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National Initiatives for Open Science in Europe

Deliverable D4.8
Final report on WP4 tools

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Abstract: This document provides the final update on the tools developed by NI4OS-Europe: LCT, RoLECT and RePol. These developments were originally reported in Deliverables D4.4 and D4.5, and updated in D4.6 and D4.7. It also includes information on related and supporting activities carried out by WP4: the work on the brochure "Incentives and rewards for supporting ORDM and FAIR"; hybrid hands-on workshop on open source, software tools and service management; and the related report with recommendations on FOSS in open science.

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Executive summary

What is the focus of this Deliverable?

The deliverable D4.8 focuses primarily on the three tools developed and deployed by WP4. These tools are: a) LCT, a tool for a simple and automated approach to licence clearance; b) RoLECT, a technical solution for self-assessment against EOSC Rules of Participation (RoP) Legal & Ethics Compliance requirements; and c) RePol, a tool for repository policies and privacy policies for online services.

LCT has been developed within T4.4 "Certification schemes for a free flow of data" as it helps in dealing with IPR management by supporting licence selection and reuse of research outputs. RoLECT and RePol, dealing with service-level requirements, have been developed within T4.3 "Open and FAIR data in practice: tools for RDM following the data lifecycle", but are also related to T4.2 "Policies and guidelines for incorporation and implementation of FAIR data practices" as they also help in adhering to the underlying policies (RoLECT), or in establishing service policies (RePol). Furthermore, this deliverable describes the brochure on rewards and incentives supporting ORDM and FAIR developed within T4.1 "Developing rewards and incentives mechanisms for ORDM and FAIR". Finally, the document summarises guidelines on the use of FOSS (free and open source software) in OS and the related hackathon, also related to T4.2.

We consider both the hackathon and the report with recommendations on FOSS in open science as important additional achievements that were not planned in the Description of the Action [1] or at the beginning of the WP4 work but have emerged naturally from the work on the tools and the interaction with end users and other work packages.

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

D4.8 reports the final versions of LCT, RoLECT and RePol, which now include all planned elements and features that have been delivered over several interim versions. This deliverable marks the conclusion of NI4OS-Europe's contribution to the development of tools that support ORDM and FAIR. The produced tools have by now hopefully matured enough to operate and grow within the broader open science ecosystem.

What are the deliverable contents?

This document provides an update on the development reported in D4.4 [2] and D4.6 [3] for LCT and D4.5 [4] and D4.7 [5] for RoLECT and RePol.

The overview describes the assessment and feedback framework developed for the tools, how it was implemented, and includes general comments on sustainability as well as recommendations for tools and services developers. For each tool, after a table of key links, an up-to-date summary of the tools is given, together with comments on their status, possible future uses and important specific comments on sustainability. The technical details, documentation and training material for the tools can be found at the links provided in this document. The same applies to the detailed materials produced as part of the supporting activities, namely the brochure on rewards and incentives to support ORDM and FAIR, the documents related to the workshop on open source, software tools and service management, and the guide "Software and free and open source software in open science".

Conclusions and recommendations

The three deliverables submitted in the first eight months of the project [6, 7, 8] provided analysis and categorisation of existing guidelines, policies, technical solutions, tools and models that address FAIR and open science issues. They helped identify gaps in the current landscape and guide the development of NI4OS-Europe tools. The subsequent work followed up in the intervening deliverables has hopefully helped to fill some of these gaps. In addition, WP4 conducted a few additional activities that emerged from or were related to the development of the tools. They are also described in this deliverable.

We have identified actions and practices that could serve as drivers for better management, publication and sharing of research and research data. They have been captured as recommendations for implementation. Also, several important lessons learned that can be of use to developers of tools and services in the field of open science are provided at the end of the document.

1. Overview

This deliverable is part of Work Package 4 (WP4) of the NI4OS-Europe project and related work in support of ORDM and FAIR. D4.8 concludes the reporting on the three NI4OS-Europe tools:

a. The License Clearance Tool (LCT) aims to facilitate and automate the clearance of intellectual property rights (IPR) for resources (data, software, content, fonts, etc.) that need to be cleared before being published under an open licence. LCT helps users select a compatible licence, taking into account the licences of their inputs, and suggests a list of compatible licences to the user after an automatic compatibility check. The tool is open to guest users, but a user can register with the tool and keep track of already conducted clearances. The target users are primarily researchers and research institutions.

b. The EOSC RoP Legal & Ethics Compliance Tool (RoLECT) aims to facilitate the assessment of the legal and ethical compliance of a resource (e.g., a service) based on the EOSC Rules of Participation (RoP). RoLECT prepares potential providers to comply with the legal and ethical measures required by the EOSC RoP, which they must meet as EOSC providers. Legal and ethical aspects require special attention due to their complexity and have not yet been adequately addressed by other FAIR-related tools. The target users are the providers of scientific resources.

c. The Repository Policy Generator (RePol) tool helps users create and maintain comprehensive, clear and machine-readable repository policies and privacy policies for online services. The policies created are formulated in line with current best practices related to FAIR, preservation, licensing and privacy regulations like GDPR. It can be easily customised to create other types of policies. The target users are repository owners and administrators and those who need to create and manage privacy policies for services.

All three tools have been onboarded to the NI4OS-Europe Agora catalogue and EOSC Marketplace and made available to the other repositories and services in the NI4OS-Europe partner countries and beyond.

Since their first releases, the tools have been continuously updated based on user feedback and consultations with external testers. All tools have a simple and self-explanatory wizard-based user interface. Their development is described in the corresponding version histories available on the tools' NI4OS-Europe Wiki pages.

The source code of the tools is licensed under the terms of the European Union Public License, Version 1.2 or later (SPDX code: EUPL-1.2-or-later).

1.1. Evaluation and feedback

WP4 aims to understand the true value of its services to users in terms of product usability, flexibility and features. This will help maintain and improve the tools. The main reasons for conducting this evaluation are to gain insight into each NI4OS-Europe application to understand where it can be improved, what aspects users value, how they

resolve issues using the support forms or technical manuals, to understand user loyalty, and to potentially gather information on what competitors are doing differently to keep their respective users engaged in terms of application features, requirements, cost, and other aspects.

The main aspects that are critical for evaluation, tools maintenance and sustainability can be illustrated by the Figure 1.

Figure 1: Tool evaluation strategy and other key tool aspects

What are we evaluating?

The WP4 evaluation strategy has been drafted to evaluate three web applications developed by consortium partners as part of the NI4OS-Europe project to establish certification standards, tools, and mechanisms for open research data management and data repository certification systems and to support EOSC.

How do we evaluate?

The evaluation process follows four parallel pathways that provide an overall evaluation for each tool. These pathways are intended to capture different aspects of the early life of the tools and the engagement of different audiences.

The evaluation strategy for the WP4 tools, or elements of it, including the questionnaire developed for the structured survey and the opportunity to collect feedback on an ongoing basis, may also be adopted by other NI4OS-Europe services if a similar need arises.

Online questionnaire

Our primary method of collecting data has been an online questionnaire to capture user experiences, sentiments, and expectations. This is a flexible solution that can be presented and accessed via numerous forms of communication (emails, chat, blog posts, social media, etc.) and therefore allows for a higher response rate. In addition, it gives the possibility to change things centrally as needed without having to re-set the forms.

Given the focus, goals, and functionalities of the three tools, a common questionnaire was designed that can serve them all and has been made available online [9].

All partners, and especially WP4 partners, were asked to provide at least one review for each WP4 tool, even if they have already tested some of the tools and provided feedback by other means. Each partner was also asked to reach out to stakeholders in their country and collect a total of at least 5 completed questionnaires, with at least one response covering each tool.

The questionnaire does not collect any personal or site-specific data, and no such data is stored anywhere.

The unified survey structure developed for the WP4 tools is provided under the Creative Commons CC0 1.0 Universal Public Domain Dedication. The collection of survey answers can be customised as needed by adding additional questions or by simply using the provided structure as an example. In WP4, the phrased questions can be easily reworded or adapted to improve their clarity for the specific tool or its context but should remain generally applicable and comparable between tools.

Feedback during and after the events

Dedicated online training events for the tools have been organised during which participant comments were captured. Additionally, the online questionnaire was offered at the end of each event.

Targeted interviews

Targeted interviews have been conducted to gather expert opinions on the tools. Experts related to the context of each tool were approached to schedule interviews which included guided walkthroughs. The tools' features and purpose were discussed and the experts' comments and recommendations were recorded. One such interview was conducted for each tool.

Process and timeline

The collection of feedback and targeted interviews with representative users started as soon as each tool was operational and usable for its primary scenario and without major anomalies, i.e., from September 2020 for LCT, February 2021 for RePol and March 2021 for RoLECT. It became clear that a more systematic approach would be needed and the evaluation strategy described here was formulated internally in October 2021. Once the common feedback form for the tools was finalised, it was integrated into all three tools

and a four-month campaign for feedback from NI4OS-Europe countries was launched in December 2021. This form continues to be available to users of all tools. In parallel, training events, interviews and some additional 'guest' presentations at other related events were organised. Training materials were developed on the NI4OS-Europe training platform between January and March 2022. Feedback collection in various forms and promotion of the tools will continue, with some events planned for February 2023.

Use of evaluation results

Evaluation results are collected and processed to provide information for the development of tools. In addition to planned features and updates to existing features, these results will help determine future fixes, patches, streamlining, and tool redesigns. These assessments are useful in planning the sustainability of the tools, as many of the considerations provide helpful guidance on the understanding and expectations but also help in planning and organising maintenance and support for the tools.

1.2. Sustainability

A more detailed sustainability analysis of all three tools can be found in D7.7 [10]. All tools are well positioned to be further used and developed in the coming years as they have become relevant and gained traction beyond NI4OS-Europe and even Open Science. LCT has attracted considerable interest in the broader IPR community, as seen at the 2022 European Intellectual Property Teachers' Network (EIPTN) conference; RoLECT has the opportunity to become an important element in the EOSC adoption strategy for its Rules of Participation; RePol has also been instrumental in the development of at least one NOSCI's overarching repository policy and privacy policies of the Serbian NREN AMRES and the University of Belgrade, which is way beyond its originally intended purpose. For completeness, summaries of the D7.7 [10] sustainability analyses for individual instruments are included separately in this document for each tool.

2. License Clearance Tool (LCT)

Access to the tool	https://lct.ni4os.eu/
EOSC Marketplace link	https://marketplace.eosc-portal.eu/services/license-clearance-tool-lct
NI4OS-Europe dashboard	https://catalogue.ni4os.eu/?_=/resources/6035f6c6-aa2e-4563-b9df-23b75a4b94b0
GitHub repository	https://github.com/ni4os-europe/license-clearance-application
Documentation and architecture	https://wiki.ni4os.eu/index.php/License_Clearance_Tool_-_Description_and_Documentation
Video usage guide or demo	https://wiki.ni4os.eu/index.php/File:Lct_demo.mp4
EOSC Success Story article	https://eosc-portal.eu/enabling-maximal-re-use-data-while-ensuring-ipr-compliance https://zenodo.org/record/7322305
NI4OS-Europe training course	https://training.ni4os.eu/mod/scorm/view.php?id=1126
Detailed user manual	https://lct.ni4os.eu/files/lct-manual.pdf

2.1. Summary

LCT helps users determine the legal boundaries that exist with a particular asset that contradict the principles of fairness, accessibility, interoperability and reusability (FAIR) and hinder the free or regulated distribution of the asset in the Open Science ecosystem. LCT offers a solution to the challenge of considering legal aspects in FAIR and Open Research Data Management. It is thus primarily intended to support researchers who are not legal experts to publish in FAIR /open modes and facilitates knowledge sharing between research communities and attribution of the author's work.

The tool covers 73 existing standard and most widely used open source licences and can therefore meet most of the needs of non-rights experts in terms of licence sharing and IPR for different types of resources. Finally, LCT is designed to be extensible and there are plans to include crowdsourced clearance options for custom licences in the future that would otherwise require the input of a legal expert.

LCT provides a user-friendly web interface that allows users to efficiently refine the rights on their work and receive a clearance report with all the information provided, highlighting the licence under which the resource is published. It is a tool that can be used "stand-alone" to perform resource clearance as part of research activity, but it can also be integrated as a necessary step during the EOSC onboarding process. LCT is

available to both guest and registered users and uses NI4OS' AAI authentication service to authenticate its users.

LCT is in production (TRL9) and available through the EOSC Marketplace and the NI4OS-Europe catalogue.

2.2. Sustainability

LCT is a technical licensing tool that helps users without legal knowledge or background to clear the IPR rights for their resources. It is easy to use and minimises the costs associated with conducting the licence and copyright clearance process. ATHENA RC aims to maintain and continue developing the tool in the coming years, as users have expressed interest in using it. Further development of the tool is currently being explored to support additional licences besides the 73 open source licences already supported.

LCT has been designed and developed in an extensible way to support additional licences and questions in the clearance wizard. This approach minimises maintenance costs, facilitating its sustainability and availability.

3. EOSC RoP Legal & Ethics Compliance (RoLECT)

Access to the tool	https://rolect.ni4os.eu/
EOSC Marketplace link	https://marketplace.eosc-portal.eu/services/eosc-rop-legal-ethics-compliance-tool-rolect
NI4OS-Europe dashboard	https://catalogue.ni4os.eu/?_=/resources/6dce115e-7063-4e56-9bb2-ade16a4ce690
Documentation and architecture	https://wiki.ni4os.eu/index.php/EOSC_RoP_Legal_%26_Ethics_Compliance_-_Description_and_Documentation
Video usage guide or demo	https://wiki.ni4os.eu/images/0/0c/Rolect-demo.mp4
EOSC Success Story article	https://eosc-portal.eu/supporting-implementation-and-adoption-eosc-helping-resource-providers-verify-legal-and-ethics https://zenodo.org/record/7179972
NI4OS-Europe training course	https://training.ni4os.eu/mod/scorm/view.php?id=1178
Detailed user manual	https://rolect.ni4os.eu/files/rolect-manual.pdf

3.1. Summary

The RoLECT tool was designed and developed as a self-assessment tool to facilitate the monitoring of a resource's compliance with the EOSC, with a focus on the legal and ethical rules of participation. Legal experts did detailed work to map the EOSC rules into different questions divided into nine categories. The technical team used these questions and their interrelationships as the basis for designing and developing a pluggable and customisable tool that guides its users step by step through the most important aspects of what they need to establish before including their resource data or service in the EOSC. The result of the self-assessment is an automatic PDF report with indications of the importance of each question concerning the EOSC RoP. Users can use this information to take the necessary mitigation action.

The application works either in guest mode or via external user authentication for (NI4OS-Europe AAI or social login). The latter provides additional features such as saving draft assessments, the ability to continue and complete previously started assessments, copy an existing assessment into a new one, and access to assessment history.

The NI4OS-Europe team is responsible for the content development of RoLECT, closely follows all related discussions within the EOSC Association and actively participates in the RoP Task Force. The tool is dependent on the EOSC RoP and has therefore been

designed to be dynamic in terms of questions and their linkages to easily adapt to any changes. To achieve this, the wizard is modelled using a custom schema in JSON format and dynamically loaded by the front-end application, which does not possess any hardcoded knowledge of the actual questions or rules. This allows RoLECT to be adapted whenever the RoP change and increases the sustainability of the tool.

A detailed end-user guide and technical information are available to assist RoLECT users in using the tool, while a dedicated contact page was set up for direct communication.

RoLECT is a tool that has been understood from the beginning as a solution to support EOSC. It has been designed and implemented as a tool that specifies the requirements provided in the EOSC RoP and helps to verify compliance with the legal and ethical parts of the RoP. RoLECT is thus directly linked to the EOSC ecosystem and activities. It is aimed exclusively at EOSC resource providers and helps to enrich the EOSC ecosystem with new resources by encouraging resource providers to overcome legal and ethics-related barriers.

RoLECT is currently at TRL9 and is available through the EOSC Marketplace.

3.2. Sustainability

The current version of RoLECT completes the related work within the NI4OS-Europe project. It comprises four distinct but interacting components: user management, data management, conformance checking and the configurator, which supports the dynamic updating of RoLECT's sections and questions to create a sustainable tool that can be easily adapted to future updates and extensions of the EOSC RoP.

The tool has reached a high level of maturity, both in terms of technical development and legal analysis of the RoP. The development team closely follows all discussions and progress on the EOSC RoP, as RoLECT is highly dependent on the related processes. Participation in the EOSC RoP Compliance Monitoring Task Force and monitoring of the outcomes of the other groups will inform future updates and releases of RoLECT as required. In addition, future updates are envisaged based on end-user feedback, not only on the actual assessment questions but also on the other features and usability.

Whether RoLECT will become part of the official EOSC certification mechanisms and schemes in the future remains to be seen, as the landscape in this regard is still nebulous. It certainly has that potential, but that depends largely on factors outside the NI4OS-Europe consortium. In any case, in its business model and sustainability plan, the team is currently considering all of the above options.

4. Repository Policy Generator (RePol)

Access to the tool	https://repol.ni4os.eu/
EOSC Marketplace link	In publishing from NI4OS-Europe Agora
NI4OS-Europe dashboard	https://catalogue.ni4os.eu/?_=/resources/0c27f89f-7ec8-49a9-b5c1-f38ba1fddae5
Documentation and architecture	https://wiki.ni4os.eu/index.php/RePol
Video usage guide or demo	https://wiki.ni4os.eu/images/2/2c/RePol_Demo-With_subtitles.mp4
EOSC Success Story article	https://eosc-portal.eu/supporting-data-trustworthiness-using-repository-policy-generation-tool https://zenodo.org/record/7434224
NI4OS-Europe training course	https://training.ni4os.eu/mod/scorm/view.php?id=1189
Detailed user manual	https://wiki.ni4os.eu/index.php/RePol

4.1. Summary

A trustworthy repository should have a transparent policy that informs users of the roles, responsibilities, rights and procedures to ensure that their deposited data is preserved and disseminated following the principles of FAIR and Open. A repository policy is required to include scientific repositories in the NI4OS-Europe and EOSC service catalogues.

The specifications and exchange of metadata for repositories have already been largely defined within OpenAIRE, EOSC Enhance, EOSCpilot and FAIRsFAIR. At the same time, it has been gradually established that each repository should have a clear policy describing its operation and what users should expect when they decide to use it. Formulating these decisions and writing a comprehensive repository policy, if taken seriously, seemed to be a major problem for repository owners and managers. The existence of service policies, and in particular privacy and repository policies, is required for services in the EOSC Marketplace, increasingly expected by end users, mandated by regulators and assessors, and required for service certification. They also describe a set of rules and practices that must be established and enforced by management, repository administrators and technical staff. Because the elements of the policies are directly dependent on decisions about how to manage the repositories and the options available are limited, the design of a policy can be largely automated. For this reason, the University of Belgrade Computer Centre (RCUB) has decided to provide a tool to facilitate key decisions and policy document design.

RePol – Repository Policy Generator is an open source web application that helps users create and maintain a comprehensive and clear repository or privacy policy. The privacy policies generated are suitable for any type of online service. A step-by-step wizard and self-explanatory forms guide the user through the policy creation process. By selecting the available options, the user designs a policy document with clauses formulated in line with current best practices. With the resulting policies, the resource owner can more easily adapt the service to meet the requirements of the General Data Protection Regulation (GDPR), as well as the requirements for onboarding and participation in open science infrastructures.

The document created can be downloaded as an XML file and additionally customised or edited before being published with the service or repository. The individual policy elements are provided in a machine-readable format that enables automated interpretation of the created policies and extraction of metadata through registries, catalogues and various operational, data discovery and workflow tools.

RePol specifically aims to support service owners in meeting the requirements for participating and joining EOSC. This extensible web application can be configured to generate any type of policy document due to the versatility of its configurable forms and document templates.

NOSCIs and infrastructure operators can decide, as Croatian Croatian Open Science Cloud Initiative (HR-OOZ) has done, not to use RePol to create individual repository policies but to create one overarching policy for all repositories in their community. Similarly, the University of Belgrade and the Serbian NREN AMRES have used RePol to create seed texts for their privacy policies by creating policies that can be applied to their typical repositories or services and then customising them. However, this introduces additional complexity in terms of approach and scope – for example, in how to express the permitted options and variations, or whether the individual sub-policies are expected to be stand-alone documents or merely declarations of options selected from the overarching policy. This affects the whole policy text and turns single choices into several alternatives offered to various services. It was therefore decided not to directly support such higher-level policies as this would greatly complicate the existing choices and templates.

RePol is in production (TRL9). It is available through the NI4OS-Europe Agora catalogue.

4.2. Sustainability

RePol has a clear and direct utility. It helps people and organisations to more easily create and manage comprehensive policies for their services and bring them in line with evolving standards. Target audiences include owners and operators of scientific repositories and other online services, as well as the creators of the relevant institutional policies. Currently, RePol supports two types of policies but can be easily adapted for other policies with a defined scope and structure. At the same time, its use leads to decisions about the most important aspects of service governance. It prompts the definition or use of established machine-readable policy descriptors.

These uses and the versatility of RePol ensure that RePol will continue to be used and maintained after NI4OS-Europe, continuing its current good visibility and use. The key

features supporting sustainability are its relative technical simplicity (no user data is persisted) and the high degree of flexibility and extensibility achieved through the use of XML configuration files designed for human editing. Because of its open source licence, RePol can be extended by any subject interested in reusing or adapting it.

UoB-RCUB has committed to maintaining RePol for at least the next six years, as it uses this tool to maintain policies for its services, which currently include 35 repositories. The main potential risks to this maintenance are the potential loss of organisational capacity to manage ICT services and their policies, the build-up of technical debt and associated technological obsolescence.

5. Supporting activities

5.1. Brochure on rewards and incentives

The deliverable D4.1 "Incentives and rewards for supporting ORDM and FAIR" [6] is not a technical tool but a set of recommendations and practices to be implemented at all levels by all stakeholders in the science and research environment. There are guidelines for researchers, research organisations, funders, policymakers, journal editors and libraries. This document was reported on at national OS events such as the PUBMET conference [11], but it became clear that its message should be made more accessible. A visually appealing follow-up brochure summarising the findings was therefore produced. This brochure is translated into local languages by the project partners' translation officers as part of WP6 and is available on the NI4OS-Europe website.

D4.1 Incentives for Supporting ORDM and FAIR	https://zenodo.org/record/3736148
"Incentives and Rewards for ORDM & FAIR" brochure in English	http://ni4os.eu/wp-content/uploads/2023/02/NI4OS_RI_ORDM__web__EN_single_pages.pdf
Versions in NI4OS-Europe languages	https://ni4os.eu/incentives-and-rewards-for-ordm-fair/
Survey on incentives and rewards	https://survey.lib.irb.hr/q/index.php?r=survey/index&sid=246548

Both documents were used by researchers from one of the partners to further elaborate on the topic in a national scientific journal article [12].

A survey for feedback on the brochure has also been designed and will be distributed to partners and readers of this document. Comments received by the end of the project will be analysed, summarised and shared so that the NRENs and policy-makers could consider them while developing the incentives and rewards related to open science. In the coming period, the survey will be periodically checked for new responses and relevant updates will be shared within the NI4OS-Europe network.

By collecting feedback on the brochure, WP4 is applying and adapting the approach used to evaluate and improve its three tools. Some informal comments have already been received: partners commented that the described instruments are appropriate, realistic and useful for developing effective instruments supporting the practising of open science. The brochure was recognised as an appropriate tool for communicating with national and organisational stakeholders who often declaratively support open science but do not define and implement specific supporting instruments, evaluation criteria and metrics. Moreover, the incentives and rewards described are a welcome complement to the principles espoused in the Declaration on Research Assessment (DORA) [13], and

the Agreement on Reforming Research Assessment of the Coalition for Advancing Research Assessment (CoARA) [14]. NOSCIs and research organisations and other subjects can also sign these declarations to additionally advocate for the adoption of the incentives and rewards at national and organisational levels and by research funding and evaluation organisations.

The importance of these incentives and rewards has been recognised by WP2 activities and deliverables (e.g., in D2.5 "Business models recommendation" [15]), and the findings and recommendations of D4.1 are taken into account. However, their adoption is hampered by the complexity of their implementation and funding issues. Indeed, NOSCIs and policymakers should establish direct requirements, plans, incentives and funding schemes for FAIR principles and communicate these to funders and stakeholders. Additional efforts should be made to identify cost categories related to FAIR and make them available for funding. Adopting guidelines related to FAIR principles and ORDM will contribute to their systematisation and recovery of actual costs.

5.2. Hybrid hands-on workshop on open source, software tools and services management

The "Hands-on workshop: Touching on Data and Open Source Software for Open Science" was organised by the UoB, RBI and SRCE on 30 November and 1 December 2022. It was held online for remote participants, while participants from Belgrade and Zagreb met in person at UoB and SRCE. The main topics covered were:

- Use of open source software in science.
- Development and provision of tools and services for open science.
- Developing and improving FOSS research software or a service and increasing its reach.
- FOSS licence selection: evaluation and related improvements and recommendations for developers.
- Quality and improvements of data on services and resources.
- Improving research and researcher data.

The organisers initially prepared the event as a hackathon. Most of the first day was dedicated to the presentation of the topics covered and related questions and discussions. The second day was intended for working in groups, but the interest was so great that it was not feasible to continue in the hackathon format: 147 people registered and about 90 people participated physically or remotely. On the other hand, not many remote participants showed interest in working in groups on the second day, while some were attracted by the topics and wanted to talk more about their work, show what they did and in which way, share their experiences and hear advice and opinions from the facilitators. To maximise the number of participants who would stay for the second day, the organisers decided to change the format and continue in a joint session where the flow was driven by community volunteers and supplemented by comments and more detailed presentations from facilitators and mentors originally recruited by the organisers. This effectively turned the event into a 'clinic' on FOSS and scientific software.

The work on this workshop also resulted in extensive preparatory materials that could be reused in planning and organising similar workshops or even as a blueprint for other hackathons related to open science.

Initial information about the event	https://ni4os.eu/hands-on-workshop-touching-on-data-and-open-source-software-for-open-science/
Registration and pre-workshop survey	https://events.ni4os.eu/event/85/
Survey results	https://wiki.ni4os.eu/images/7/79/Survey_Results_-_Hands-on_workshop_Touching_on_Data_and_Open-Source_Software_for_Open_Science_%C2%B7_NI4OS_%28Indico%29.pdf
Materials on workshop organisation and outcome	https://wiki.ni4os.eu/index.php/Hands-on_workshop_on_FOSS_and_tools

Opinions about open source software in science

The pre-workshop survey was answered by 63 people. The most interesting finding from the data collected is that in terms of the relationship between open science and open source software, participants agreed most strongly with this statement (with an average agreement score of 4.73):

- Researchers would benefit from more open source software in science.

These three statements follow each other closely and rank almost equally (with values of 4.65, 4.65 and 4.60 on a scale from 1 to 5):

- Research funders should provide better support to open source software and its adoption.
- Researchers would benefit from more training on open source software.
- Software developed during the research should be open source.

When asked about reasons for using open source software, participants primarily chose the three reasons that combine practical and aspirational attitudes:

- I can use it without buying it or paying for licences. (20.87%)
- Open source software assists and enhances open science. (20.00%)
- I agree with its principles and development model. (15.65%)

Other reasons (circumventing bureaucratic obstacles, previous use during academic training, community use, and maintainability) were each given by about 11% of participants.

5.3. Report with recommendations on FOSS in open science

Work on a report with information and recommendations on FOSS for researchers, providers and developers in OS was carried out to support the preparation of the

workshop, record some conclusions from the survey conducted before the workshop and offer supporting material on its main subject. The result is the document:

Report name	Software and free and open source software in open science
Web address	https://wiki.ni4os.eu/index.php/Software_and_free_and_open_source_software_in_open_science

The first part of the document deals with software in science, with separate consideration of FOSS and open science. More specific details about the use of software in OS practices, the actual software used and the attitude of researchers are provided and discussed based on the recent SOSP-FR report [16]. Resources for finding research software are recommended. This is accompanied by an illustrative description of tools for the social sciences. This topic is concluded with recommendations for supporting FOSS adoption and software development and visibility in (open) science.

The second part deals with FOSS licences, listing the most commonly used ones and describing their benefits and types, differences between various licences, copyrights, patents, warranties and other related restrictions and rights. Source-available and 'fauxpen' licences and related concepts of contributor agreements and relicensing and associated issues are also discussed.

The section on FOSS licence management covers licence selection, compliance and compatibility, licence impact on the community, software quality, longevity and sustainability. It concludes with an overview of the licence management process and suggestions for software composition analysis and licence selection tools.

The guidance on reporting open source technologies within NI4OS-Europe Agora was developed based on the content of this catalogue from July 2022. It details further the original description of the field ERP.MTI.5 in the EOSC Portal Profiles specification [17] and recommends a more comprehensive and machine-parsable documentation scheme. To facilitate the delivery of all these elements, it suggests exemplary names, licences, URLs and usage descriptions of FOSS products and components most frequently mentioned in Agora. It also includes suggestions for software components for DSpace-based repositories for cases where there are available alternatives. WP5 has combined this guidance with other data improvement recommendations and distributed them to the NI4OS-Europe resource providers. They are currently updating this information for their resources.

6. Conclusion and recommendations

Within the NI4OS-Europe project, we have identified actions and practices that could serve as drivers for better management, publication and sharing of research and research data. We would like to capture the recommendations for implementation in the partner countries, which also highlight the barriers and obstacles that need to be overcome. We also provide brief reflections on how we have tried to contribute to solving these problems.

- The use of FOSS in science, the application of FAIR to software, and the legal and ethical aspects of scientific services and research tools need to be more widely considered, streamlined and supported by open science stakeholders. The NI4OS-Europe tools and supporting WP4 activities have specifically addressed these concerns.
- Service, data protection and privacy policies, details of operational, legal and aspects such as EOSC compliance, certifications and fulfilment of specific requirements, and the use of open source by tools and services should become machine-readable to the extent that these resources can be seamlessly inserted into scientific and operational workflows. This requires the creation of machine-readable descriptors that can be used to automatically match resources and validate their compatibility and suitability for the joint fulfilment of research and management tasks. Mapping the concerns addressed by the NI4OS-Europe tools to decisions and options provides a good working set of elements for such standardisation.
- In open science, it is recommended to use open source software tools that are freely available and accessible to all. These include tools for data analysis, visualisation and management, as well as tools for collaboration and communication among researchers. The tools developed by NI4OS-Europe are freely available and open source.
- Researchers and decision-makers need to be educated about the benefits of open source software for open science by receiving appropriate training and support. Researchers should be offered incentives such as funding, recognition and career advancement to encourage them to use and contribute to open source software. NI4OS-Europe contributed by organising a workshop and developing extensive material on the use and development of FOSS software and tools.
- The use of open source software that adheres to open standards promotes interoperability and facilitates the sharing of data and resources with others. It is also important to document software and its use so that other researchers can understand and use it. The NI4OS-Europe tools are well documented, have been implemented using industry and usability standards, and embody conceptual models that could be used in the development of policy description and compliance standards.
- High-quality research software can only be achieved through the joint work of researchers, developers and supporting specialities, interdisciplinary collaboration, partnerships between academia, industry and governments, and the participating and contributing community to ensure its continuous improvement and relevance. This also requires improving skills, capacities and

awareness, such as software governance skills among researchers, open science awareness among developers and soft skills among both groups. The work of NI4OS-Europe, and in particular the work on WP4 tools, is an example of such an approach.

Several important lessons that can be of use to tools and services developers have been learned during the development of WP4 tools:

- Researchers, policy developers and service operators love tools as a good way to encapsulate knowledge and rules and the means to achieve greater productivity and more consistent results. It is therefore relatively easy to encourage them to solve some procedural, organisational, legal and policy problems that would otherwise be much more difficult for them to solve or begin to deal with.
- Tools need to be as simple and accessible as possible and maximise the benefits-to-effort ratio; otherwise, users would quickly turn away. Try to cut out all unnecessary details from the interaction with users. Less is more.
- For a tool to be used, it needs to create a buzz in the community by being mentioned at relevant events and covered in webinars, presentations and training. These promotional activities will result in an authentic online presence and amalgamation of the tool with the topics it intends to address.
- For the tool to meet user expectations and remove barriers to use, user feedback needs to be collected continuously and responded to appropriately.
- The designers, developers and promoters of the tool need to seek and exploit all available opportunities for broader or expanded use and be ready to recognise and embrace emerging opportunities and adapt their attitudes and the tool accordingly.
- The developers and analysts working on the tool should engage in other related activities by participating in related task forces and supporting or developing standards and guidelines for the tool's target area. This will help them systematise their knowledge, acquire additional expertise, improve the tool, increase its credibility and establish a reputation as subject matter experts.
- Sustainability is difficult. All of the above help to maintain momentum, but long-term sustainability needs to be considered and addressed at every stage of the tool lifecycle.