.umontreal.ca/files/sites/60/2016/09/Haustein-et-al._STI2016.pdf

6. CONCLUSIONS

This White Paper has examined the landscape relating to Open Science and Open Scholarship and proposes a consolidated set of draft policy recommendations aimed at reducing or removing barriers to the EOSC in the area of openness, and encouraging EOSC implementation and uptake. It forms part of the work of EOSCpilot Deliverable D3.3 which in addition examines Data Protection, Procurement and Ethics.

The White Paper identifies that open science practices and their support by funders, institutions, infrastructures and services are still in the process of being developed and adopted. Significant further policy measures and altered processes still need to be developed or standardised if research outputs produced through the European Open Science Cloud are to be open, FAIR and citable. Numerous valuable policy initiatives and proposals have been produced or are underway, addressing many of the aspects required to permit or facilitate the practice of open science, but these still require to be consistently adopted and implemented throughout the European research community, by funders, RPOs and RIs, and by the EOSC governance and Rules of Participation.

This White Paper is submitted shortly after the publication of the EC's proposal for revision of the PSI Directive as well as its updated Recommendations on access to and preservation of scientific information. These are ground-breaking news for OS policy making in Europe, relevant to this policy shortlisting activity since they concern the same policy areas as D3.3 (publications, research data, infrastructures, skills and competencies, rewards and incentives). The proposals and recommendations in these two documents may be expected to increase Member States' efforts and provisions for open access to scientific information. In addition, several EC expert groups - the OSPP, the second High Level Expert Group on the EOSC, and the FAIR Data Expert Group - have recently published recommendations or draft reports, and numerous other initiatives are working in the area of Open Science and Open Scholarship, whether specifically in the context of the EOSC or more generally.

T3.1 achievements are inter-dependent with those of Task 3.2 Policy Supporting Services, especially for the needs of the OS Policy Registry which will be a prototype enabling machine-readable policies. Validation, alignment and support between the two tasks thus forms part of the work of WP3. Progress of the D3.3 work detailed in this White Paper relating to Open Science and Open Scholarship, however, already fulfils the promise to enrich the OS Monitor with information on Openness and FAIRness for a broader range of research outputs, widening its data-centric approach. Finalisation of the D3.3 activity will possibly result in new metrics in areas like that of the Open Science Infrastructures. Desire to apply FAIRness to other resources beyond research data was initially expressed by the FAIR principles, anyway. Moreover, discussions by the FAIR Data Expert Group during the LIBER webinar "Turning FAIR Data Into Reality" in April 2018 [122], acknowledged that one of the top three priorities in moving forward with FAIR is extending the principles to technical ecosystem/ infrastructure[123].

Subtask 3.1.1 (Open Science and Open Scholarship) will seek for interdependencies both from inside the EOSCpilot project (internally with WPs) and from partnerships (externally with projects contributing to the EOSC implementation, such as FREYA, EOSC-Hub and OpenAIRE) as well as other relevant organisations and projects advocating and supporting Open Science so as to further provide validity to the Final Policy Recommendations deliverable (D3.6) while at the same time contributing to preventing silos in OS policymaking within the EOSC.

[122] https://www.slideshare.net/libereurope/liber-webinar-turning-fair-data-into-reality

[123] Remaining two are: training (given the highest priority both for data scientists and data stewards) and social dimensions (adoption and implementation of FAIR policies by research communities).

ANNEX A. REVIEW OF SCHOLARLY COMMUNICATIONS POLICY AND PRACTICE DURING THE EOSCPILOT

There were around 40 participants at the Policy workshop in Brussels in November 2017[124]. The majority represented research communities and institutions or research infrastructures, with around a quarter designating themselves as policy makers and an eighth as research funders (respondents could choose more than one category). Most were both service providers and consumers, with the majority providing generic services to all communities, although there was also a strong representation in the room from the humanities. The majority claimed to have an open access policy (74%) and data management plans (66%). Only 37% responded that they had a data preservation plan. 59% responded that they applied the FAIR data principles in their datasets.

These results show clearly that there is room for data preservation planning to be more widespread, and that application of the FAIR data principles needs to be encouraged and supported if it is to become the norm. The workshop did not record in detail what measures could be taken to achieve this, and nor did it discuss the standards and consistency of open access policies.

It is generally agreed that data stewardship is a broad term and that there is a need for restricting its scope. Data stewardship according to EOSCpilot Deliverable D7.1 Skills Landscape Analysis and Competence Model[125], consists of four skills areas: domain research, data science and analytics, data management and curation, data science & engineering. Each element is further classified into sub elements as explained in D7.2 (Interim Report and Catalogue of EOSC Skills Training and Educational Materials). The skills framework required for the data stewardship for EOSC is proposed along with a mapping of the training materials catalogue. The gaps within current trainings are accounted for in the skills framework by connecting individual competences to organisational capabilities[126]. The suggested individual competences are to comprehend, apply, synthesize and analyse the data. The suggested team/organisation capabilities are ensuring cooperation between team members about re/use of data, and providing funding for individuals for FAIR and open science practices.

Discussion at the Pisa Policy workshop in March 2018[127] showed that development of FAIR principles for services, developing an Open Science skills framework, developing appropriate rewards, and flexible licences were seen as the most important ways in which EOSC could contribute to stimulating Open Science. These are all dealt with in other sections of D3.3 or else – in the case of the skills framework – by WP7 of EOSCpilot. Open research data guidelines and mandates for funders and ministries were also seen as potentially beneficial, working together with appropriate rewards and incentives for researchers.

EOSCpilot Deliverable D6.3 proposes an EOSC Datasets Minimum Information (EDMI) set of metadata to support finding and accessing datasets across scientific disciplines by exposing FAIR data to EOSC services and users, and the interoperability of metadata catalogues. A citation describing the dataset is included in the proposed EDMI set, but as an optional field rather than a mandatory one. Consultation with WP6 will be undertaken in the next phase of work to discuss whether this assignment ought to be altered to support citability of all research objects.

The EOSCpilot WP4 Science Demonstrators produced reports in February 2018 based on their work to date (a mixture of final and ongoing Science Demonstrators)[128]. They were asked to provide their opinions about what the highest-priority policy areas or issues were for their Science Demonstrator. Comments include:

- …the need for more easily available and standardised data policies; development of standardised policies around data sharing – improving reproducibility and reusability of data (EGA, Month 8 report)

[124] Slido survey results are in the WP3 Repository

[125] https://eoscpilot.eu/sites/default/files/eoscpilot-d7.1.pdf , p.41

[126] Draft EOSCpilot D7.3 Skills Framework, not public yet

[127] Notes and Mentimeter survey results are in WP3 repository

[128] Reports are in the EOSCpilot WP4 Repository

- …policies…to enable maximisation of interoperability of services and seamless flow of data … work to go beyond community specific standard could be performed at different levels favoring in first place communication among RIs and mapping requirements considering the different levels of advancement, the history and the target community of each RI (ERFI, Month 8 report)
- …our interest is in: facilitating open and accessible data; ensuring IP through appropriate acknowledgments; guidelines and support for ensuring protection of personal data in accordance with law while maintaining openness and traceability of scientific provenance (LOFAR Month 8 report)
- Genomic data handling in the cloud remains an area of fragmentation in Europe. Specific policy to provide uniform data handling guidelines across Europe would be instrumental to move forward (Pan-Cancer pre-final report)
- …It is also necessary to preserve (as done in TEXTCROWD) the valuable assets developed by research communities in the process of porting them in the EOSC framework without upsetting their functionality. This may require more flexibility than the one envisaged so far: it is the EOSC that must adapt to the research needs, not vice versa (TEXTCROWD final report).

In an interview conducted with Dr Thomas Zastrow[129] in December 2017, he commented *"There are so many different kinds of rules, restrictions and regulations, all the different actors have their own. Different data centers, universities, in different countries."* This seems to sum up quite well the policy situation faced by researchers practicing collaborative science and endeavouring to share their data.

A theme which emerges from these comments is the need for a properly developed, well publicised, uniform and widely adopted set of standard data handling policies around data sharing, whilst recognising that individual research disciplines and communities may have specific needs.

Comments made by Sami Niinimäki of the Finnish Ministry of Education and Culture[130] provide a useful summation: "I really think we should keep things as simple as possible and be thoughtful about creating barriers for access to research data. We should not have restrictions for only "academic or educational use" if not absolutely necessary. We should cherish academic freedom, which doesn't mean researchers are free to compromise on openness. In Finland the constitutional law requires that researchers need to make sure that knowledge is easily available for the community. The role of HEI's [higher education institutions] is to provide means to reach this knowledge. There has been a shift from the personal rights of the researcher to the rights of the community. I do not think incentives for researchers are that crucial, we just need to create the right supporting services and infrastructures to make things as straightforward as possible."

[129] Dr. Thomas Zastrow, Max Planck Computing and Data Facility, TEXTCROWD Science Demonstrator. Interview report is in WP3 Repository

[130] Interview with Sami Niinimäki, Senior Advisor at the Department of Higher Education and Science, Finnish Ministry of Education and Culture, November 2017

ANNEX B. RELATIONSHIP BETWEEN NEXT GENERATION METRICS AND THE EOSCPILOT OS MONITOR

Karen Vandevelde, one of the HLEG Next Generation Metrics report's authors talked about drivers and barriers on rewards and incentives during a workshop organised by the EOSCpilot project on 19-2-2018, in Barcelona. The talk stressed that rewards are part of change management where awareness raising comes first to let everyone know about the subject and the area of the given concept (the "what"), training & development follows to provide guidance on implementation practices and the skills needed to adhere to them (the "how"), to finally result to a promotion and rewards system stimulating research behaviours towards the introduced concept (the actual practice - the "do"). Among recommendations made by the presenter was the importance of establishing combined metrics (e.g. how much are the downloaded materials used), an element highlighted also by the EC in the Next Generation Metrics report.

Although the EOSCpilot OS Monitor (D3.2) has taken into consideration Next Generation Metrics recommendations, a comparison between them and what has been achieved so far in D3.2 OS Monitor specifications, makes evident that some areas could be strengthened. The comparison showed that:

"formats of relevance: altmetrics can identify new formats of scholarly products to measure, which have not been considered in research assessments before, e.g., research data and software".

The Monitor concerns publications, research data, code/software and educational resources.

"forms of impact: these refer to the new audiences captured, who interact with or react to scholarly products and scenarios related with that, e.g., policy makers and policy documents".

The Monitor recognises policy makers as a new audience interacting/reacting to policy related issues. More specifically, it captures OS policies' preparedness, adoption, compliance.

"targets and uses: these reflect the purposes for which altmetrics can be used, e.g., budget allocation or self-assessment and career development."

The Monitor includes indicators relevant to career progression and promotion without however further exploring their potential use when there are budget allocation issues for example.