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NI4OS-Europe

National Initiatives for Open Science in Europe

Deliverable D4.1
Incentives for supporting ORDM and FAIR

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Abstract: This deliverable describes the incentives and rewards that can be employed to improve the uptake of ORDM and FAIR in general as well as their integration in EOSC through country-tailored systems of rewards and incentives. Some of them are or will be employed within the NI4OS-Europe activities in the fifteen partner countries. The landscaping survey conducted as part of T2.1 activities and narrative reports from four partner countries show different stages of national and institutional OS implementation. Based on the current state in partner countries, and numerous reports, guidelines and documents, a set of incentives and reward mechanisms are proposed that can be used by different stakeholders at different levels of OS implementation.

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RENAM	Beneficiary	Moldova (Republic of)
IIAP NAS RA	Beneficiary	Armenia
GRENA	Beneficiary	Georgia

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List of Acronyms

D2.1	NI4OS-Europe Deliverable 2.1: Stakeholder map, inventory, policy matrix
D2.2	NI4OS-Europe Deliverable 2.2: National OSC initiatives models
D3.1	NI4OS-Europe Deliverable 3.1: Best practices for on-boarding and related policies
D5.2	NI4OS-Europe Deliverable 5.2: First report on provider and repository integration
DABAR	Croatian repository infrastructure
DIP	Dissemination information package
DMP	Data management plan
DORA	San Francisco Declaration on Research Assessment
EUA	European University Association
EOSC	European Open Science Cloud
EC	European Commission
EU	European Union
FAIR	Findable, Accessible, Interoperable, Reusable
H2020	Horizon 2020
HEI	Higher Education Institution
IF	Journal Impact Factor
SPARC	Scholarly Publishing and Academic Resources Coalition
OA	Open Access
OAIS	Open Archival Information System
ORDM	Open Research Data Management
OS	Open Science
OS-CAM	Open Science Career Assessment Matrix
RPO	Research-performing Organization
RDM	Research Data Management
SIP	Submission information package
T2.1	NI4OS-Europe Task 2.1: Stakeholder analysis & mapping activities
VSC	Flemish Supercomputer Centre

Executive summary

What is the focus of this deliverable?

This report focuses on rewarding and incentive mechanisms for ORDM and FAIR. Some of them are or will be adopted by NI4OS-Europe partner countries. The goal is to define the common ground and recommend rewarding mechanisms that can be used by different stakeholders.

What is next in the process to deliver the NI4OS-Europe results?

The deliverable and workflow progress are described in the project Annex-I – Description of the Action.

What are the deliverable contents?

This document consists of four parts. The first is an introduction to the OS concepts based on literature survey. The second presents the results of the NI4OS-Europe landscaping survey on current rewards and incentives for ORDM and FAIR conducted as part of T2.1 activities in fifteen partner countries. The third part gives a short review of current best practices for ORDM and changes in research evaluation processes. The fourth part summarizes recommendations to policymakers, funders, institutions, and researchers for different kinds of incentives and rewards leading to the full adoption of ORDM and FAIR.

Conclusions and recommendations

This deliverable brings the list of benefits and recommendations for ORDM and FAIR uptake for different stakeholders. The landscaping survey of fifteen NI4OS-Europe partner countries and the narrative reports from four countries show different stages of OS implementation. Some partner countries have adopted OS policies on the national level, but most are trying to implement the OS agenda bottom-up and/or by adopting institutional policies.

Different actions can be taken at different levels to enforce ORDM and FAIR practices, like endorsing policies and introducing changes in the assessment and evaluation processes and criteria. An important precondition for all actions related to ORDM is infrastructure, whose creation and maintenance require sustainable financial and organizational support. Raising awareness about ORD benefits for researchers, institutions, funders, and the society and improving all stakeholders' skills and capacity building should be supported by systematic education and training. Global implementation of ORDM is raising many ethical issues. To protect research integrity, data privacy and confidentiality, ethical concerns should be included in all initiatives and policies. In addition, appropriate attribution has a great potential in the promotion of data sharing and data re-use. Future tools for measuring data usage and impact in the form of certificates or badges could encourage researchers to embrace ORD and increase the quality and added value of repositories. Publishers too can contribute to ORD through advanced publishing practices.

1. Introduction

Specialization and fragmentation of sciences, recent pressure to publish, and lack of the available research data have led to the crisis of reproducibility [1] and commercialization of scientific publishing. As opposed to the practices in the so-called Republic of Letters where scientific discovery was contained in a single report along with data and described methods [2], today, a scientific report in the form of journal article usually lacks access to raw data and a clear description of the whole process, from data acquisition and processing to analysis. This is partly owed to ever more complex scientific research, but the pressure to publish (and all the issues that come with it) is the main reason for the current shortcomings and both the driver and obstacle to Open Research Data Management (ORDM).

As a consequence, the reproducibility crisis [3] results in science that fails to comply with the basic postulates of validation and communication of scientific discoveries and advancements. Along with the reproducibility crisis, a few other problems also emerge, like the inaccessibility of research outputs hidden behind the wall of high subscription prices. All these issues are followed by evaluation crisis, as the appraisal of the outputs is still primarily based on quantitative metrics like the journal impact factor (IF), which cannot adequately assess individual research output and certainly does not support ORDM, reuse, and reproducibility. Early studies on the inefficiency of scholarly communication called for six changes: (a) full embrace of digital communication; (b) open access (OA) to all published research; (c) disentangling publication from evaluation; (d) breaking the "one article, one journal" model with a grading system for evaluation and diversified dissemination outlets; (e) publishing (peer) reviews; and (f) allowing open, continuous peer review [4].

The Open Science (OS) movement is a direct answer to those challenges and an appeal to do science right. OS means opening all phases of research to the public. The research process is to be more transparent and research outputs findable and accessible in standardized formats through interoperable infrastructures. This would render research reusable and reproducible. When it comes to data and ORDM, these requirements are postulated as FAIR data principles [5][6].

Numerous documents, reports, declarations, and recommendations have been issued to support successful transition to OS and ORDM. One of the first widely accepted documents emphasising qualitative assessment and the importance of open data for evaluation is the Leiden Manifesto [7]. Another important document, the 2012 San Francisco Declaration on Research Assessment (DORA), is primarily advocating for changes in the assessment of research output:

The outputs from scientific research are many and varied, including research articles reporting new knowledge, data, reagents, and software; intellectual property; and highly trained young scientists.
[8][9]

General recommendations of DORA also call for changes in the current assessment system:

For the purposes of research assessment, consider the value and impact of all research outputs (including datasets and software) in

addition to research publications, and consider a broad range of impact measures including qualitative indicators of research impact, such as influence on policy and practice.

Make available a range of article-level metrics to encourage a shift toward assessment based on the scientific content of an article rather than publication metrics of the journal in which it was published.

The new EU Directive on open data and the re-use of public sector information (Open Data Directive) came into force in July 2019 and is to be implemented by the EU member states in two years. This Directive focuses on how to make publicly funded research available to public:

Member States shall support the availability of research data by adopting national policies and relevant actions aiming at making publicly funded research data openly available ('open access policies'), following the principle of 'open by default' and compatible with the FAIR principles. In that context, concerns relating to intellectual property rights, personal data protection and confidentiality, security and legitimate commercial interests, shall be taken into account in accordance with the principle of 'as open as possible, as closed as necessary'. Those OA policies shall be addressed to research performing organisations and research funding organisations.[10]

The European Commission has already adopted the mandate for OA to publications and research data from Horizon 2020, the EU's biggest research and innovation programme so far. All the publications resulting from the H2020 and Euratom projects should be available in OA either on publisher's web pages or OA repositories, which is left for authors to decide. If they choose to publish their publications in OA journals, costs of publishing can be planned in the project's budget, but they should still self-archive the published version of their publication in an OA repository. The H2020 program has also implemented the Open Research Data Pilot, which requires developing (and updating) Data Management Plans (DMP) and providing OA to research data if possible. Data management costs are eligible for reimbursement for the duration of the project and can be claimed under conditions defined in the grant agreement. [11][12]

In 2018, the Commission also supported Plan S and committed itself to speed up the transition of scientific publications to full OA [13]. With the new EC R&I Framework Programme Horizon Europe, the principle of OS will become the modus operandi, requiring OA for both publications and research data. This will assist market uptake and increase the innovation potential of results generated by EU funding [14]. There are various incentives in the Horizon Europe framework. Its three main pillars – open science, global challenges and industrial competitiveness, and open innovation – call for producing high-quality open knowledge, strengthening the impact of research, and fostering all forms of open innovations. According to the Scholarly Publishing and Academic Resources Coalition (SPARC) Europe, the adoption of the principle of "fostering open science and ensuring visibility to the public and open access to scientific publications and research data, including appropriate exceptions" [15] is crucial for making OS the modus operandi of Horizon Europe. Likewise, Annex I of the Programme states that: "Horizon Europe will provide dedicated support for open access to scientific publications, to knowledge

repositories and other data sources." [16] Horizon Europe is also encouraging transdisciplinary and inter-sectoral approaches that include economy, civil society organisations, and citizens.

The mandate for OA to publications and data will be reinforced through the new Open Research Europe publishing platform that will manage the entire publication process (from submission to publication, post-publication content curation, and long-term preservation) and implement an open peer-review system. Together with services, research data is the main building block of the European Research Infrastructures and EOSC.

1.1. Benefits of data sharing for different stakeholders

Open Science has the potential to increase the quality, impact and benefits of science and to accelerate advancement of knowledge by making it more reliable, more efficient and accurate, better understandable by society and responsive to societal challenges, and has the potential to enable growth and innovation through reuse of scientific results by all stakeholders at all levels of society, and ultimately contribute to growth and competitiveness of Europe. [17]

The benefits of data sharing are immense. Whether they follow their institutional or national mandate or their own, self-imposed mission to contribute to the "scholarly community and society as a whole" [18] more and more researchers adopt open science practices.

Here we summarise possible benefits for researchers, institutions, funders, and society, drawing on different sources [19]–[24].

1.1.1. Researcher benefits

Possible benefits for researchers from sharing research data are:

- Increased transparency and trust in their work
- Research findings more easily available to other researchers
- Reproducibility and reuse: findings can be verified and reproduced and data reused in new ways
- Increased readability, citation, and impact
- Scientific discovery is stepped up by allowing others to reuse and build on top of their data
- New, better research questions are raised
- Reinforced research integrity
- Improved collaboration
- Facilitated discovery of relevant research
- Reduced existing inequalities in science (gender, sex, race…)
- Removed bias against early-career scientists (open peer review, exclusion of quantitative metrics)
- Long-term archiving and preservation
- New insights and services

- Maintaining competitive advantage over peers
- New ways of gaining recognition and reputation
- Improved experimental design and methods
- Prevented manipulation of "researcher degrees of freedom or p hacking"
- Enriched research and analytical capacity
- New project and employment opportunities

1.1.2. Institutional benefits

The benefits for institutions supporting and enabling research data sharing and RDM are:

- Increased visibility
- Increased impact
- Transparent liability to taxpayers
- Justified existing funding
- Better chances to bid for and win new research funding
- Encourages and attracts collaboration (academic and commercial, particularly cross-disciplinary)
- Visibility of its academic research
- Ability to attract high-quality researchers
- High-quality research showcased to a global audience
- Maintained quality of grant bids
- Improved researchers' knowledge and engagement
- Credible open research
- Greater impact of research
- Greater influence on society
- Increased number of citations
- Improved research integrity (transparency enables validation of research results)
- Reduced risk of inappropriate or sensitive data release through enhanced quality assurance process
- Maximised potential of open data assets through re-use
- Increased productivity in an era of tight budgets

1.1.3. Funder benefits

Funders have multiple benefits if research data from the projects they fund are well managed and shared in OA:

- Getting more value from their investment
- Avoiding duplication in collecting, creating, transferring and re-using scientific material
- Improved quality of research (by building on previous results and avoiding duplication of effort)
- Increased speed of innovation (faster progress to the market of ideas)
- More accurate verification of scientific results
- Stepped up scientific enquiry and discovery for the benefit of society
- Increased innovation potential

- Informed policy decisions

1.1.4. Benefits for the society

Sharing of research data produces multiple benefits for the whole society, such as:

- Improved interaction (dialogue) between science and society
- Removed societal and national barriers
- Opportunity for anyone to partake in high-quality research
- Improved citizens' trust in science
- Better public health and environmental protection
- Improved citizen engagement leads to active participation in scientific experiments and data collection
- Increased society's support for research funding.

1.2. Barriers to research data sharing and reuse

The European University Association (EUA) carried out a 20-question survey "Open Science and Access Survey on Research Assessment" that was completed by 260 universities in 32 European countries. It provides a comprehensive overview of how European universities assess research [25]. Here are some of the important findings:

- In 2018, 62% of European universities had an OA policy on research publications in place compared to only 13% with an OA policy on research data;
- At over 75% of universities, research publications and attracting external research funding are the two academic activities most valued when assessing researchers;
- Social outreach, knowledge transfer, OS, and OA are the lowest-ranked categories among important academic activities for research careers;
- Universities use three main ways to assess research outcomes: a) number of publications and citations, b) peer-review, and c) research impact and knowledge transfer indicators (e.g. intellectual properties such as patents and licenses);
- Quantitative publication metrics, notably the IF and h-index, and qualitative peer-review are the most important practices for evaluating researchers and their output; and
- More dialogue between stakeholders is essential to take research assessment forward

Current career advancement criteria encourage (a) generating new ideas rather than pursuing additional evidence for or against earlier ideas; (b) reporting positive results and ignoring negative ones; and (c) pursuing design, reporting, and analytical strategies that increase the likelihood of obtaining a positive result just to get published [26]. Without revising these criteria and mandating open research data, publishing datasets will remain low on researcher's priority scale, as it is focused on securing future publishing and funding [27][28]. Preparing a dataset takes significant time, effort, and financial resources. Furthermore, the researcher may be discouraged by the risk that someone else may find

errors in data acquisition or analytical methods or benefit more from their published datasets by publishing more research papers or registering a patent.

According to Berends et al. [29], barriers to data publishing and re-use can be clustered into six groups: political, organisational, legal, technical, financial, and awareness. Political barriers include lack of political will, low priority of research data to policymakers, and discouraging political setup. Organisational barriers include lack of integration of research data into institutional internal processes, mainly because people are unskilled to handle open data. Legal barriers could be overcome by clear national open science policy and institutional mandates and proper licencing to resolve privacy issues. Low quality of data and accompanying metadata is the main technical barrier. Furthermore, barriers to technical support, such as storing and providing access to research data and support for re-use are closely tied to financial considerations. In fact, most countries identify the financial barrier as the most important. As for awareness barriers, significant benefits of open data are often not recognised, and raising awareness should resolve this issue.

In addition, re-using data is difficult because the formats are not standardised and interfaces of open data portals are not user-friendly [30]. Re-use is also made difficult because data are diverse and come with various formats, languages, and licenses. For institutions, the main barriers are lack of processing skill and capacity, resistance to research assessment reform, concerns over costs involved, limited awareness, absence of incentivising policies and guidelines, lack of coordination, and lack of institutional autonomy from funders [25].

Major changes in the current reward systems in scholarly communication that would fully acknowledge OS practices could provide sufficient visibility of individual research output, including research data. Improved systems of incentives and rewards for researchers, institutions, projects, and funders should "put scientific quality over quantity, ensure reproducibility of results, notably through methodological rigour, generate FAIR data; curate and preserve data; share data and results; reuse data, work with stakeholders across disciplines and sectors, and interact with societal stakeholders for defining research questions and co-creating results" [26].

2. Current state of reward and incentive mechanisms for ORDM and FAIR

This chapter brings an overview of the current state of the OS and the mechanisms for rewarding and incentivising ORDM and FAIR in fifteen NI4OS-Europe partner countries (Albania, Armenia, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Georgia, Greece, Hungary, Moldova, Montenegro, North Macedonia, Romania, Serbia, and Slovenia). It is based on the analysis of responses gathered from a landscaping study conducted as part of NI4OS-Europe Task 2.1: Stakeholder analysis & mapping activities (T2.1). In addition, Annex 2 provides more detailed information about the current state of OS implementation in Croatia, Greece, Serbia, and Slovenia written by project partners from those countries. This information has also been analysed and used as valuable input for the recommendations of incentives and rewards for ORDM and FAIR.

2.1. NI4OS-Europe partner countries

2.1.1.   Analysis of the landscaping survey data

Before we can talk about incentives and rewards for ORDM and FAIR, let's take a look at current implementation of OS initiatives in 15 NI4OS-Europe partner countries, which includes stakeholder analysis and mapping of all information about OSC initiatives, infrastructures, services, policies, actors and topics. Stakeholders were divided in five groups, and the 15 NI4OS-Europe partners identified key stakeholders in each group for their country, as follows:

- Funders and policymakers - FUND (n=81)
- The ones who perform research - CREATE (n=604)
- The ones who support research - SUPPORT (n=304)
- The ones who "consume" research - CONSUME (n=115)
- OS facilitators (including OS initiatives) - FACILITATE (n=66)

These stakeholders (n=1170) were invited to complete an online questionnaire. 41 FUND stakeholder (51% of all mapped FUND stakeholders), 403 CREATE (67%), 94 SUPPORT (31%), 25 CONSUME (22%), and 12 OS FACILITATORS (18%) responded [31].

The results of NI4OS-Europe T2.1 are presented in Deliverable D2.1: Stakeholder map, inventory, policy matrix (D2.1). However, as stated in the report, it "...does not include a detailed analysis of the collected responses, but offers only general information about the structure of the collected responses and the initial mapping of infrastructures and services and a policy matrix based on the responses." [31]. Our overview of the current state about certain OS aspects in NI4OS-Europe partner countries combines relevant results published in the D2.1 and some preliminary results of our analysis of raw data gathered through the landscaping study. Some specific details on individual countries will be covered in other policy-related documents (D3.1; D2.2; D5.2).

According to the landscape study and the D2.1 report, funders and/or policymakers in 7 out of 15 NI4OS-Europe partner countries have adopted OA policies to publications (Bulgaria, Cyprus, Greece, Hungary, Romania, Serbia, and Slovenia), in 5 countries they

have adopted OA policies to research data (Cyprus, Greece, Hungary, Romania and Serbia), and in 2 countries policies for mandatory software sharing (Hungary and Romania). These data also show that funders and/or policymakers have implemented some kind of policy compliance monitoring in 8 countries (Bulgaria, Cyprus, Greece, Hungary, Moldova, North Macedonia, Romania, and Slovenia) [31]).

In addition to the NI4OS-Europe landscaping results, we have analysed the results from SPARC Europe's August 2019 report on Open Science Policies in Europe According to the report, 14 out of 28 EU member states have national research data-related policies, 3 non-EU members have active policies, while 16 EU member states (plus one non-EU state) are still developing their national policies. If we look only at data for the 15 NI4OS-Europe partner countries, 3 have adopted their national data-related policies (Cyprus, Slovenia, and Serbia), while 5 are still developing them (Bulgaria, Croatia, Greece, Hungary, and Romania) [16].

The landscaping survey also shows that in almost every NI4OS-Europe partner country there are institutions which have adopted their OA policies and that some countries have significantly more institutional policies than others (Figure 1). However, one has to take into account differences in research structure between countries and the influence of local culture and wider context on policy adoption.

Figure 1: Institutional OA policies by NI4OS-Europe country (source of data: D2.1 [31]**)**
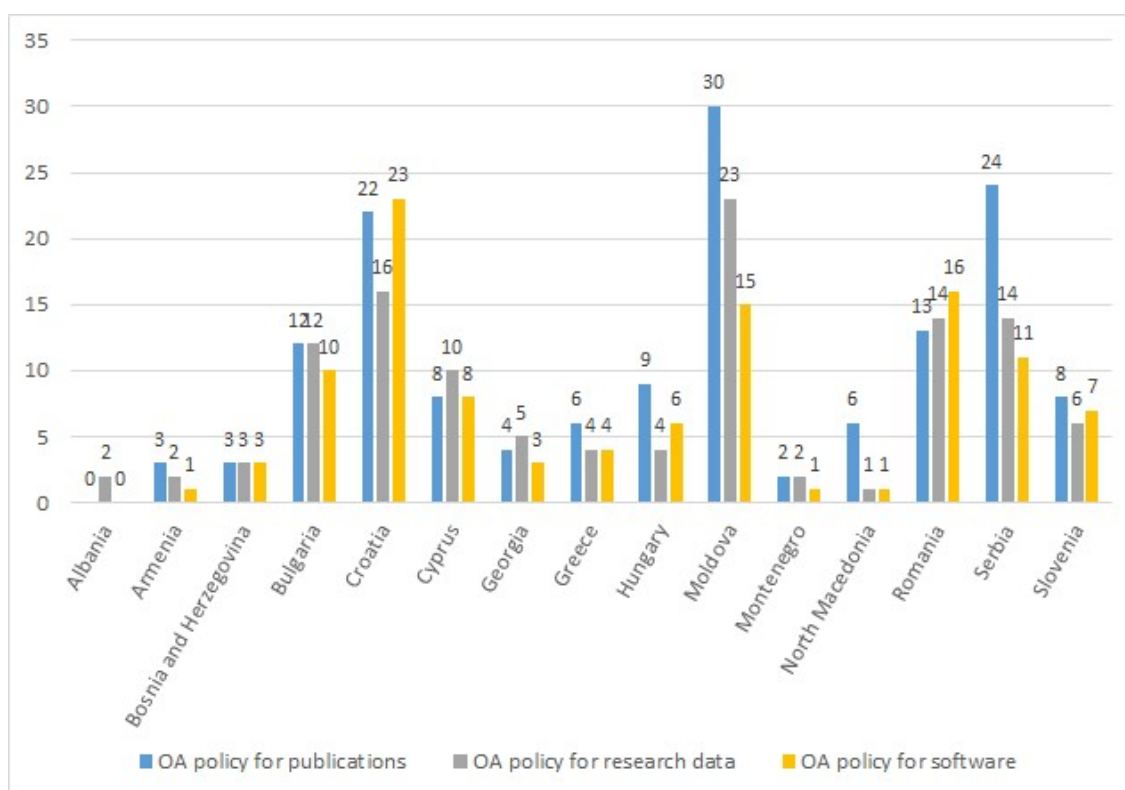

The data from the landscaping survey show a somewhat different picture than the information obtained from experts in the field which have written detailed narrative reports

about their countries (available in Annex 2). D2.1 also acknowledges some inconsistencies in the data from the landscaping study:

> *[...] a brief insight into the responses reveals major inconsistencies:*
> *e.g. in the answer to one question it is claimed that an institution has a*
> *policy on A to research data, while in the answer to another, the same*
> *respondent says that no rules are in place regarding OA to research*
> *data. There are many such examples. Accordingly, the reliability of the*
> *responses may be disputed.* [31]

The preliminary analysis of raw data from the landscaping survey singles out research publications as the most important parameter for researcher evaluation in NI4OS-Europe partner countries – 98% of all answers rated research publications very important or important. Besides research publications, highly rated were project participation, attracting external research funding, research collaboration with academia, and research impact, knowledge transfer and research networking (Figure 2). On the other hand, parameters of researcher evaluation related to OS activities have received the lowest scores: data (average score - 3.6), software (3.2), OS and OA (3.4), and social outreach, knowledge transfer, citizen science (3.5).

Figure 2: Importance of certain parameters for evaluation of researchers (298 answers of FUND, CREATE, CONSUME, and FACILITATE respondents)
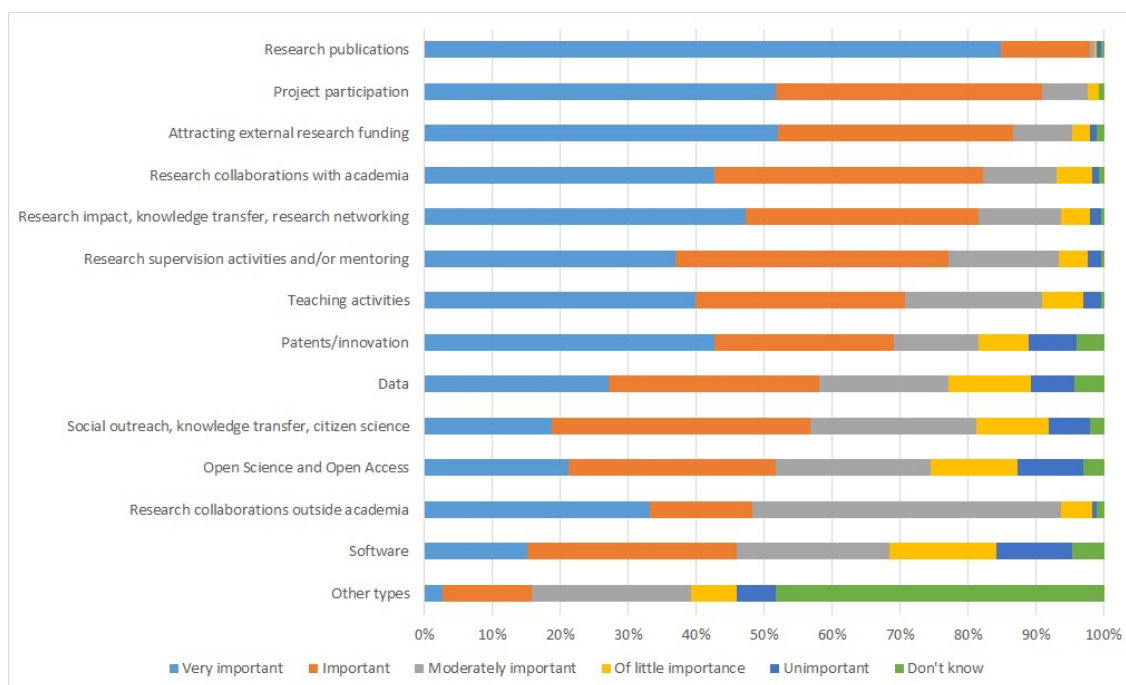
All respondents (n=534) were asked about support and training they provide (Figure 3) and about the need for training, support, or advice in particular areas to make data FAIR (Figure 4). Institutions in the NI4OS-Europe partner countries mostly provide training in intellectual property rights and copyright (47%) and repositories (40%), followed by training in open practices - methodologies, peer review, metrics, citations, etc. (38%) and open education resources (36%), while only 26% provided training in research data

management - publishing of open data, FAIR, RDM plans, data protection, data curation, long-term preservation (Figure 3). However, of the 353 respondents who currently don't provide training in RDM, more than half (184) plan to provide it in the future, which suggests that this particular area of training will be gaining momentum. It is quite alarming, though, that 22%-38% (depending on the subject) of respondents do not even plan to provide support/training.

Figure 3: Institutional support and training by areas in NI4OS-Europe partner countries (534 respondents from the CREATE, SUPPORT, CONSUME, and FACILITATE groups)
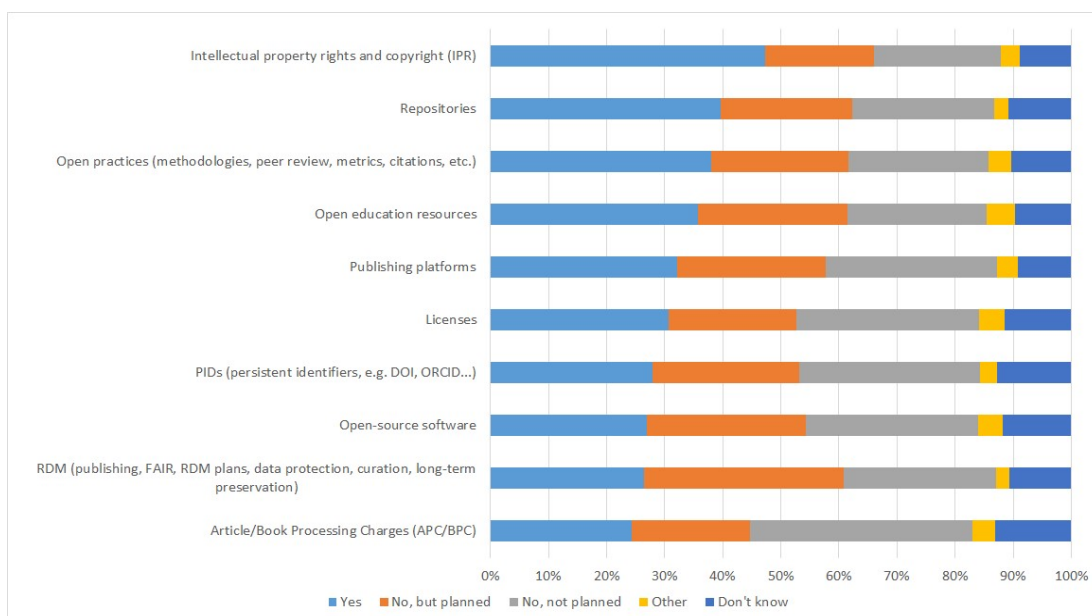
Figure 4 shows that nearly all respondents recognise the need for researchers and support staff to get training, support, or advice in almost every area to make data FAIR. We can only assume the reasons why they are not already providing (or even planning to provide) these trainings and support (such as the lack of expertise, staff, and/or resources) because this information was not gathered in the landscaping survey.

Figure 4: Areas of training, support, or advice which researchers and support staff need to make data FAIR (534 respondents from the CREATE, SUPPORT, CONSUME, and FACILITATE groups)
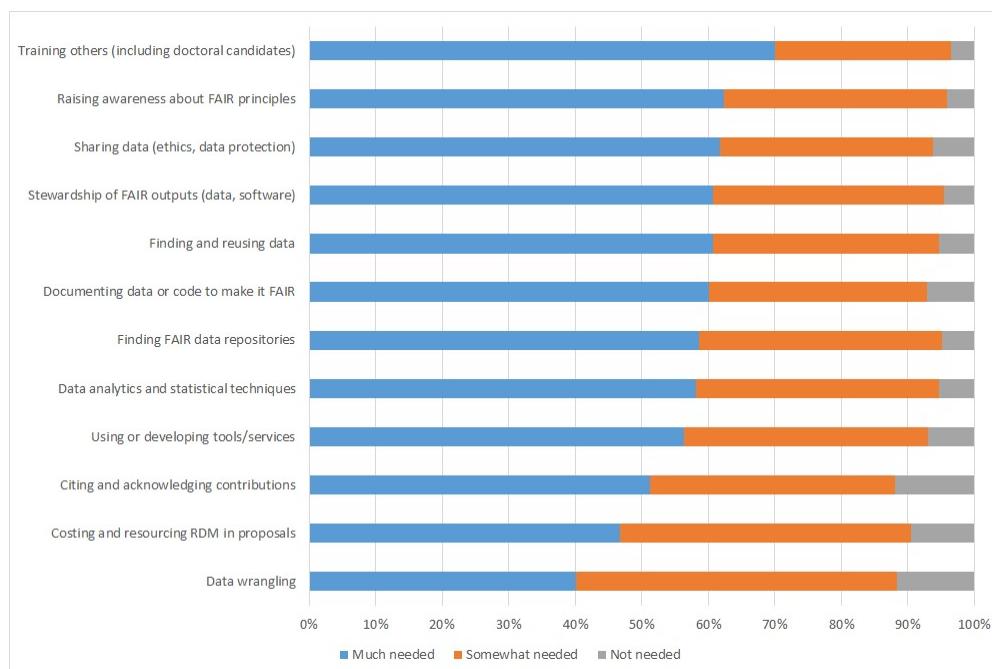
Perhaps the most relevant information from the landscaping survey is the one provided by 83 of the 93 SUPPORT respondents (10 did not answer this question) about the importance of 21 open data and OS-related concepts (Figure 5). Majority of them (>74%) rated all these concepts important (grades 4 and 5). Financial resources, additional costs, and funding as well as incentives for research organizations received the highest ratings by 68% of respondents, followed by practical experience and knowledge (67%); policies - national, funder, institutional (65%); guidelines and best practices (65%), and incentives for individual researchers (63%).

Figure 5: The importance of open data and open science-related concepts (83 SUPPORT respondents)
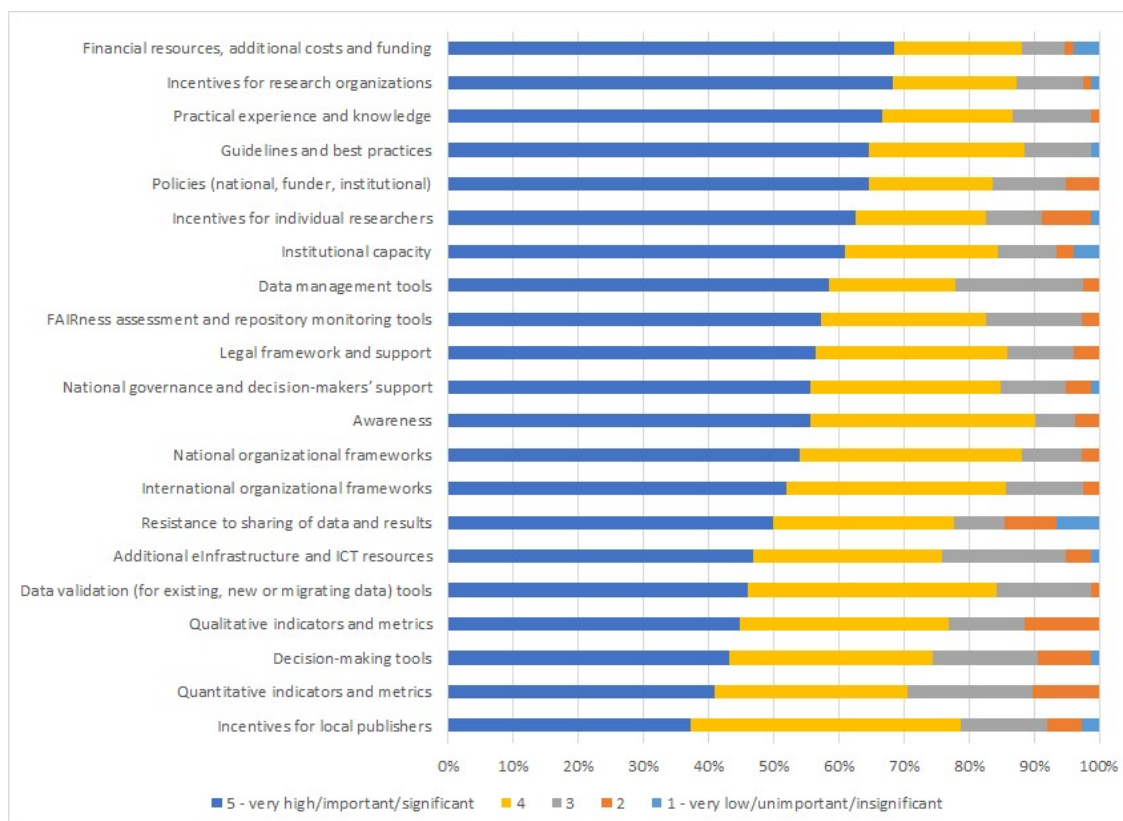
2.1.2.   Conclusions based on the data from the landscape survey and detailed country surveys

Our analysis of the current state of OS initiatives and ORDM and FAIR practices in 15 NI4OS-Europe partner countries is for the most part based on 575 completed responses to the landscaping survey (conducted as part of T2.1 of the NI4OS-Europe activities) from 482 distinct entities in the partner countries [31]. However, this online questionnaire could not capture and explain all the aspects and specifics in different countries. Therefore, our analysis also includes inputs from four partner countries that provided a more detailed narrative report on the current state of OS initiatives and ORDM and FAIR practices (Croatia, Greece, Serbia, and Slovenia). The choice of these countries reflects different levels of OS policy implementation, infrastructure, and practices.

The landscape survey provided some valuable information on the level of awareness about ORDM and FAIR in NI4OS-Europe partner countries, the importance of OD and OS-related concepts, as well as information about provided and/or needed support and training in different OS-related areas.

However, there are some inconsistencies in data gathered from respondents which may distort the real picture in some countries. For instance, landscaping survey data reported in D2.1 suggest that Croatia has in place a large number of OA institutional policies, but information from experts (see Appendix 2, Croatia) suggests that the reality is significantly

different, especially when it comes to OA research data and software policies[1]. Similar discrepancies are found for Greece. The landscaping survey suggests there are many OA policies to publications and research data in place, while the narrative report (see Appendix 2, Greece) suggests differently and elaborates more in detail the current state of OS policies in Greece.

The reasons for somewhat misleading findings in the landscaping survey could be many. The questions may have not been understood correctly by people responding to them and/or the people responding to them were unfamiliar with standard OS terminology (the concepts they describe) and subject matter. This could to a certain degree explain contradicting responses by different people from the same institutions. In fact, more than 55% of respondents admitted not to be familiar with the concept of FAIR (22% were not familiar at all, and 34% were not very familiar). However, this information is also a useful finding as they unveil the differences in the perception, which could also point to the need for further awareness and training to increase knowledge and understanding. In addition, the survey is also a valuable starting point in mapping and tracking policies in partner countries, but an additional effort should be made to clear the data, especially on the national level, and put them into a wider context [31].

With a high degree of reliability it also clearly shows that the vast majority of respondents find training, support, and advice important for research data to be FAIR. In addition, the responses about the importance of open data and OS-related concepts could be very helpful for the implementation of incentives and awards for ORDM and FAIR.

Detailed narrative reports on four countries (Croatia, Greece, Serbia, and Slovenia) presented in Appendix 2 give a better insight into OS-related activities and valuable input for recommending incentives and rewards for OS.

The examples of these four countries show that the implementation of OS should be tailored for each country. In an ideal situation, OS policies are developed and adopted in parallel with the OS infrastructure which is supposed to support them. But more often than not, the development of OS infrastructure is set in motion only when an OS policy has already been adopted or the other way around, an existing OS infrastructure determines the pace of the adoption of OS policies on different levels, usually bottom-up. If we look at the four case studies described in this report (Annex 2), Croatia is mostly following the second, bottom-up scenario. However, the development of the Croatian repository infrastructure called DABAR is an example of how the policies (national mandate for archiving theses and dissertations) can push forward the development of relevant OS infrastructure even without funders' financial support for this specific purpose. Greece too has a repository infrastructure in place without an OS policy. Slovenia has adopted several important OS documents and has a repository infrastructure in place, while Serbia is an example where national OS policy is adopted without necessary infrastructure in place. Bottom line, the policy should drive the development of infrastructure (especially repository infrastructure for research data).

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[1] Croatian higher education institutions had to solve the issues of archiving thesis and dissertation into digital repositories (required by law), so some institutions implemented procedures to ensure archiving but not necessarily through an official OA policy. However, OA to research publications and/or research data/software in most cases was not addressed at all.

However, assessment procedures in all fifteen countries still fail to recognize and reward OS-related practices. There are only a few isolated examples where OA or OS-related activities are awarded.

2.2. Best practice examples

Many HEIs and RPOs realize that the adoption of the OS agenda requires significant changes in their research assessment procedures. DORA's list of signatories includes 1.887 organizations and 15.618 individuals at the time of writing this deliverable, showing wide support for the promotion of real changes in research assessment. Still, many DORA signatory institutions still use "traditional" metrics as the main evaluation tool, namely journal prestige expressed through its impact factor, number of publication and number of citations. In our best practices list of institutions, we didn't want to be too extensive, so we decided to select few institutions that made real changes in their practices, moving from quantitative metrics towards more qualitative ones. Also, we looked for the institutions promoting openness in research assessment, especially ORD and FAIR. The list of best practice examples does not include all institutions that have implemented ORD incentives and rewards in their assessment and evaluation systems, but few that can serve as a good illustration of the changes that are taking place.

2.2.1.   Ghent University

Ghent University decided to combine the prevalent quantitative assessment, based on quantitative indicators such as IF and h-index, with qualitative assessment, based on peer-review [32]. Several documents were created to help describe, plan, and evaluate research. One of them is the *Portfolio of research dimensions* (2019) with two main sections: (1) research design and development and (2) research impact (scientific, societal and/or economic) in terms of OS:

> *Making science "open" to fellow scientists via open access to*
> *publications and open data and data management according to the*
> *principles of FAIR (findable, accessible, interoperable, reproducible)*
> *increases the scientific impact of researchers.* [33]

The University of Ghent recognises the priorities of OS: scholarly publishing, FAIR data, European Open Science Cloud (EOSC), education and skills, incentives and rewards, next-generation metrics or altmetrics, research integrity, and citizen science. Ghent University fully recognizes the importance of the existing RDM policies and support, following FAIR data principles. To support researchers in RDM practices they will appoint data stewards and provide appropriate training. In addition, in collaboration with Flemish Supercomputer Centre (VSC) they are preparing their data and services for inclusion in the EOSC.

Concerning incentives and rewards, to support the transition from "exclusively or primarily quantitative and metric-focused assessment to a better and sensible mix of quantitative and qualitative assessment of research, research impact, and research careers", much more attention will be given to underlying data, research practices, and the culture of open research.

2.2.2.   TU Delft strategic plan "Open Science Programme 2020-2024"

By adopting a new Open Science Programme 2020-2024: Research and Education in the Open Era, TU Delft wants to push OS practices to become the standard way of doing research [34]. This is also reflected in the TU Delft Strategic Framework 2018-2024, with "openness" as one of its major principles. There are five goals in the Programme to be achieved: open education, open access, open publishing platform, FAIR data, and FAIR software. Successful implementation will strongly depend on the "appropriate rewards and recognition for Open Science practices, building successful collaboration with industry, and skills development" [34].

The FAIR data project creates "a stronger bridge between the current policy, infrastructure and culture of data stewardship and scientific practice, for instance by exploring new roles like data manager, in order to fulfil the researchers' actual needs in managing their research data. A coherent approach to FAIR data helps make research more transparent and efficient, by creating FAIR disciplinary guidelines, data hubs for specific disciplines, a suite of courses, completed pilot data managers, and strategic plan for sustaining data managers." [34]

Moreover, research software is considered fundamental part of research, particularly in the context of reproducibility [34].

According to the Plan, the existing assessment system will be revised in order to incorporate OS in the criteria for hiring and promotion, ensure differentiation in career paths, and integrate alternative research assessment methods.

2.2.3.   Responsible metrics at the University of St Andrews

The University of St Andrews relies heavily on the DORA recommendations and encourages universities, researchers, and others to assess research on its own merits rather than on where it was published [35]. In its assessment policy, the university relies on five core principles: expertise, diversity, data, integrity, and transparency.

2.2.4.   The Neuro, McGill University

The Neuro (Montreal Neurological Institute-Hospital) is a showcase of the adoption of OS at institutional level through four aspects: OS principles and values, OS platform, OS ambassadors, and OS symposium. The main OS principle is:

Share scientific data and resources: The Neuro researchers will share all positive and negative numerical data, models used, data sources, reagents, algorithms, software and other scientific resources publicly available no later than the publication date of the first article that relies on this data or resource. [36]

2.2.5.   *University of Bristol*

After having mandated depositing published research in the university's OA repository, the University of Bristol moved on to the next level of OS:

Producing open research outputs as appropriate by adopting good practice in, for example, sharing data and code, sharing materials, sharing digital outputs, publishing preprints and pre-registering study protocols. [37]

To align researchers' careers with the benefits for science in general they revised their hiring and promotion criteria "...to include open research practices, for use from the 2020-21 promotion cycle**.** Along with more conventional indicators, such as publication record, the adoption of open research practices, as appropriate to an individual's research, will be recognised in promotion cases" [37].

3. Summary of rewards and incentives for ORDM and FAIR

This section brings possible actions to set up or improve the existing systems of rewards and incentives for researchers, which are based on recent analyses and reports (see Chapter 1), findings from the stakeholder landscaping survey (Chapter 2), the four country reports provided by project partners (Appendix 2), and previous relevant research. Besides specific actions to be taken on the national/funder/institutional level, this section discusses alignment with current research practices and measures to streamline a shift from current researchers' attitudes towards ORDM, FAIR, and OS in general. Each section starts with key activities and actors, followed by a short description.

Several reports are relevant for the incentives and rewards concerning ORDM and FAIR [18], [25], [38]–[45]. The list of selected reports is available in Annex 1.

3.1. Enforcement of ORDM and FAIR through policies

Key activities:

- mandating DPMs
- setting up policies for FAIR data archiving and publishing
- issuing FAIRness level certificates for repositories
- favouring OS practices through research assessment and career advancement criteria
- OA publishing, including datasets and software, as a default

Key actors:

- funders
- RPOs and HEIs
- publishers

ORDM and the FAIR principles cannot be promoted, regulated, and implemented without policies, especially the ones setting the rules for career advancement or funders' project evaluation. These policies are there to shape researchers' behaviour and to motivate them to make OS and pertaining activities part of their everyday work.

Current research evaluation systems are mostly based on quantitative metrics, e.g. number of publication and/or citations, which is the easiest way but not the best way to evaluate and compare researchers' work. In most countries and institutions assessment procedures do not consider rewarding ORDM and FAIR activities, and even when they do recommend research data archiving/publishing, they do not provide real benefits for researchers.

Implementing policies requires in-place technical infrastructure and skilled staff, but these are only preconditions. The most straightforward way of acknowledging ORDM practices is to provide credits, extra points, or badges for dataset publishing according to the FAIR principles. This cannot be achieved without mandating dataset publishing, clear guidelines for citing datasets, technical infrastructure facilitating data archiving and publishing based

on FAIR principles, support infrastructure (training and data stewardship), evaluation rules for ORDM performance, and evaluation framework for assessing the FAIRness of data. Publishing dataset as a standard procedure requires not only a mandate by research funders and/or publishing venues but also various kinds of encouragement at national and institutional level.

Successful policy development is a top-down process consisting of interdependent synchronous activities. Mandating policies requires financial support for infrastructure, human resources, and provision of a framework for rewarding or penalizing certain behaviours. The real challenge is how to create this self-contained system and make a paradigm shift in understanding what research lifecycle and scholarly communication should really look like.

3.2. Assessment and promotion criteria on all levels

Key activities:

- integration of ORDM and FAIR activities into research assessment and evaluation at different levels:
- promotion of researchers
- recruitment procedures
- project proposal assessment
- institution's evaluation
- funding allocation systems
- research awards

Key actors:

- policymakers
- RPOs and HEIs
- funders

The results of the NI4OS-Europe landscaping survey and the 2019 EUA Open Science and Access survey on research assessment [25] indicate that the number of publications is still the most widespread criterion for researcher evaluation, followed by attracting external research funding, participation in projects, and collaboration with academia. OS and OA activities seldom make part of institutional reward systems (Figure 2) [18]. The documents which recommend the use of multiple indicators for the evaluation of researchers, such as DORA, the Leiden Manifesto, and the European Commission (EC) report "Next-generation metrics" made an important impact, and some institutions have integrated them into their recruitment, career advancement, and other awarding procedures.

In 2017, the EC's Working Group on Rewards under Open Science issued a report in which they proposed the so called Open Science Career Assessment Matrix (OS-CAM) and described it as "...a possible, practical move towards a more comprehensive approach to evaluating researchers through the lens of Open Science" [18]. Besides publications, OS-CAM takes into account a broad set of researcher's activities recognizing the entire

research output and activities related to research process, service and leadership, research impact, teaching and supervision, and professional experience. The emphasis is on the OS aspects of those activities and research output is measured against the FAIR data principles, quality standards in ORDM and open datasets, and whether researchers have made use of open data from other researchers.

The shift in evaluation practices toward acknowledging OS activities (including ORDM and FAIR) should involve evaluation of individual researchers (for research promotion, recruitment, and research awards), evaluation of research groups and institutions, i.e.for the allocation of funds, and evaluation of project proposals and outputs.

The importance of incentives for individual researchers and for research organizations has also been recognised by respondents to the NI4OS-Europe landscaping survey (Figure 5) who would all probably agree that incentives may have the greatest 'motivational' potential.

3.3. Support for data infrastructure

Key activities:

- organisational and financial support
- for OS infrastructure development and maintenance
- for personnel costs
- for training activities

Key actors:

- funders
- RPOs and HEIs

There are several types of ORDM activities, like data management planning, acquisition and managing research data during the project, data curation, and data archiving and publishing and all of them need sustained and sufficient organisational and financial support.

Based on the reference model for an Open Archival Information System (OAIS), these activities could be linked to different outputs: submission information package (SIP), archival dissemination package (AIP), and dissemination information package (DIP). Each activity involves a set of technical requirements on one side and organizational challenges on the other. A large number of tools (i.e. DMP online) and repositories (such as those listed in re3data.org) are already available, but researchers and institutions usually want to manage the data through their own infrastructures for better control of secure data sharing among team members during ongoing research and specific long-term preservation strategies. To achieve this a secure data storage centres and FAIR-compliant repositories for the dissemination of DIPs need to be developed and maintained. An example of a funder standing behind its mandate is the Zenodo repository, which was developed under the OpenAIRE project and funded by the EC as a repository for research outputs supporting the EC's Open Access Pilot in FP7 in 2008 and the Open Research Data

Pilot in 2017. This practice of backing up policies and encouraging desired actions by making it easy to comply with demands could be widely adopted and is one of the basic incentives to build upon. Luckily, subject-based and institutional repositories are common these days, and it is usually pretty straightforward to upgrade them to support dataset depositing. Since a dataset is just another digital object, functionalities such as certification schemes or long-term preservation strategies do not have to be created from scratch but can be extended and shared. Services and expertise that come with ORDM activities go beyond implementing new metadata profiles, adding workflows, and extending storage resources.

3.4. Increasing skills, capacity, and awareness

Key activities:

- education and training of students at different levels
- education and training of researchers
- education and training of support staff
- providing discipline-specific guidelines and training
- providing stakeholder-specific guidelines and training

Key actors:

- RPOs and HEIs
- OS infrastructure providers

Adopting OS policies, developing related infrastructure, and integrating ORDM- and FAIR-related criteria into research assessment and evaluation can be achieved only by raising the awareness of all stakeholders. To adopt OS practices on a daily basis a researcher needs to acquire new knowledge and skills through continuous discipline-specific training and support and best practices in the field. In addition, HEIs should also include OS, ORDM, and FAIR-related topics into their curricula.

The importance of skills, capacity building, and OS and ORDM awareness has been recognized by 94% of the respondents to the NI4OS-Europe landscaping survey. 70% think that training, including doctoral candidates, on data FAIRness is much needed, and 24% think that it is somewhat needed. Similar were the answers about the importance of raising awareness about FAIR principles: 62% found it much needed, 34% somewhat needed, and only 4% not needed at all (Figure 4). In addition, the importance of OS and OD awareness, practical experience, and knowledge was also recognised by the SUPPORT group respondents (Figure 5). However, publishing of open data, FAIR, RDM plans, data protection, data curation, and long-term preservation are taught or supported by only 26% of the respondents (Figure 3).

3.5. Enforcement of ethics and research integrity

Key activities:

- adopting research integrity policy at all levels
- enforcing research integrity policy

Key actors:

- RPOs and HEIs
- funders
- publishers

Most researchers appreciate the benefits of sharing research data but may be reluctant to share their own data. The strongest incentive to share research data none the less are direct career benefits: greater visibility, reciprocal data exchange, and recognition/acknowledgment and/or attribution [46]. According to a recent study by Shah et al. [47] a vast majority of research participants agrees that it is important for research to advance as quickly as possible, yet they still want to have control over what type of data should be shared and with whom.

Collaborative sharing of data with peers, project partners, research collaborators, and other trusted groups is quite common in a research community. There are many issues and threats to solve before sharing these data publicly becomes a norm. Although research data sharing practices and motivation differ across disciplines, norms and policies at different levels (funder's, institution's, publisher's) could be strong external drivers for researchers to cross these boundaries between disciplines [46].

Policies and standards should always be reminding researchers and other stakeholders of one core ethical principle of science communication: attribution. But this can go even further; the creator of the original dataset should get a heads-up that another researcher intends to use this dataset. The original researcher should also get to see the results of research that has used their dataset. These new requirements could be integrated into current or future ethics and research integrity policies to be adopted by all RPOs, HEIs, publishers, and funders.

3.6. Providing support and fostering collaboration

Key activities:

- support for ORDM and FAIR activities to different stakeholders (researchers, support staff, institutions, funders)
- infrastructure support
- helpdesk
- data stewards
- collection and sharing information about best practices

- collaboration with national and international partners

Key actors:

- RPOs and HEIs
- funders
- publishers

The importance of support, of sharing the best OS and ORDM practices, and of collaboration on different levels has also been recognised by the NI4OS-Europe landscaping survey respondents from the SUPPORT group (Figure 5), who rated guidelines and best practices, legal framework and support, international organizational frameworks, national organizational frameworks, institutional capacity, and practical experience and knowledge as very important.

Support in research data stewardship would enable researchers to spend less time on data curation and focus on research instead. This could be achieved by educating librarians and other information specialists, building their ORDM skills, and especially by establishing discipline-specific data services on the institutional or national level.

3.7. Proper dataset attribution, citing and metrics

Key activities:

- fostering a culture of sharing and using open research data
- facilitating and standardizing dataset attribution and citation
- development of new and innovative research data metrics

Key actors:

- researchers
- RPOs and HEIs
- publishers
- funders

Attribution of datasets should be fully adopted and standardised to provide a unique identifier and acknowledge their creators. New dataset citation metrics should be developed too and used in evaluation and academic publishing practices. This could encourage researchers to share their data in line with the FAIR principles.

Respondents to the NI4OS-Europe landscaping survey acknowledge the importance of quantitative and qualitative indicators and metrics related to OS and OD (Figure 5), the need for training, support, and advice about citing, and acknowledging contributions in order to make data FAIR (Figure 4).

3.8. Use of certification schemes

> Key activities:
>
> - certification of OS infrastructures
> - certification of OS policies
> - certification of DMPs
> - FAIR compliance of the data infrastructure
> - DMPs and policies harmonization across stakeholders
>
> Key actors:
>
> - OS infrastructure providers
> - funders
> - RPOs and HEIs

Certification serves to verify specific characteristics of someone or something. In terms of scientific performance, this someone are individual researchers and something includes organisations, services, infrastructures, policies, and management procedures. Clear rules and criteria can build trust in platforms and the services we provide. Certification of repositories should inevitably include FAIR compliance criteria and a reward (e.g. seal of approval, inclusion in a catalogue of services) for being compliant. Certification may also be implemented at the policy (e.g. harmonized, machine-readable policies) and other levels (e.g. training programs, support QoS, etc.), but the certifying body should not lose sight of the purpose of certification and set realistic goals for all.

3.9. Use of research infrastructures

> Key activities:
>
> - foster ORDM and FAIR through the rules for the use of common research infrastructure
>
> Key actors:
>
> - RPOs and HEIs
> - funders
> - policymakers

One of the goals of the NI4OS-Europe project is to catalogue online platforms that share research results and data and enable research analysis. Access to these services is sometimes restricted due to limitations of background hardware and software, and one can assume that the pressure will be even stronger after making them more transparent. These platforms are valuable for researchers, and service providers could stipulate that researchers grant access at least to DMPs. A valid DMP would currently be sufficient evidence of the awareness about the importance of RDM and an incentive to dig deeper into DMP requirements.

3.10.   Improving publishers' practices

Key activities:

- enabling fully transparent editorial policies
- enabling (and mandating) publication of datasets alongside research papers in OA
- developing interoperability with other OS infrastructures
- implementing more transparent peer review processes
- implementing high ethical standards into their publishing practice
- enabling text and data mining

Key actors:

- publishers
- researchers

ORDM and FAIR activities could also be encouraged (and rewarded) through improved publishers' practices. Publishers have a strong influence on researcher's behaviour. They can enforce OS activities, including ORDM and FAIR, by defining desirable behaviour, by allowing or even mandating publication of datasets alongside research papers (not necessarily on publisher's servers, but on institutional, national, or transnational ones), by implementing high ethical standards, and by enabling text and data mining. Publishers should also enable interoperability with relevant OS infrastructure and embrace OA as a standard for reporting research results. Publishers can also improve the way research results are reported by introducing a variety of formats (beyond PDF), multimedia, and semantic markup. Also, a more transparent peer review process can improve the reliability of published content. Authors/researchers should respect publisher's high ethical standards and respect the principles of research integrity.

In addition, publishers could use OS badges as a simple incentive for authors, institutions, and funders. A case in point is the journal *Psychological Science* which shows that such badges could significantly increase the use of underlying data, available as supplementary material to the published article [48]. There are other examples of how to promote specific activities with open material and pre-registration badges [49].

4. Conclusions and final remarks

NI4OS-Europe partner countries are currently at different stages of OS implementation. Some have adopted OS policies on the national level, while others have institutional policies instead. Some have implemented OS activities bottom-up. The EU strongly promotes OS and ORDM/FAIR principles at the policy level, but also in practice by implementing OA and ORDM requirements in the projects it funds, while the member states are mandated to implement ORDM and FAIR principles into their policies on the national level.

OS infrastructure necessary for putting ORDM and FAIR to work is still not sufficiently developed in all partner countries. The awareness about the importance of OS exists, but the implementation of OS activities in researchers' everyday activities is very limited. Incentives and rewarding mechanisms for practising ORDM and FAIR need to be developed and integrated into research evaluation processes at different levels to encourage all stakeholders to pursue OS activities. This report analyses different possibilities for incentives and rewards to help stakeholders realize the advantages and benefits of supporting/pursuing ORDM and FAIR activities. For instance, policies on the national level, as well as funder policies mandating research data archiving and publication based on FAIR principles could encourage researchers to give more attention to ORDM issues. Rewarding and advancement policies should take into account ORDM "footprint" in researcher assessment, while funders could reward or penalize new applications based on the past ORDM activities of project participants.

Given these differences, not all ten ORDM and FAIR reward and incentive mechanisms identified and described in this document are equally mature and immediately applicable in every national context. Their simultaneous installation by policymakers, funders, RPOs and HEIs could be less effective than gradual implementation in synergetic and successive clusters, especially if we keep in mind that the discussion on incentives for OS activities is still a work in progress on a global level (e.g. rewards for opening data, infrastructural support to open peer-review, developing reliable alternative and open metrics, etc.). NI4OS-Europe will work with the key stakeholders on their prioritisation and will back the core reward and incentive mechanisms by supporting the related activities and actors and ensuring their alignment across the reconciled regional ecosystem. At the same time, NI4OS-Europe will keep track of all relevant developments in Europe, seeking to assess their applicability in individual local contexts and, if possible, adjust them to local needs.

Appendix 1 - Key resources for self-study

During our work on the deliverable, we made a list of key documents to be read by policy makers and other stakeholders interested in the subject. We classified these documents in four groups: Open Access, Open Science, Open Research Data, and Research Assessment.

Open Access

- Commission Recommendation (EU) 2018/790 of 25 April 2018 on access to and preservation of scientific information (European Commission)[2];
- "Plan S – Principles and Implementations"[3].

Open Science

- Draft ERAC Opinion on the Future of the ERA (No. WK 13883/2019 INIT), (ERAC Ad-hoc Working Group on the future of the ERA ERAC), 2019[4];
- "OSPP-REC: Open Science Policy Platform Recommendations," (European Commission) 2017[5];
- H. Brinken *et al.*, "A Case Report: Building communities with training and resources for Open Science trainers," *Lib. Q.*, vol. 29, no. 1, p. 1, Oct. 2019[6].

Open research data

- Turning FAIR into reality (European Commission), 2018[7];
- FAIRsFAIR Work Package 3 (WP3): FAIR Data Policy and Practice (FsF)[8];
- An analysis of Open Data Policies in Europe, v4 (SPARC Europe), 2019[9];
- J. Berends, W. Carrara, H. Vollers, T. Fechner, and M. Kleemann, "Analytical Report 5: Barriers in working with Open Data", 2017[10].

Research Assessment

- The Leiden Manifesto for Research Metrics[11];
- The Declaration on Research Assessment (DORA)[12];

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[2] Available at: URL: https://www.eosc-portal.eu/sites/default/files/CELEX_32018H0790_EN_TXT.pdf

[3] Available at: URL: https://www.coalition-s.org/addendum-to-the-coalition-s-guidance-on-the-implementation-of-plan-s-principles-and-implementation/

[4] Available at: URL: https://era.gv.at/object/document/5053/attach/item_4_-_Draft_Opinion_Future_of_ERA.pdf

[5] Available at: URL: https://ec.europa.eu/research/openscience/pdf/integrated_advice_opspp_recommendations.pdf

[6] Available at: URL: https://www.liberquarterly.eu/article/10.18352/lq.10303/

[7] Available at: URL: https://op.europa.eu/en/publication-detail/-/publication/7769a148-f1f6-11e8-9982-01aa75ed71a1/language-en/format-PDF/source-80611283

[8] Available at: URL: https://www.fairsfair.eu/fair-policy-and-practice

[9] Available at: URL: https://zenodo.org/record/3379705

[10] Available at: URL: http://www.europeandataportal.eu/%0Ahttps://www.europeandataportal.eu/sites/default/files/edp_analytical_report_n5_-_barriers_in_open_data.pdf

[11] Available at: URL: http://www.leidenmanifesto.org/

[12] Available at: URL: https://sfdora.org/

- C. O'Carroll *et al.*, *Evaluation of Research Careers fully acknowledging Open Science Practices: Rewards, incentives and/or recognition for researchers practicing Open Science*, 2017[13];
- S. Leonelli, "Mutual Learning Exercise: Open Science – Altmetrics and Rewards: Incentives and Rewards to engage in Open Science Activities," no. Thematic Report No 3, 2017[14];
- S. Leonelli, "Mutual Learning Exercise: Open Science – Altmetrics and Rewards: Implementing Open Science: Strategies, Experiences and Models," no. Thematic Report No 4, 2017[15];
- Mutual Learning Exercise: Open Science - Altmetrics and Rewards, Final report (European Commission), 2018[16];
- B. Saenen, R. Morais, V. Gaillard, and L. Borrell-Damián, "Research Assessment in the Transition to Open Science: 2019 EUA Open Science and Access Survey Results," no. October, 2019[17];
- P. Wouters *et al.*, *Indicator Frameworks for Fostering Open Knowledge Practices in Science and Scholarship*, no. July. 2019[18]

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[13] Available at: URL: https://ec.europa.eu/research/openscience/pdf/os_rewards_wgreport_final.pdf

[14] Available at: URL: https://rio.jrc.ec.europa.eu/en/file/11619/download?token=uiOzNZM

[15] Available at: URL: https://rio.jrc.ec.europa.eu/en/file/11905/download?token=ZQF9wGZ5

[16] Available at: URL: https://rio.jrc.ec.europa.eu/en/file/12405/download?token=Cy9bQifW

[17] Available at: URL: https://eua.eu/resources/publications/888:research-assessment-in-the-transition-to-open-science.html

[18] Available at: URL: https://doi.org/10.2777/445286%0Ahttps://op.europa.eu/en/publication-detail/-/publication/b69944d4-01f3-11ea-8c1f-01aa75ed71a1/language-en/format-PDF/source-108756824

Appendix 2 - Current state of OS implementation and incentives in four NI4OS-Europe countries

Croatia

National level

National policies on access and preservation of scientific information are mainly the responsibility of the Croatian Ministry of Science and Education (MSE). In principle, MSE supports OA to scientific information but it still has not adopted a national OA or OS policy. However, openness is mentioned in a few strategic documents and supported by many stakeholders in the research community. In 2012, a number of institutions and researchers signed the Croatian Open Access Declaration, which clearly states that "results of the activities financed by public funds, especially in the field of education and science, should be made available in OA"[19]. The Croatian Act on Scientific Activity and Higher Education mandates archiving digital versions of all higher education theses in a corresponding academic library repository[20]. There is no similar mandate for other types of publications or research data on the national level. The Croatian Research and Innovation Infrastructures Roadmap 2014-2020 addresses the promotion of OA to scientific papers and research data, especially those funded by public sources[21]. MSE's Strategy of Education, Science, and Technology recognizes that setting up an OA system for research data, publications, and teaching resources is a key to improving research environment[22]. The Croatian Rectors' Conference has declared support to OA in its document "Research assessment and promotion of OA to scientific information and research data[23]. It believes that OA would promote transparent evaluation of individuals and organizations. It also supports the idea that OA to scientific publications should be mandated in Croatia. The recommendation of the Minister of Science and Education to Croatian research organizations is to share information on scientific equipment acquired by public funds through the national database of scientific equipment - Šestar[24].

Currently, there are no ORDM-related policies or requirements for research funders and other research sector stakeholders in Croatia, nor are there rewarding mechanisms in place. The Croatian Science Foundation (CSF), the main national funder of scientific, higher education and technological programs and projects in Croatia, has not adopted any

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[19] Croatian open access declaration (2012). Available at: URL: https://www.fer.unizg.hr/oa2012/declaration (available in English)

[20] Zakon o znanstvenoj djelatnosti i visokom obrazovanju (pročišćeni tekst). Available at: URL: https://www.zakon.hr/z/320/Zakon-o-znanstvenoj-djelatnosti-i-visokom-obrazovanju (available only in Croatian)

[21] Croatian research and innovation infrastructures roadmap 2014-2020 (2014). Available at: URL: https://rio.jrc.ec.europa.eu/en/library/croatian-research-and-innovation-infrastructures-roadmap-2014-2020 (available in English)

[22] New colours of knowledge – strategy for education, science and technology (2014). Available at: URL:https://mzo.gov.hr/UserDocsImages//dokumenti/Obrazovanje//Strategy%20for%20Education,%20Science%20and%20Tehnology.pdf (available in English)

[23] URL: http://www.rektorski-zbor.hr/fileadmin/rektorat/O_Sveucilistu/Tijela_sluzbe/Rektorski_zbor/dokumenti2/Vrednovanje_znanstvenog_rada_i_otvoreni_pristup_znanstvenim_informacijama_Rektorski_zbor.pdf (available only in Croatian)

[24] Baza podataka instrumenata za Znanstvena istraživanja – Šestar. Available at: URL: https://sestar.irb.hr/en/

policies on RDM yet, but it informs applicants about the importance of research data management and FAIR principles as they prepare a research proposal.

However, there are institutions that are actively engaged in the promotion of ORDM. The Ruđer Bošković Institute (RBI) makes it possible to deposit research data in the institutional repository dubbed FULIR. It also organizes workshops and webinars on OS and DMP and provides support for researchers at the national level through the OpenAIRE NOAD activities and its participation in the development of the national infrastructure for hosting digital repositories - Digital academic archives and repositories - DABAR[25]. Zagreb University Faculty of Humanities and Social Sciences (FHSS) participated in several open research data projects[26, 27, 28]. It also organizes events on ORDM and participates in the development of the DABAR infrastructure. Since December 2019, when the Croatian Social Science Data Archive was launched, Croatia has become a CESSDA member, and FHSS service provider. Zagreb University Computing Centre (SRCE) supports ORDM and FAIR through the development of the DABAR infrastructure, PUH service, training on ORDM, and through the promotion of best practices in research data sharing as a Croatian National Research Data Alliance (RDA) node.

Except for some general guidelines, national regulations do not strongly encourage ORDM or OS. As a consequence, ORDM practices are not taken into account when researchers, research institutions, and their research outputs are being evaluated.

From the early 1990s, numerous OA and OS initiatives have emerged to compensate for the lack of national policies, mostly enabling infrastructure at different levels to support openness, such as the Croatian national bibliographic database called Croatian Scientific Bibliography - CROSBI[29], Portal of Croatian Scientific and Professional Journals - HRČAK[30], and the Database of Scientific Instruments – Šestar. HRČAK is an OA publishing platform hosting over 400 Croatian OA journals and providing access to more than 200.000 full-text articles. Recently it conducted a survey[31] to get a better insight in journal research data publishing policies and to estimate the level of awareness about the FAIR principles and ORDM in general. Research data were rarely mentioned, and only in ethical guidelines, not in instructions for authors as expected. In rare cases where public access to data was mentioned, it was without clear instructions how these can be used, especially in terms of the FAIR principles. Croatian research and higher education institutions can establish their own discipline- or subject-based repositories on DABAR. Since the end of 2018, all repositories in DABAR share research data in compliance with the FAIR principles. Besides DABAR, some researchers use the Zenodo repository and/or their domain-specific

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[25] Digital Academic Archives and Repositories. Available at: URL: https://dabar.srce.hr/en

[26] Support for Establishment of National/Regional Social Sciences Data Archives (SERSCIDA). Available at: URL: http://www.serscida.eu/en/

[27] South-Eastern European Data Services (Seeds). Available at: URL: https://seedsproject.ch/

[28] Consortium of European Social Science Data Archives (CESSDA ERIC). Available at: URL: https://www.cessda.eu/ Consortium of European Social Science Data Archives (CESSDA ERIC)

[29] Croatian Scientific Bibliography – CROSBI. Available at: URL: https://www.bib.irb.hr/

[30] Portal of Croatian Scientific and Professional Journals – HRČAK. Available at: URL: https://hrcak.srce.hr/?lang=en

[31] M. Glavica, I. Kranjec and A. Vodopijevec, "Journal Data Policies: Are Croatian Journals Following Trends?", presented at: PUBMET2019 - The 6th conference on scholarly publishing in the context of open science, Zadar, 18.09.2019.-20.09.2019. Available at: URL: https://urn.nsk.hr/urn:nbn:hr:131:412515

repositories for archiving research data. They can also use the national service PUH[32] for reliable storing and sharing data during a research project.

As a part of the Scientific and Technological Foresight project, led by the Ministry of Science and Education and funded by the EU, development and implementation of a national Current Research Information System (CRIS), named CroRIS, is on its way. CroRIS will be completed and ready to go in 2022.

Institutional level

Research institutions in Croatia are autonomous, but they strongly rely on national policies and regulations. There are only a few institutional OA mandates, such as those of the RBI, SRCE, Faculty of Mechanical Engineering and Naval Architecture of the University of Zagreb, and the Physics Department of the Faculty of Science at the University of Zagreb, mostly addressing OA to publications. Only SRCE's OA policy includes research and other data management, but still does not refer to the FAIR principles.

Croatian research institutions can use a national repository infrastructure DABAR to maintain their FAIR compliant OA institutional digital repositories free of charge. Researchers from institutions without their own repository can use thematic or other large-scale repositories like Zenodo, FigShare, or others.

Some institutions provide support for OA and ORDM activities for their researchers. The level of support varies and usually consists of infrastructure, training for using the infrastructure, and creation of DMPs.

To the best of our knowledge, ORDM and/or FAIR are not rewarded by institutions, but some reward OA to publications[33].

Researcher level

Current Croatian regulations and criteria for career advancement and hiring in RPOs and HEIs favour two quantitative measures: the number of papers published and the prestige of the journals in which they were published. Prestige stems from whether the journal is indexed by the Web of Science Core Collection, Scopus or similar database, but more importantly from high Journal Impact Factor. For now, OS or ORDM in no way up researcher's chances for advancement.

Research data sharing in Croatia is in its initial phase, and researchers are not encouraged and/or rewarded for sharing their research data, except when mandated by funders (e.g. EC through H2020 projects).

Greece

National level

Until recently, national policies on access to and preservation of scientific information have been under the responsibility of the Ministry of Education, Research and Religious Affairs. However, the change of Government in July 2019 brought new formations in the public

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[32] Pohrana i upravljanje podacima - PUH. Available at: URL: https://www.srce.unizg.hr/puh

[33] B. Macan (2017) Internal institutional regulations and incentives at the Ruđer Bošković Institute in the open science context. Available at: URL: http://fulir.irb.hr/4088/1/944193.MLE-Dubrovnik_2017-Macan.pdf

authorities and now research activities run under the responsibility of the Ministry of Development and Investment, thus introducing silos in implementing OS in Greece. It is still unclear who should/will take the lead and what will their roles be on issues related to OA and OS as more than one public authority is concerned and therefore should be involved in the process.

Currently, Greece doesn't have a national policy on research data. Law N. 4310/2014 on Research, Technological Development and Innovation includes provisions for the preservation of scientific articles of Greek scientific excellence in public repositories, but this has not been enforced yet. At this point, OA to publications and data is introduced by EC-funded research or bottom-up initiatives. In specific, OA to publications and data is followed only when research funding is associated with European projects of Horizon2020 or ERC or on other occasions where Greek partnership is involved in grants by foreign funders requiring the practice of OA. Another paradigm is the one of the General Secretariat for Research and Technology (GSRT), one of the main Greek funders for research who is the main body responsible for setting research policy priorities and is a major direct funder of Research and Development. In their 2015 Strategy for the European Research Area (ERA), GSRT is bound to achieving OA to publications by 2025[34].

In the bottom-up national Open Science Task Force (OSTF) consisting of 17 national institutions, research infrastructures, nodes and OS initiatives[35], there are discussions around RDM and FAIR principles which are being incorporated in the draft National OS Plan for Greece to be made available for public consultation in early 2020[36]. No policy is in place and no national monitoring mechanism to measure its compliance. Currently, the only indication about OA/OS uptake in Greece can be found in a recent study concerning an early evaluation of Greek participation in H2020[37]. Additionally, the OSTF foresees in its work, a control mechanism to measure compliance with the policy concentrating on the monitoring of publicly funded publications and research data.

Institutional level

Examining the current situation at the institutional level, there are several recent initiatives which have marked some gradual progress in the field of OS and specifically concerning open and FAIR data. Initially, not many Greek RPOs responded to the 2012 Communication on access to and preservation of scientific information[38]. Only two Universities developed OA policies for the publications that are produced in the context of research carried out by their academic staff and students which had since been revised following the new Recommendation on access to and preservation of scientific information[39]. That means that their policy documents now contain the encouragement of depositing research data along with publications, but without involving good practices for RDM or without posing specific incentives for doing so. To foster the adoption of OS policies

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[34] Available at: URL: http://www.gsrt.gr/News/Files/New1234/Greek%20ERA%20Strategy%20EN.pdf

[35] Available at: URL: https://www.openaire.eu/blogs/drafting-the-proposal-for-a-national-open-science-strategy-in-greece-an-interinstitutional-approach

[36] Available at: URL: https://www.openaire.eu/blogs/national-plan-for-open-science-towards-the-open-consultation-1

[37] Available at: URL: http://ereader.ekt.gr/books/mnwx/#p=17

[38] Available at: URL: https://ec.europa.eu/research/science-society/document_library/pdf_06/recommendation-access-and-preservation-scientific-information_en.pdf

[39] Available at: URL: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0790&from=EN

in Greece, OpenAIRE Greek NOADs[40] drafted a model policy for Universities based on the OpenAIRE model policy templates[41]. The model policy was presented to librarians, archivists and other information professionals[42] and is now being finalized in order to be presented to the Council of Rectors.

In terms of infrastructure, all academic libraries that are part of the HEAL-Link network have developed and run at least one literature repository and/or digital library. It is possible that some research data has been/ are collected as grey literature and are stored and preserved in these repositories, but this needs to be further examined. The national data repository "HELIX Data"[43] is the most suitable and preferred infrastructure for research data deposit and preservation as it has been developed according to open and FAIR principles and is constantly being improved to meet new criteria. Currently, HEAL-Link is also developing data repositories according to and linked to the HELIX[44] model and services.

Researcher level

Research data archiving is neither incentivized nor rewarded in Greece. The lack of such a framework is clear in the recent EUA report on research assessment where Greek input is of absence[45]. The level of data-sharing culture among researchers is based on internal motivation, influence from their community or access to information. Scholars who are part of research communities usually deposit their research data in thematic data repositories as suggested by their community, which pushes forward the RDM maturity of the whole community. Thus, it is essential to facilitate researcher's access to information and provide more incentives.

There is an effort to change that with the policy suggestions made to the Political Leadership by the Greek OSTF. Following the global community, OSTF recommendations take stock of DORA and the Leiden Manifesto to state that open practices should be recognized in evaluation criteria relevant to professional growth and contributions of Greek researchers. Moreover, detailed insights on recent developments of incentives and rewards will be gained after the analysis of the landscaping survey.

Regarding researchers' support, OpenAIRE Greek NOADs are responsible for OS in Greece providing consultation to researchers in their RDM activities. The Greek NCPs network[46] might also be contacted for ORDM issues by successful applicants who are interested to understand the practical steps of compliance with EC requirements tied to their grants.

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[40] Available at: URL: https://www.openaire.eu/item/greece

[41] Available at: URL: https://www.openaire.eu/openaire-releases-model-templates-and-checklists-for-policy-makers

[42] Available at: URL: https://palc25.lib.uoc.gr/en/program/workshop-on-open-science-policies-at-higher-education-institutions-from-theory-to-practice

[43] Available at: URL: https://data.hellenicdataservice.gr/

[44] Available at: URL: https://hellenicdataservice.gr/main/

[45] Available at: URL: https://www.eua.eu/resources/publications/888:research-assessment-in-the-transition-to-open-science.html?utm_source=social&utm_medium=Twitter&utm_name=Twitter-social-22-10-2019

[46] Available at: URL: http://www.eie.gr/ncp-people/

Serbia

National level

The national OS policy in Serbia, Open Science Platform (OSP) was adopted in July 2018 by the Ministry of Education, Science and Technological Development of the Republic of Serbia. It stipulates a hard Green OA mandate for publications. It also defines the basic requirements that publication repositories have to meet, which are in line with FAIR principles. The maximum embargo periods for publications are longer than in the EU: 12 months for STEM and 18 months for SSH[47].

Although not mandated, ORDM is explicitly mentioned and discussed in the document. OSP says that research data "should" be deposited in a repository and it is recommended to make them open whenever there are no ethical or legal limitations. Although the term FAIR is not mentioned as such, the principles are incorporated in the policy, especially in Annex II: it is specified that data should be deposited in an appropriate repository, assigned a PID, described in detail using structured metadata and assigned a machine-readable CC license. Links should also be established between deposited data and the corresponding publications. RDM plans are also addressed: it is recommended that an RDM be part of each research project.

The policy mentions compliance monitoring and establishes a link between compliance and the evaluation of project impacts and funding applications. However, it does not say who will do the monitoring, how, at what intervals, whether and how the compliance will be rewarded and non-compliance penalized. There are several reasons why compliance monitoring and incentives have not been discussed in greater detail. First of all, the repository infrastructure in Serbia was still underdeveloped at the time when the policy was accepted. Most publication repositories were established only after the policy had been adopted, and there are still no local data repositories. For most researchers and institutions, it would have been impossible to comply with the policy. Secondly, at the moment when the policy was adopted, it was known that the research funding system would change, but the new legislation, organization structure, bodies and procedures were yet to be set up. The 2019 Law on Science and Research recognizes OS as an area of general interest that should receive public funding (Article 12)[48]. The Science Fund of the Republic of Serbia[49] was established in 2019. Although no details are known at the moment, it is reasonable to expect that this line of development will lead to funding for OS infrastructure, a system of incentives for OS practices and compliance monitoring mechanisms.

An initiative to establish a national data service for social sciences (Serbian Data Centre in Social Sciences (SER-DAC) in Serbia was launched by the Institute for Economic Sciences Belgrade within the SERSCIDA project, funded by the EC within the FP7. SER-DAC decided to use Dataverse as the software platform for the data repository[50]. Although

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[47] 'Open Science Platform'. (2018) Ministry Education, Science and Technological Development. Available at: URL: http://open.ac.rs/svevesti/87328781babfe70aad60429fad8f4feb/Open-Science-Policy-Serbia.pdf.

[48] Zakon o nauci i istraživanjima. (2019) Available at: URL: http://www.parlament.gov.rs/upload/archive/files/cir/pdf/zakoni/2019/1802-19.pdf.

[49] Science Fund of the Republic of Serbia. Available at: URL: http://fondzanauku.gov.rs/?lang=en

[50] Report on Tool Evaluation and Selection / SEEDS - South-Eastern European Data Services. (2017) D9. Available at: URL: https://seedsproject.ch/wp-content/uploads/2015/06/D9_FINAL.pdf.

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an instance of Dataverse was installed[51], there have been no signs of progress towards establishing a functional data repository.

Keeping in mind that MESTD is still the main research funder in Serbia, OSP is also a funder policy. Research and research support activities in Serbia have so far been funded by MESTD, through projects. Beginning in 2020, institutional funding will be provided by MESTD for core research and research support activities, whereas the newly established Science Fund will provide funding for projects. At the moment, the Science Fund does not have an OS policy on its own. Nevertheless, in the first two calls for funding (September and November 2019), the application forms included a section related to RDM (data types, data formats, archiving, curation, data-related costs, access). At the moment, it is impossible to say whether the grantees will be required to submit a DMP and verify that they have archived data resulting from the project. These issues might be addressed in grant agreements.

Institutional level

All institutional policies in Serbia (currently 12)[52] mandate Green OA to publications and recommend OA to research data. Eight institutional policies (four universities and four institutes) foresee procedures for policy compliance monitoring: the monitoring is performed by librarians at least once a year. Two institutions plan to define monitoring procedures later, in a new document.

Five institutional policies (one university and four institutes) explicitly mention and explain the FAIR principles and make reference to EOSC. Researchers are encouraged to deposit research data both in a FAIR compliant repository and in the institutional repository; they are strongly advised to avoid publishing data as un-FAIR supplementary materials in journals.

A major shift towards encouraging data archiving is made in the institutional OS policy of the University of Novi Sad[53], where a DMP template is provided in Annex 2. This is currently the only officially recommended DMP template in the Serbian language. The same university makes a shift in terms of rewarding open research data: in the evaluation procedure, citations gained by research data will be treated in the same way as citations gained by publications. A step forward in the implementation of the OS policy is made by amending the Bylaw on Doctoral Studies: PhD students who have produced/collected research data during the research related to the PhD thesis shall submit a DMP when submitting the report on the evaluation of the PhD thesis for making it public on the website of the University of Novi Sad[54].

To the best of our knowledge, no institutions in Serbia have dedicated persons or teams to support ORDM activities. Few institutions (less than five) have self-trained librarians who would be able to support these activities. Along with the lack of proper training at the

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[51] Available at: URL: http://dataverse-serbia.ien.bg.ac.rs/dataverse.xhtml

[52] Available at: URL: http://open.ac.rs/politika

[53] Rulebook on Implementation of the Open Science Platform of the Ministry of Education, Science and Technological Development at the University of Novi Sad. (2019) University of Novi Sad. http://www.beopen.uns.ac.rs/documents/11a0b31c4bf671c40a0c1872dfef783b/UNS_Open%20Science%20Rulebook.pdf.

[54] Decision on Amendments to the Bylaw on Doctoral Studies. (2019) University of Novi Sad. Available at: URL: http://www.beopen.uns.ac.rs/documents/11a0b31c4bf671c40a0c1872dfef783b/UNS_Decision%20on%20Amendments%20to%20the%20Bylaw%20on%20Doctoral%20Studies.pdf

local level, this results in the poorly developed data archiving and data-sharing culture among researchers and the fact that most decision-makers and researchers have not identified the need for systematic support in this area.

Researcher level

At the local level, the researchers involved in ORDM activities are largely limited to those involved in Horizon 2020 projects. They usually share their data on Figshare and Zenodo. Judging by the number of researchers ready to share research data as part of various types of supplementary materials published in journals or websites and blogs, the local research community has a prevailingly positive attitude to data archiving (and sharing). Mandating DMPs and FAIR compliance in grant agreements, as well as providing proper training and support and incentives for ORDM would certainly yield results.

Slovenia

National level

The Government of the Republic of Slovenia adopted the National Strategy of Open Access to Scientific Publications and Research Data in Slovenia 2015-2020[55] in September 2015 (ROARMAP record) and the action plan[56] in May 2017. Slovenian research performing organizations have not yet adopted the Open Access policies. Mr Peter Sterle from the Ministry of Education, Science and Sport acts as the National Point of Reference in accordance with the Commission Recommendation[57] of 25 April 2018 on access to and preservation of scientific information. In Slovenia, the 'Open Data Project' (2010-2013)[58] produced a draft open research data policy and a draft action plan for the establishment of a national open research data infrastructure. Before the adoption of the open research data mandate, a national pilot programme 'open access to research data' will be carried out. The Slovenian Government adopted two national strategies 'Research Infrastructure Roadmap 2011-2020'[59] and the 'Open Data Project (2010-2013)' as the main policy documents for the development of e-Infrastructures in the country. The first contains a chapter on national digital resources and it assures that publication repositories as well as data archives will be made OpenAIRE compliant to ensure quality, metadata harvesting and interoperability. It further envisages the adoption of measures to ensure sustainability and long-term preservation of e-Infrastructures for scientific research; although no

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[55] National Strategy of Open Access to Scientific Publications and Research Data in Slovenia 2015-2020. Available at: URL: https://www.gov.si/assets/ministrstva/MIZS/Dokumenti/ZNANOST/Strategije/National-strategy-of-open-access-to-scientific-publications-and-research-data-in-Slovenia-2015-2020.pdf [English]

[56] Action plan for the implementation of the National Strategy of Open Access to Scientific Publications and Research Data in Slovenia 2015-2020 Available at: URL: https://www.gov.si/assets/ministrstva/MIZS/Dokumenti/ZNANOST/Strategije/Akcijski-nacrt-izvedbe-nacionalne-strategije-odprtega-dostopa-do-znanstvenih-objav-in-raziskovalnih-podatkov-v-Sloveniji-2015-2020.pdf [Slovenian]

[57] Available at: URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32018H0790

[58] Open Data Project (2010-2013). Available at: URL: https://www.adp.fdv.uni-lj.si/media/publikacije/predavanja/2013/2013_odpp10_pub_stebe.pdf [Slovenian/English]

[59] Research Infrastructure Roadmap 2011-2020. Available at: URL: https://www.gov.si/assets/ministrstva/MIZS/Dokumenti/ZNANOST/Strategije/Research-Infrastructure-Roadmap-2011-2020-Revision-2016-ENG.pdf [English]

specific details were provided. The 'Open Data Project' drafts open research data policy and action plan for development of open research data infrastructures.

The organization of the Slovenian research environment is defined in the Research and Development Activity Act[60], which also specifies how research and development policies are implemented and how research is funded by government funds and other sources (European programmes and frameworks, local communities, and business enterprises). Research and development activities are carried out by the research performing institutions through programmes and projects, and by private researchers through projects. The Research and Development Activity Act states that results of research and development activities financed by government funds should be made publicly available with the only limitations being those set by the regulations on intellectual property, authors' rights and personal data. A new Research and Development Activity Act is in the adoption process and covers open science as a very important issue. The Resolution on Research and Innovation Strategy of Slovenia 2011-2020[61] determines Open Access to raw research data from publicly financed research and preparation of an action plan by year 2014 as a basis for a national Open Research Data policy.

The Research Infrastructure Roadmap 2011-2020 envisages the international cooperation of Slovenia in ESS, DARIAH and CESSDA projects. National repositories for scientific publications and raw research data are planned and are to be connected to the national Current Research Information System (SICRIS[62]). Deposit of research publications and raw data is to be made mandatory when the infrastructure is established. Building of an open social sciences and humanities research infrastructure is also anticipated.

Information on Open Access in the Slovenian language is available through the national portal Open Access Slovenia[63]. Slovenian scientific journals are indexed in the Directory of Open Access Journals. The electronic versions of all publicly co-financed Slovenian journals and final reports of research projects financed by the Slovenian Research Agency, as well as doctoral dissertations, must be deposited into the Digital Library of Slovenia[64]. Many of the scientific journals use the Open Journal Systems for managing the publication process. The country does not have a national portal for Open Access journals or Open Access monographs. The Open Science Slovenia[65] portal has been established to harvest metadata from Slovenian repositories and other archives for scientific publications and research data The portal enables joint display and federated search and provides access to full texts. All Slovenian researchers are requested to deposit into one of the Slovenian repositories. Slovenia takes part in the OpenAIRE2020 project (the National Open Access Desk at the University of Ljubljana). The Social Science Data Archives[66], a member of CESSDA, maintained by the Faculty of Social Sciences of the University of Ljubljana, collects research data from the social sciences research. CLARIN.SI[67] is the Slovenian

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[60] Research and Development Activity Act. Available at: URL: http://pisrs.si/Pis.web/pregledPredpisa?id=ZAKO3387 [Slovenian]

[61] Resolution on Research and Innovation Strategy of Slovenia 2011-2020. Available at: URL: https://rio.jrc.ec.europa.eu/en/library/research-and-innovation-strategy-slovenia-2011-2020 [English]

[62] SICRIS. Available at: URL: https://www.sicris.si/public/jqm/cris.aspx?lang=eng&opdescr=home [Slovenian/English]

[63] Open Access Slovenia. Available at: URL: https://www.openaccess.si/ [Slovenian]

[64] Digital Library of Slovenia. Available at: URL: http://www.dlib.si/?&language=eng [Slovenian/English]

[65] Open Science Slovenia. Available at: URL: http://openscience.si/default.aspx [Slovenian/English]

[66] Social Science Data Archives. Available at: URL: https://www.adp.fdv.uni-lj.si/eng/ [Slovenian/English]

[67] CLARIN.SI. Available at: URL: http://www.clarin.si/info/about/ [Slovenian/English]

research infrastructure for language sources and technologies. The SI-DIH DARIAH[68] search engine enables search for research data in different repositories and archives of institutions and societies from the humanities and the arts.

Major funders of research are the Slovenian Research Agency (ARRS) and the Ministry of Education, Science and Sport. The ARRS is the most important partner in establishing the Slovenian open access policy. They have been including open access criteria in their tenders and also reimbursing the APC costs to authors for scientific articles resulting from projects they have funded. They, however, have not yet implemented the obligation to deposit research data or to prepare DMPs. In 2019, they joined Coalition S, signed Plan S and the DORA declaration.

Institutional level

Research and development activities are carried out at approximately 400 research institutions. There are three public universities in Slovenia: the University of Ljubljana, the University of Maribor and the University of Primorska. The largest among the private academic institutions is the University of Nova Gorica. The four universities form the Rectors' Conference of the Republic of Slovenia. The largest research institutes in Slovenia are the Jožef Stefan Institute, the Scientific Research Centre of the Slovenian Academy of Sciences and Arts, the National Institute of Chemistry, the Institute of Oncology, the Agricultural Institute of Slovenia, and the National Institute of Biology. The umbrella interest association of research institutes is KOsRIS (Coordination of Independent Research Institutions of Slovenia). Data on Slovenian researchers, organisations, research groups, projects and programmes are available via the Slovenian Current Research Information System SICRIS (personal bibliographies of researchers are also used for research evaluation). More information on the national research environment is available at Research and Innovation Observatory (RIO) – Slovenia. The University of Maribor is the only institution in Slovenia, which signed the Berlin Declaration in 2014, they also signed the DORA declaration in 2019. The Slovenian Social Science Data Archives (ADP) was established in 1997 as an organizational unit of the Social Sciences Research Institute at the Faculty of Social Sciences, University of Ljubljana. It is a national research infrastructure for social sciences, whose main mission is to manage data and data services in order to support research, education and general well-being. Digital curation of high-quality research data that are openly accessible to researchers and other interested public is at the essence of the ADP activities. This way, financial savings are being made in cases of unnecessary duplication of new research data, as well as enabling higher quality of research findings. Within its mission, the ADP establishes itself as a national infrastructure that collects important data sources from a wide range of social sciences, interesting for analyzing the Slovenian society, deposits, preserves and promotes their further use in scientific, educational and other purposes. The Ministry of Education, Science, and Sports of the Republic of Slovenia has appointed ADP as the national data service provider for social sciences within its membership in CESSDA. The long-term national importance of the ADP is clear also in the ongoing support of the ministry, which from the establishment onwards ensures funding of ADP. Since 2004, the funding of operations has been provided within the infrastructure program Network of research infrastructure centers at the University of Ljubljana (MRIC UL). ADP have acquired the Core Trust Seal certificate and

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[68] SI-DIH DARIAH. Available at: URL: https://sidih.si/ [Slovenian/English]

their platform supports FAIR principles. The current project they are involved in is SSHOC. Slovenian repositories for the research outcomes (Digital Library of the University of Maribor, Repository of the University of Ljubljana, Repository of the University of Primorska, Repository of the University of Nova Gorica, Digital Repository of the Research Organizations of Slovenia) enable collection, storage and availability of scientific publications to the public. Repositories are compatible with the OpenAIRE Guidelines and are included into the OpenAIRE portal. Their platforms support FAIR principles. Slovenian research performing organizations do not have policies mentioning ORDM, including FAIR principles or research data archiving. The institutional repositories enable archiving of research data on the institutional level, but metadata formats are not subject-specific. Currently, we are building a national research data repository in Slovenia, which will be hosted on Slovenian HPC infrastructure. We do not have a dedicated person (or a team) supporting researchers in their ORDM activities, except for social sciences, as we mentioned before.

Researcher level

Institutional repositories for scientific publications exist and they are connected to the Slovenian Cooperative Online Library System and Services (COBISS[69]) and National Current Research Information System (SICRIS). The current evaluation system of scientific excellence is based on quantitative measures: number of articles and other publications and on the impact factor of the journals (Web of Science Core Collection and Scopus). No OS or ORDM incentives or rewards are currently being implemented. The current level of data sharing culture among researchers is not systematic or rewarded and it is voluntary, except when the researchers are involved in European projects and the funder mandates it. Institutions and higher education libraries work intensively on the promotion of ORDM and FAIR principles among their researchers, but need the strategy for the next period 2021 – 2030 at the national and institutional level.

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[69] COBISS. Available at: URL: https://www.cobiss.si/en/ [Slovenian/English]