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National Initiatives for Open Science in Europe

Deliverable D7.7

NI4OS-Europe Sustainability Report

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Abstract: Deliverable D7.7 – Sustainability Report – describes project activities and outcomes produced between 1 September 2019 and 28 February 2023, highlighting the contribution NI4OS-Europe made to the EOSC governance to achieve the vision of EOSC, to implementation of collaborative research standards in Europe. The sustainability of project outcomes is described based on a three-pillar approach: EOSC-level key exploitable results, national or local-level key outputs and others.

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List of Acronyms

AAI	Authentication and Authorization Infrastructure
AARC	Authentication and Authorization for Research and Collaboration
API	Application Program Interface
CMDB	Configuration Management Database
EC	European Commission
e-IRG	e-Infrastructure Reflection Group
EOSC	European Open Science Cloud
EU	European Union
FAIR	Findable, Accessible, Interoperable, Reusable
ICT	Information and Communication Technologies
IT	Information Technologies
KER	Key Exploitable Result
LCT	License Clearance Tool
MVE	Minimum Viable EOSC
NOAD	National Open Access Desk
NOSCI	National Open Science Cloud Initiatives
OS	Open Science
OSC	Open Science Cloud
R&D	Research and Development
R&E	Research and Education
RDA	Research Data Alliance
RDM	Research Data Management
RePol	Repository Policy Generator
RoLECT	EOSC RoP Legal & Ethics Compliance
RRI	Responsible Research and Innovation
SMEs	Small and Medium Enterprises
TNC	Transnational Cooperation
TRL	Technology Readiness Level

Executive summary

What is the focus of this Deliverable?

The Deliverable 7.7 Sustainability Report provides information on the perspectives of Key Exploitable Results (KERs) established within the NI4OS-Europe project. As the project ends in spring 2023, this document focuses on how the results can be sustained or integrated into other activities.

This report has the following objectives: (1) assesses the progress of the implementation of results, (2) outlines further steps to maintain the presence of the region in the European Open Science Cloud (EOSC) landscape, and (3) outlines the benefits of Open Science to the region's scientists and societies. This report does not include reference to all project outputs delivered during the project lifetime, but only to those that might be practical to sustain long-term both at EOSC and national or local level. NI4OS-Europe results may be used as building blocks for future projects, regarding topics such as Open Science awareness raising, governance, OS and FAIR training, and onboarding services to EOSC.

The D7.7 report contains a summary of major project outputs and provides insights into their practicality and application possibilities. This document examines opportunities to sustain the intellectual outputs produced in the project's lifetime. As the planned results of the NI4OS-Europe project are delivered, the next step is to find ways to maintain these results for the future.

What are the deliverable contents?

In this report, first, we define the aims of the NI4OS-Europe project as a key supporter of EOSC. We summarise the main NI4OS-Europe project activities that are aligned with the 14 action areas, that were previously defined for EOSC. The focus will be on those five action areas in which the NI4OS-Europe participates. The inventory of project outputs, previously defined as KERs, and all other outputs of the project that partners plan to sustain further, can be viewed in Appendix A.

The Sustainability Methods chapter is based on the sustainability solution using a three-pillar structure.

In the Market Positioning chapter project outcomes are presented in relation to EOSC as a research environment. Followed by the Sustainability of Project Outputs chapter, which describes KERs in detail, recommending solutions for further use. In the next chapter, we take note of challenges regarding the long-term preservation and future maintenance of services and tools, and possible developments of the NI4OS-Europe project outcomes. Finally, we give a summary of the report.

Conclusions and recommendations

This report explains sustainability solutions for NI4OS-Europe project outputs. Since the sustainability of NI4OS-Europe follows a three-pillar structure, methods are described accordingly.

During the execution of project results, partners always considered user feedback, finetuning the goals to meet the needs of the user-communities.

1. Introduction

The NI4OS-Europe project aims to be a core contributor to the EOSC service portfolio, commit to EOSC governance and ensure inclusiveness on the European level. The objective of the project is to support the development and inclusion of the national Open Science Cloud initiatives in 15 Member States and Associated Countries in the overall scheme of EOSC governance; spread the EOSC and FAIR principles in the community and train it; and provide technical and policy support in on-boarding of the existing and future service providers into EOSC, including generic services (compute, data storage, data management), thematic services, repositories and data sets – thus covering the whole spectrum of services related to Open Science, data and publications.

The NI4OS-Europe project contributed to the vision of EOSC for a collaborative European research environment, with outputs that were selected and prioritised due to their high potential. The selected results have key benefits for all the stakeholders. These outputs are referred to as Key Exploitable Results (KERs) [8] in this report. These results can be defined on three different levels: EOSC level, national or local level, or other. They are also divided into more subcategories, detailed in chapter 2.

This report describes which project activities and outputs should be preserved long-term and discusses which results may be channelled into EOSC for further development. One of the main goals of EOSC is to provide FAIR access to research outputs through an interoperable infrastructure. The NI4OS-Europe project is one of the top supporters of EOSC, which offers researchers of Europe a virtual environment to store, share and re-use their data across disciplines and geographical borders, and provides an environment for European researchers to do collaborative research.

The European Open Science Cloud governing bodies [3] have identified fourteen action areas to help deploy the EOSC ecosystem. The NI4OS-Europe project activity is connected to the following areas.



Figure 1: Action areas defined by EOSC governing bodies, that NI4OS-Europe participates in

All project outcomes and KERs are part of the five action areas. Moreover, the six chosen KERs support making Open Science a reality and implementing the guidelines for FAIR data management.

The document is structured based on the five action areas defined by EOSC governing bodies, focusing on the activities NI4OS-Europe carried out. In the Sustainability methods section, we describe the sustainability of the chosen KERs, aligning the method with the previously defined sustainability plan.

2. Sustainability methods

The project goals and activities lead to results that vary in structure and purpose therefore a unified methodology could not be used to achieve long-term preservation and continuous support to maintain and improve services for user communities. Sustaining NI4OS-Europe project results requires a customised approach, aligned with the purpose of the given result. Furthermore, different approaches have to be considered if the results are planned to be sustained at the EOSC level, national or local level. For other project outcomes, such as the website and project deliverables, it is relatively easy to apply a methodology for sustainability. These results will be archived and provided permanent access to a multidisciplinary repository. The website will be accessible, but not updated after the closing date of NI4OS-Europe. The exact levels of the three-dimensional sustainability method can be viewed in Figure 2.

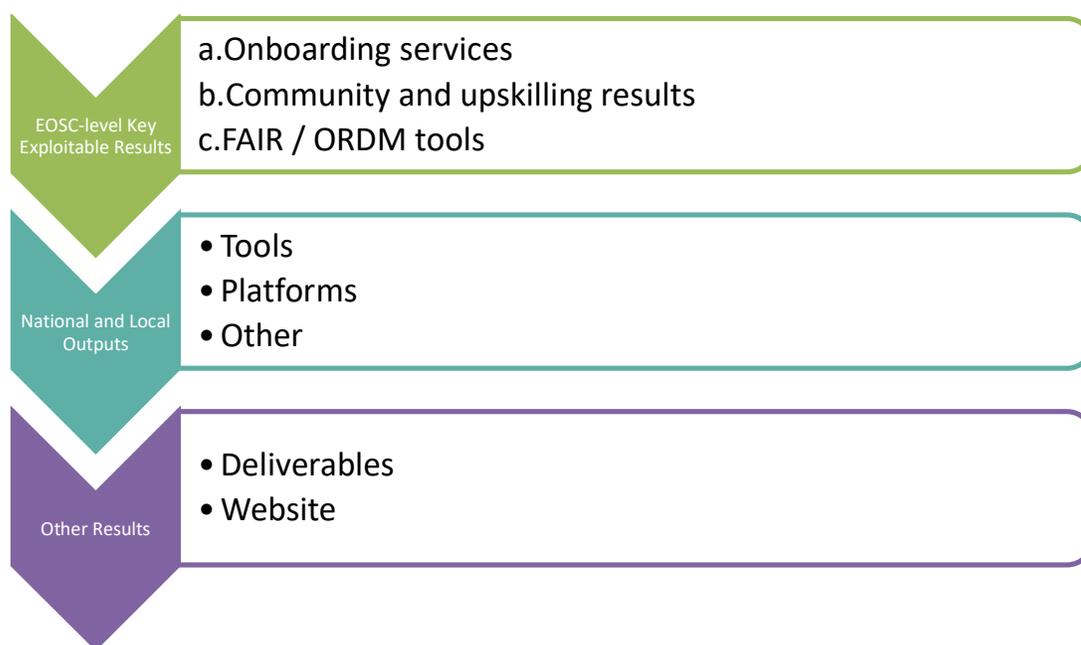


Figure 2: Three-pillar structure of sustainability

The description of each KER includes a brief overview of the given output, shows the TRL status, where possible, investigates whether the result needs to be sustained, how it can be sustained, and also defines the possible target communities [1]. This method is supplemented with the name of the partner institution(s) for National or Local Level Key Outputs.

During the project period, partners collected and evaluated feedback from user communities on all project activities, such as dissemination events, tools, NOSCIs or the Training Platform. The feedback from different user groups helped us to align the project outcomes with user preferences. Different surveys were created for different outcomes to gather information on possible improvements, and actions were taken to adjust the services and activities based on the inputs of users, for greater success.

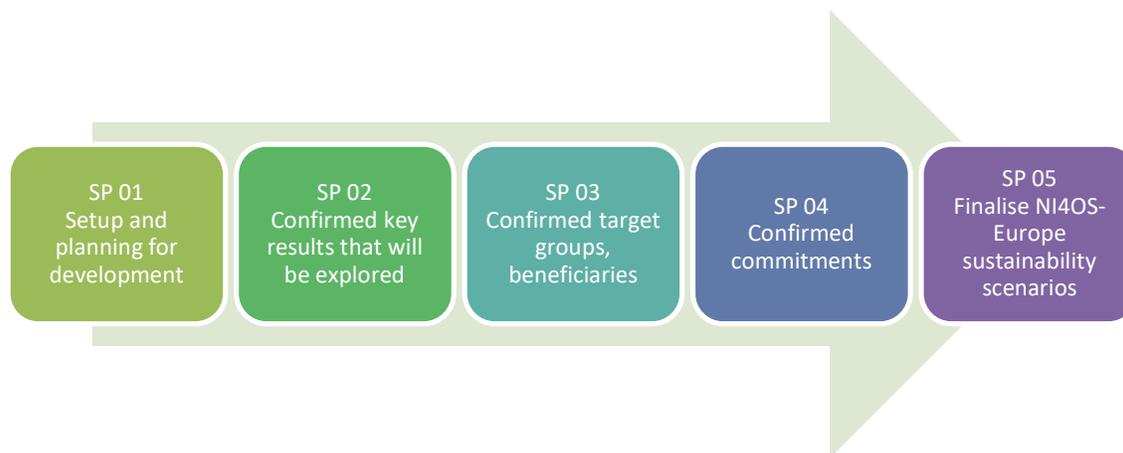


Figure 3: NI4OS-Europe sustainability process

The project is currently in phase 5 of the sustainability planning process, finalizing the sustainability scenarios. Having completed the previous four phases of the process, a solid ground has been created to build and expand contributions to EOSC. The activities that took place in each phase for the phases are described in Table 1.

Table 1: NI4OS-Europe sustainability process phases

Sustainability process phase	Activities
SP01: Setup and planning for development	To identify and determine project results that could be further exploited and sustained and plan development the following actions were completed: <ul style="list-style-type: none"> • monitored ongoing activities to determine which ones could be exploited. • identified collaborations related to sustainability platforms. • identified key project results that could be further exploited.
SP02: Confirmed key results that will be explored	<ul style="list-style-type: none"> • On the grounds of D2.1 – Stakeholder map, inventory and policy matrix landscaping study and the insights gained on the status of OSC initiatives, infrastructures, services, policies, stakeholders, and topics in partner countries, activities were initiated in the following areas: • networking activities (policy support, training, and marketing) • service-oriented activities focusing on on-boarding services and service maintenance (on-boarding platform, pre-production environment).

	<ul style="list-style-type: none"> FAIR, ORDM and EOSC-supporting tools development activities focusing on data standards, processes, certification and IPR (LCT – License Clearance Tool, RoLECT – EOSC RoP Legal & Ethics Compliance Tool, RePol – Registry Policy Generator).
<p>SP03: Confirmed target groups, beneficiaries</p>	<p>As some key tasks from phase 2 were completed, phase 3 activities were initiated including:</p> <ul style="list-style-type: none"> Training activities were conducted and outreach programs were organized to approach stakeholders. Services onboarding platform was tested, and operational practices were standardized. (First services have already been on-boarded) marketing for innovation developments was defined and marketing activities started (marketing material, newsletters, blog articles, posters) <p>COVID-19 affected planned national dissemination events in this phase.</p>
<p>SP04: Confirmed commitments from interested partners to contribute to EOSC development processes</p>	<ul style="list-style-type: none"> Establishing NOSCI in all NI4OS-Europe partner countries and promoting policies and frameworks for OSC strategic plans. Training on NOSCI with webinars, blog posts, and face-to-face events. Establishing in each NOSCI strong partner links in every NI4OS-Europe partner country. Defining business models while maintaining collaboration on this with other 5b-INFRAEOSC projects. Exploiting the collaborative international network of OpenAIRE. Onboarding more services to the NI4OS-Europe catalogue. Product development: Improving WP4 tools and bringing them to a development stage “close to the market”. In parallel develop business models for each one of them, to allow for their exploitation and sustainability after the closing of the project.
<p>SP05: Finalize NI4OS-Europe deployment, exploitation, sustainability scenarios and plans</p>	<ul style="list-style-type: none"> Key Exploitable Results were defined and distributed at the EOSC level, project partners will take care of the long-term maintenance of the KERs. Tools have been finalized and onboarded to EOSC Catalogue.

	<ul style="list-style-type: none"> • MoU has been signed between NI4OS-Europe and Skills4EOSC for sustaining the training materials that have been created. • NOSCI have been established in 15 partner countries, and most of them will be continued on a national level.
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2.1. Inventory of project outputs

EOSC Association in collaboration with RDA prepared a questionnaire, that was sent out to EOSC-relevant projects in the spring of 2022 [7]. The survey served as a tool to gather information on up to six EOSC-related KERs per project. With this method the organizations managed to get information from 22 projects, counting 119 KERs. The document “Delivering for EOSC Key Exploitable Results of Horizon 2020 EOSC-related projects” contains results for all associated projects, including NI4OS-Europe. The NI4OS-Europe project benefited from analysing the defined results. Originally, the KERs were presented in Figure 4. The names and numbers of KERs are listed in Table 2.

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation						✓
	1.2 Researcher Engagement and Adoption	✓				✓	
	1.3 Rules of Participation Compliance Monitoring		✓	✓	✓		✓
AG 2	2.1 FAIR Metrics and Data Quality			✓			
	2.2 Semantic Interoperability	✓	✓				
AG 3	3.1 Data Stewardship Curricula and Career Paths						
	3.2 Research Careers, Recognition, and Credit						
	3.3 Upskilling Countries to Engage in EOSC	✓	✓	✓		✓	
AG 4	4.1 AAI Architecture				✓		✓
	4.2 Infrastructure for Quality Research Software	✓		✓			
	4.3 Technical Interoperability of Data and Services		✓		✓		✓
AG 5	5.1 Financial Sustainability					✓	
	5.2 Long-term Data Preservation	✓	✓	✓			
AG1: Implementation of EOSC		AG2: Metadata and data quality		AG3: Research careers and curricula			
AG4: Technical challenges on EOSC		AG5: Sustaining EOSC					

Figure 4: Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

Focusing on the intentions for supporting the developments of Open Science Cloud schemes in 15 EU Member States and associated countries, the following KERs were defined in consensus with all project partners and based on the activity information from INFRAEOSC-5b projects. Table 2 is containing KERs delivered throughout the project's lifetime. It includes the name of the output, a short description, TRL, the name of the responsible institution and the target user group(s).

Table 2: Inventory of project outputs

Name of output	Short description	TRL	Responsible institution	Target user group(s)
Training Platform (KER #1)	Moodle-based e-learning solution.	9	UKIM	Researchers, Academics & Librarians, Policy-makers
Pre-production environment supports the on-boarding of service providers (KER #2)	Supporting assessment and integration of relevant services to EOSC.	9	IPB	Researchers, Academics & Librarians, Educators, Research Groups, Resource Provider Managers, Providers
FAIR/ORDM tools (KER #3)	LCT, RoLECT, RePol	8-9	ATHENA/UoB	Researchers, Academics & Librarians, Educators
NI4OS-Europe Login (AAI) service (KER #4)	Authentication and Authorisation Infrastructure (AAI) for the NI4OS-Europe infrastructure.	9	GRNET	Research Groups, Resource Provider Managers, Providers, Researchers, Research Infrastructure Managers, Resource Managers, Research Communities
National Open Science Cloud Initiatives (NOSCI) (KER #5)	Coalition of national organisations, promoting synergies at the national level for optimising participation in EOSC, supporting its governance and developing national OS policies.	N/A	All partners	Researchers, Academics & Librarians, Educators, Policy-makers, Funders
AGORA service portfolio management tool (KER #6)	Used for the curation of the services to be onboarded to EOSC by the NI4OS-Europe Onboarding procedures.	8	GRNET	Research Groups, Resource Provider Managers, Research Managers, Policy Makers, Research Projects, Providers, Research Infrastructure Managers, Resource Managers, Research Organisations, Research Communities

2.2. Market positioning

All NI4OS-Europe results support the development of the EOSC environment, therefore this section describes how the outputs developed by the project could be positioned within the framework of the EOSC. The Strategic Research and Innovation Agenda [3] defines the 14 core action areas of EOSC to deepen the vision of scientific cooperation among research communities in Europe. In this effort, the resources are channelled to improve the gadgets, tools and other offers of the digital age, exploiting their potential and enhancing their digital capabilities with the primary aim to serve science. One of the main goals is to provide a virtual space for researchers to store, share and re-use research data in a findable, accessible, interoperable and reusable (FAIR) way.

Market positioning in the context of sustainability is difficult to define in the case of NI4OS-Europe since it delivers project outcomes in support of an environment that has many supporters, but not competitors. Several projects are working in parallel with a common goal to support the development of the EOSC environment. Therefore, this chapter focuses on the market positioning of EOSC services themselves, based on several published documents, highlighting how the NI4OS-Europe project results can be connected to them.

EOSC acknowledges and supports the strategy of the European Commission to aid and advance the European Research Area (ERA). From 2019 to 2024, the Horizon Europe program articulated six priorities for the work program of the European Commission. EOSC recognizes these priorities and aligns its activity to support them.

This report assesses the progress of the implementation and outlines the further steps to achieve a prominent presence of the region in the EOSC landscape and to deliver the benefits of Open Science to the region's scientists and the society at large. For sustaining NI4OS-Europe project outputs we must take into account that they are going to be sustained in a distributed environment. Since the NI4OS-Europe project is a contributor to the development of the EOSC environment, all project outcomes must be viewed under this prism in the matter of sustainability.

The EOSC Working Group on Skills and Training gathered the digital skills required for different research roles, in different environments. The digital skills detailed in the report 'Digital skills for FAIR and open science' [6] are necessary to operate a sustainable EOSC. The NI4OS-Europe project had activities to deliver training materials, maintain a dedicated training platform and organize events in partner countries for the end-users of the EOSC services.

For security reasons, a federated AAI needed to be established [2] [3], that takes care of the management of roles and rights in the European scientific environments. AAI technology is a core item of advancing e-science, in the creation of virtual reality for academics. It takes care of preserving digital identities long-term, which is quite significant in scientific collaborations. NI4OS-Europe Login (AAI) allows connecting services using popular protocols, such as OpenID Connect and SAML, to securely authenticate and identify their users, organise them in groups, assign them roles and centrally manage access rights for accessing protected resources. Access control can prevent unauthorized individuals from tampering with or altering data, which is critical to maintaining the integrity of scientific research. In summary, authentication and authorization are key in protecting data and privacy, maintaining data security, and facilitating collaboration.

For users to interact with EOSC, different user environments were established. Initially, user environments are dashboards, landing pages and services for accessing services of EOSC. NI4OS-Europe created the [NI4OS-Europe Catalogue](#), where end-users may review on-boarded resources in five categories. The establishment of the onboarding workflows is also serving the action area of User Environments defined by the EOSC governing bodies. The NI4OS-Europe catalogue acts not only as a user environment but also as a resource provider environment since EOSC is not a single monolithic organization, but a federation of many. The SRIA states that EOSC uses a system of systems approach to provide resources for its consumers.

NI4OS-Europe has developed the RoLECT tool to assist prospective resource providers to verify compliance with the Rules of Participation during the onboarding process of resources to the EOSC ecosystem with a special focus on the Legal and Ethics

Requirements. The EOSC Rules of Participation (RoP) Working Group defined openness, transparency, and inclusiveness as key principles, which makes the application of legal and ethical aspects a challenging task. The tool NI4OS-Europe developed works as a guided self-assessment tool. This is a specialised service aimed to help service providers, researchers and their organizations take care of legal and ethical issues in science.

As data continue to become a core aspect of research, EOSC is expected to act as a high-capacity network among scientists, connecting existing data infrastructures, and involving education and innovation communities, making it possible for collaborative science to be a success in Europe. As it is highlighted in the Solutions for a Sustainable EOSC [2], funding is always of significance.

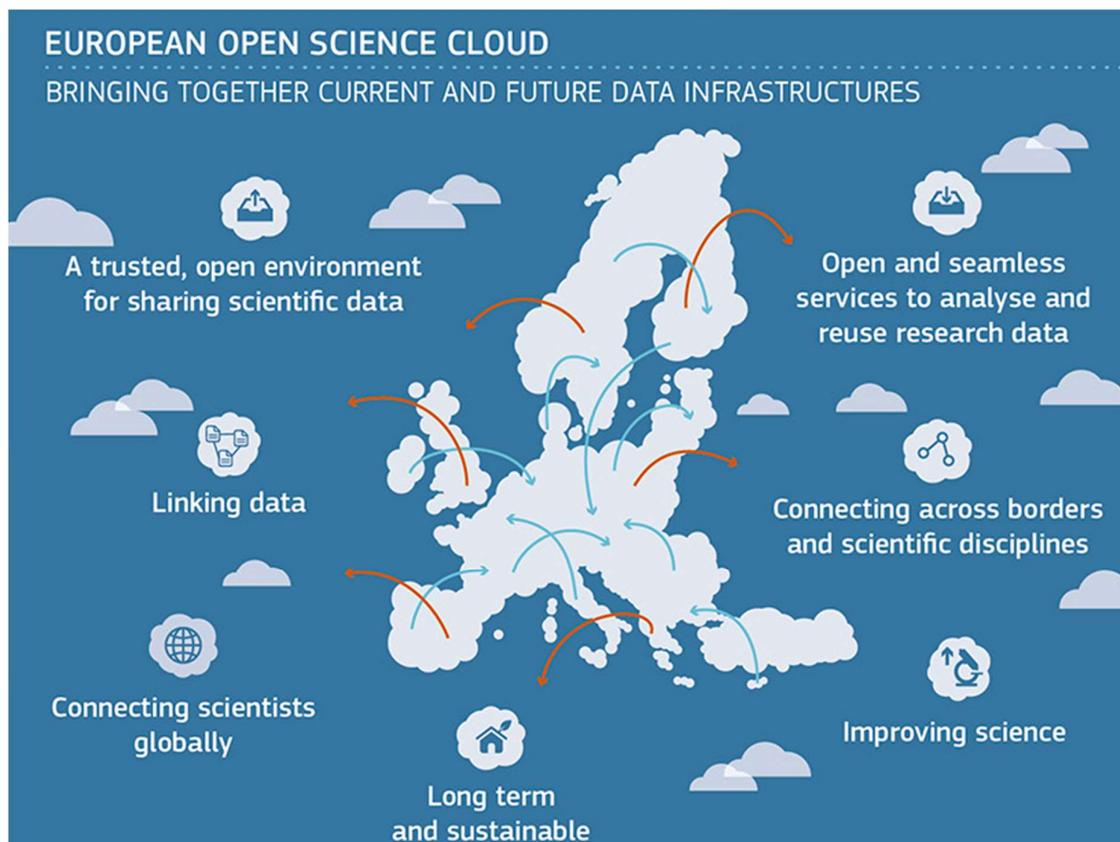


Figure 5: Partial image from digital-strategy.ec.europa.eu

EOSC has been introduced as an effort to overcome national or disciplinary borders in European science. Researchers need access to a network of services EOSC can provide, allowing them to share publications, data, software and other digital research outputs. EOSC can also influence research careers, connecting 1.7 million researchers and 70 million science and technology professionals in a virtual environment [5]. This could be a place for researchers to get a better reputation for their work, rewards and recognition in academia, they may find opportunities for international scientific work that would advance their career or mastering in a scientific field and later educate early career researchers. EOSC acknowledges researchers' needs and as a key actor in research infrastructure development provides services to fulfil these needs. Research infrastructure is the backbone of the virtual space, where science will happen in the future, exploiting the advantages of the digital era in the advancement of European science and innovation.

They foster the definition, implementation, and further development of advanced solutions for the effective provision and use of high-quality scientific data with characteristics, such as detailed metadata descriptors, ease of access, interoperability, and reusability, implementing the FAIR principles. EOSC also offers the promotion of open research in Europe through access and license policies. The initial goal was to overcome geographical and disciplinary borders in science, but we must recognize that due to ethical, legal and commercial reasons, access should be controlled. To respect the boundaries of legal and copyright aspects, it might be necessary to provide access through authentication and authorization. On many occasions in research, the resource changes through different stages of the research, therefore EOSC must provide a solution for setting up the licences and change them if necessary. NI4OS-Europe AAI offers a solution for this demand.

Research data continue to be even more significant in academia, therefore EOSC is required to offer a solution for long-term data preservation. IT specialists and scientists join efforts to work on data curation and guarantee the long-term usability of research data, with a determination of focusing on open research data [2]. The future of science understands that data is valuable, therefore it is a key action point to create the conditions for data preservation on more than one level, such as regional, national, and institutional levels. A network of data repositories is necessary for science.

The attention has shifted to research data and methods of data management in the past few years, which resulted in a demand for storage and HPCs. Science is seeking solutions for global problems, such as climate change, which requires high-performance computers (HPC) and artificial intelligence (AI). EOSC is already communicating with several HPCs in Europe providing resources to researchers to work on global challenges in collaboration. It is a goal to expand access to more HPCs, forming the EuroHPC network [2].

EOSC acknowledged that sections of its services work differently and target various audiences, therefore they tend to operate in their unique way sometimes. For this to happen, EOSC allows its sections to follow different business models. This operation model allows dissemination of best practices and enhances collective learning within cross-border activities. To make research more productive, EOSC facilitates transactions between research users and suppliers by introducing standardized and optimized processes, regulations and agreements.

The report 'Solutions for a Sustainable EOSC' [2] states that a network effect is an initial necessity for Open Science and FAIR data to become defaults for research. Stakeholders, who invest in EOSC, need to stay engaged to create the desired network effect, therefore incentives must be put in place for service providers and researchers, as well.

The above-mentioned network effect cannot be complete without achieving interoperability among different systems, such as data catalogues in the EOSC DF. This might create extra costs, which must be included in the budget plans.

The last important aspect to advance the European research ecosystem is supporting FAIR digital objects, which requires a great change in research culture. The report entitled 'Turning FAIR into reality Final Report and Action Plan on FAIR Data' [4] goes into detail about how to implement FAIR mechanisms into the data services EOSC applies in its operation.

2.3.SWOT analysis focusing on KERs

This analysis is based on the previous SWOT analysis from deliverable D7.4, focusing on KERs.

Table 3: SWOT analysis per project output

Output/Activity	Strength	Weakness	Opportunities	Threats
Training Platform	The portal is designed in such a way that provides a friendly environment for navigation throughout the training material is available. It also incorporates the BigBlueButton, a specialized open-source plug-in, which enables partners to host training events and webinars. The portal is developed and administered by highly skilled researchers.	Like all technology tools and platforms, in case of the failure of a server, access to the portal is lost.	The portal can be enriched by training material covering all different aspects supported by NI4OS-Europe. Additionally, it can be used for the further uptake of topics related to EOSC, FAIR, ORDM, and its uptake by other initiatives.	The end of the NI4OS-Europe project will affect the renewal of the training material in the portal.
Pre-production environment supports the on-boarding of service providers	Based on the accumulated knowledge and partnership within the region, the pre-production environment offers EOSC-compatible service integration to the regional service providers, enabling them to upgrade and integrate their services with support from within the region.	Lack of redundancy might affect the system's performance.	It is an environment that enables the partners to implement all the EOSC integration and on-boarding procedures with support for their services that can be on-boarded to EOSC. It can be extended for pan-European uptake	The end of the NI4OS-Europe project will affect the seamless operation of the Pre-production environment.
License Clearance Tool (LCT)	An intuitive tool for IPR & licence clearance. Strong for derivative work that combines existing works. Works through licence- or resource-driven workflows. Created for non-legal experts and researchers. Facilitates research sharing and exploitation.	Currently supports only open-source licenses. Requires legal knowledge and effort to accommodate non-standard licenses and calculate their compatibility.	The specific demonstrator is innovative and answers the increased demand for providing technical solutions to address legal aspects in FAIR and ORDM. From the evaluations conducted, many researchers find the tool interesting and potentially helpful, willing to contribute to testing. Training workshops and meetings with	Researchers may not be convinced of the product value at the moment, because the use of the product is imposed and comes along adoption of OS, OA and FAIR principles. A competitive product may emerge as the importance of IPR clearance is increased and becomes essential among researchers

Output/ Activity	Strength	Weakness	Opportunities	Threats
			target users are required to train them how to use the application and gain user feedback and user acceptance insights.	and other types of users.
EOSC RoP Legal & Ethics Compliance	Aligned with the EOSC governance, this tool allows for IPR, ethics and data protection compliance both at the policy and legal levels. Provides an aggregated guided assessment for EOSC RoP integrating model procedures for Copyright acquisition, management, dissemination policies and Data Protection (GDPR compliant) processes. The two main areas of the tool aid in legal and ethics. The tool allows users to make their work compliant with EOSC’s RoP.	A big part of the assessment process is content-wise bound to developments of the EOSC RoP	This can be considered an innovative tool answering the increased demand for providing technical solutions to address the need for researchers to publish in FAIR/open modes. Targets service providers, researchers and research organisations in their increasing need to interact with EOSC and onboard their resources and services. RoLECT provides a specialised service for a need that has not been covered yet by other relevant tools, due to the nature and the difficulties associated with the legal and ethical aspects of the RoP. RoLECT focuses on the ethical and legal aspects of RoP which in general are important before releasing a tool. This creates additional opportunities for the tool to be adopted under a different context.	The tool deals with a specialised yet essential aspect of EOSC RoP and may require specialised/trained staff if the wide audience finds it difficult to comprehend and interact with it. Will require test cases to be demonstrated that would happen in a still-evolving EOSC RoP environment. EOSC may decide to significantly change the Rules of Participation and this may make the tool unusable if it won’t be easy to adapt it to the new rules.
Repository Generator (RePol) Policy tool	Addresses management of OS service policies, a mandatory requirement that the service managers and admins often are reluctant to or do not feel qualified to deal with. Technical simplicity (no application database or user	No persistence of user-related data or histories in the app. It would require significant refactoring if the tool is repurposed for scenarios requiring persisting of user data or content. XML files used to configure RoLect are relatively	Extension to other types of policies and related documents for which the topic, element and usual formulations are convergent. ToCs in general are not such documents but could be within some limited service domains.	Failure to standardise or at least streamline and establish a loose consensus about the scope and concepts addressed in research repository and privacy policies. Potential loss of staff who can maintain the

Output/ Activity	Strength	Weakness	Opportunities	Threats
	<p>accounts), which also greatly reduces privacy and data protection-related concerns. Configurability and extendability without programming. Open-source licence with source code available on GitHub.</p>	<p>complicated to master. XML files used to configure RoLec are relatively complicated to master. No multi-language support (GUI, closely linked multilingual templates).</p>	<p>Technical services that are highly standardised in terms of functionality and interfaces, such as those provided by identity federations and identity providers (IdP), or services that collaborate in providing multi-party scientific workflows. The same is valid for the prospective SSI (Self-Sovereign Identity) services if they gain traction in the R&E community. Bottom-up contribution to the standardisation of machine-actionable policies.</p>	<p>system (IT admins and software developers familiar with the technical stack) and keep policies up to date (Open Science service admins and practitioners with sufficient proficiency in English) Technical debt that is potentially built up by copy-paste-style maintenance. Technological obsolescence of the platform on which the tool runs (Proxmox Virtual Environment, Ubuntu Linux, NGINX web server, Tomcat app container, Java, JSF).</p>
<p>NI4OS-Europe Login (AAI) service</p>	<p>Increased convenience: Through NI4OS-Europe Login, researchers can use their existing academic or social login credentials across multiple EOSC services, eliminating the need to create new accounts or remember multiple usernames and passwords.</p> <p>Improved onboarding experience: Researchers don't need to go through complex user registration processes.</p> <p>Easier integration: NI4OS-Europe Login provides a single point of integration for multiple identity providers, services and resource providers using industry standards such as OpenID Connect, OAuth 2.0, JSON Web Tokens, and SAML.</p>	<p>NI4OS-Europe Login supports alternative authentication options (such as social login) for enabling the onboarding of users who are not supported by the eduGAIN global network of academic identity providers. However, it can be difficult for resource providers to trust that the identity information being presented to them is accurate and belongs to the person claiming it.</p>	<p>NI4OS-Europe Login can be used by service providers as a testing environment to validate the readiness of their services for integrating and interoperating with authentications providers and service providers participating in the EOSC AAI Federation.</p>	<p>The EOSC AAI requirements and guidelines are rapidly evolving following the shifts in the AAI domain (for example OpenID Connect Federations, Self-Sovereign Identities), therefore further developments will be required to maintain the interoperability of NI4OS-Europe Login with the EOSC AAI Architecture. Other threats -applying to federated identity systems in general and not specific to the NI4OS-Europe Login service include the following: Malicious actors may create multiple fake identities for requesting access to resources so caution is required by the administrators of groups/roles when evaluating the assertions about the identity</p>

Output/ Activity	Strength	Weakness	Opportunities	Threats
	Scalable authorisation: NI4OS-Europe Login can centrally manage user roles & access rights across multiple protected resources.			attributes of users requesting access; Phishing techniques may be used to try to trick users into giving away their login credentials information from their home organisation to gain access to resources protected through NI4OS-Europe Login.
NOSCI	NOSCI are envisaged as coalitions of national organisations that have prominent roles and interests in the EOSC. NOSCI are supported by relevant Ministries and should propose the mandated organisations to EOSC Association. This will allow them to promote synergies at the national level, and to optimise/articulate their participation to EOSC and beyond. They will provide a link between EU Member States and EOSC and facilitate EOSC governance highlighting local strengths and weaknesses. They provide expertise in OS and OSC and will translate EOSC directions to local policies and strategies.	The coalition of organisations forming a NOSCI requires, in most cases, a lot of effort to make the first steps and will remain fragile until at least an MoU has been signed among the members. This may be even more prominent for cases where government support is minimal or non-existent, especially after discussions for coalition have progressed to a maturity level. An effort is required to produce a lot of material that could be proposed to government officials to support the NOSCI case.	The current status of the EOSC Association provides a major window of opportunity for NOSCI. Formed NOSCI with official national support will have a strong saying in EOSC governance, steering decision-making according to national strengths and weaknesses. Will propose the mandated organisations to EOSC thus forming a stable link of bi-directional communication between EOSC and EU Member States. Will progressively ensure a significant percentage of EU OSC funding for national infrastructures and services. NOSCI have the opportunity to fast forward OSC adoption to EU Member States mitigating risks and closing gaps between EOSC and local state of things fine tuning actions according to local pace and needs.	Time and proper timing of associated actions are considered essential for NOSCI. NOSCI should be established early enough to be able to play a prominent role in both EOSC governance and national OSC strategy. Political uncertainty is a major threat to the formation and establishment of a NOSCI. Lack of official support will also result in a fragile NOSCI coalition that will have limited power in EOSC governance. Comparably a coalition that does not include all appropriate and relevant members of a national OS community will seem insufficient for national representation.
AGORA service portfolio management tool	Both methodology and dashboard are scalable and could easily tack and include further EOSC development. Organized into	Since the EOSC is a dynamic environment, a permanent effort is required to monitor this development and incorporate new aspects into	At this development stage of the EOSC, the onboarding methodology and dashboard could be used as the EOSC profiles	Once the EOSC portal becomes mature enough, the dashboard might reach the end of its lifecycle but still be used on the regional level.

Output/ Activity	Strength	Weakness	Opportunities	Threats
	independent building blocks, both are extendable and can include some project-specific aspects of onboarding.	the methodology and dashboard.	specification testing environment.	

3. Sustainability of project outputs

3.1. EOSC level key exploitable results

3.1.1. **Onboarding services**

3.1.1.1 AGORA service portfolio management tool

Description:

The NI4OS- Europe Onboarding procedure uses the AGORA Service Portfolio Management tool (AGORA.ni4os.eu) for the curation of the services to be onboarded to EOSC. AGORA was the 1st regional catalogue to be fully integrated with the EOSC Service Catalogue and is a central production service of the project. The proposed NI4OS-Europe onboarding procedures are based on the latest recommendations by EOSC, comprising different possible levels of integration, along with the desired readiness levels of the services to be onboarded. The onboarding and the verification of the services are done using the NI4OS-Europe pre-production environment.

TRL: 8

Why does it need to be sustained?

AGORA is fully integrated with the EOSC Platform. At the same time, the NI4OS onboarding process follows the Rules of Participation as defined by the EOSC Association. The use of AGORA and equivalent tools that are integrated with the EOSC Resource Catalogue allows scaling of the EOSC Onboarding process by making use of regional or thematic collaborations such as NI4OS-Europe. Additionally, the use of AGORA allows NI4OS-Europe to apply its own stricter rules of participation earlier than EOSC as it deals with a smaller and more coherent community.

How it will be sustained?

GRNET will operate Agora and a lightweight onboarding process for Greece to support and promote the onboarding of services and resources by Greek organisations to EOSC and will run an instance for the region. GRNET will also seek National Funding towards the establishment of the Greek National EOSC Node and to operate nationally the necessary tools and platforms to be integrated with EOSC.

Target communities:

Research Groups, Resource Provider Managers, Research Managers, Policy Makers, Research Projects, Providers, Research Infrastructure Managers, Resource Managers, Research Organisations, Research Communities

3.1.1.2 Pre-production environment supports the on-boarding of service providers

Description:

The main goal of the pre-production environment is to support service providers in the process of onboarding, maturity assessment and integration of relevant services to EOSC. The components of the pre-production environment match the minimum viable EOSC core,

thus helping service providers to troubleshoot and align their services according to the requirements set by EOSC and is an essential tool for successful technical and policy onboarding.

TRL: 9.

Why does it need to be sustained?

Based on the accumulated knowledge and partnership within the region, the pre-production environment offers EOSC-compatible service integration to the regional service providers, enabling them to upgrade and integrate their services with support from within the region

How it is/will be sustained?

The project partners who host elements of the pre-production environment can continue to support a certain part of the environment based on in-kind contributions for regional collaboration. Any further advancements in the workings of the pre-production environment, and its provision on a pan-European level, should be supported by the EOSC Partnership and enabled by obtaining funding from future EC calls. There has already been positive action on this regarding inclusion inside the new EOSC-Core.

Target communities:

Researchers, Academics, Librarians, Educators, Research Groups, Resource Provider Managers, Providers

3.1.1.3 NI4OS-Europe login (AAI) service

Description:

The NI4OS-Europe Login service is the Authentication and Authorization Infrastructure (AAI) for the NI4OS-Europe infrastructure. It enables researchers to securely access and share common resources and services using identities from eduGAIN, the global network of academic identity federations. For users coming from the industry or citizen scientists who may not have access to eduGAIN, the NI4OS-Europe Login service supports additional trusted authentication providers, such as social networks, community identity providers and other platforms that can provide federated user identities. NI4OS-Europe Login allows connecting services using popular protocols, such as OpenID Connect and SAML, to securely authenticate and identify their users, organise them in groups, assign them roles and centrally manage access rights for accessing protected resources.

TRL: 9

Why does it need to be sustained?

NI4OS-Europe Login provides a single integration point allowing individual researchers, research communities and citizen scientists to access services using existing authentication credentials. Specifically, services connected to NI4OS-Europe Login can become available, with little or no administrative involvement, to users from more than 5,200 Universities and Research Institutes from 80 National Identity Federations participating in eduGAIN. Compliance with the AARC Policy guidelines and the EOSC Security Baseline ensures sufficient user attribute release, as well as operational security, incident response and traceability. Furthermore, users without an account on an academic Identity Provider are still able to authenticate themselves by using other federated identity platforms, such as Google or GitHub. NI4OS-Europe Login enables users to manage their

accounts from a single interface, link multiple identities together and gain authorised access to services based on their roles and group membership rights. Service providers can use industry standards, such as OpenID Connect or SAML, for connecting to NI4OS-Europe Login. Users can thus use their preferred identity sources and services regardless of the federated authentication protocol used. The adoption of the EOSC AAI interoperability guidelines enables the integration of NI4OS-Europe Login with the existing AAIs of other e-Infrastructures and research communities within EOSC to allow cross-infrastructure workflows.

How it will be sustained?

GRNET will maintain the NI4OS-Europe Login (AAI) Service as an in-kind contribution to the regional collaboration and access to regional services. However, further developments will be required to meet the evolving requirements and interoperability guidelines for the EOSC AAI Architecture. GRNET and the partners involved will seek funding for these developments from future EC Calls and are looking for alignment on these issues with the EOSC Association and the Partnership

Target communities:

Research Groups, Resource Provider Managers, Providers, Researchers, Research Infrastructure Managers, Resource Managers, Research Communities

3.1.2. Community and upskilling results

3.1.2.1 Training platform

Description:

The NI4OS-Europe training platform is a Moodle-based e-learning solution, which hosts all relevant training materials produced in the project. It also provides links to other existing training materials to enrich the learning experience on open science and EOSC. The basis is an integrated webinar system that is used primarily to support online training events organised by the project partners. The platform also provides self-paced courses on relevant topics and offers learning paths that guide the users' learning process on a given topic.

TRL: 9

Why does it need to be sustained?

Training activities are cornerstones for the implementation of FAIR Principles and EOSC. Project partners have been working together on upskilling their countries and providing different types of training via this platform. For the region, it is important to have training materials which can be utilized in long term training activities.

How it is/will be sustained?

UKIM will continue to host the NI4OS-Europe Training Platform as an in-kind contribution to the regional collaboration. All project partners will be able to add new content to the platform and support existing and new users and events. The platform follows the recommendations for minimum metadata description of the training materials. However, as these definitions and their standardisation are in working progress, further developments are required to align the platform with the evolving requirements and interoperability guidelines related to training catalogues, training materials metadata, and

publications in cross-referencing catalogues. Also, funds will be needed to set up pan-European-linked training catalogues. UKIM and other partners will strive to obtain funding for these efforts from future EC calls aligned within SRIA, where training activities gain priority in project agendas. Support for the partnership is needed.

Target communities:

The NI4OS-Europe Training Platform offers a vast range of training materials covering general topics related to the implementation of Open Science and EOSC. It also provides specialised training content focused on the process of service on-boarding to EOSC and the process of using the services already on-boarded. With this, the target communities for the platform include researchers, librarians, policy makers, service providers and service managers, as well as service users.

3.1.2.2 National Open Science Cloud Initiatives (NOSCI)

Description:

NOSCI and blueprint (D2.2 National OSC initiatives model). The National Open Science Cloud Initiatives (NOSCI) are a coalition of national organisations that have a prominent role and interest in the EOSC with the main objective to promote synergies at the national level for optimising participation in EOSC, supporting its governance and developing national open science (OS) policies. NOSCI are key elements of the NI4OS-Europe project and the cornerstone to reducing OS policy fragmentation in the region. To support the establishment of NOSCI, NI4OS-Europe presented a comprehensive framework– the Blueprint, which includes three elements: a. a set of indicative indicators to support the establishment and the monitoring of NOSCI (checklist – indicators for the NOSCI establishment), b. the workflows for setting up the initiatives which include three different approaches: top-down, bottom-up and hybrid (workflows for setting up NOSCI), c. the operational aspects such as EOSC governance, strategy and sustainability issues. The main advantage of the blueprint is that it can be further customised by any country and can be used as a valuable tool to advance the national OS agenda and facilitate the governance of EOSC. This approach was very successful, and already 10 NOSCI have been established in Southeast Europe (SEE), and five more countries are in the progress of creating a NOSCI.

Why does it need to be sustained?

NOSCI are envisaged as coalitions of national organisations that have prominent roles and interests in the EOSC. NOSCI are supported by relevant Ministries and could have a leading role in proposing and supporting the mandated organisations to the EOSC Association. This will allow them to promote synergies at the national level, and to optimise/articulate their participation to EOSC and beyond. They will provide a link between EU Member States and EOSC and facilitate EOSC governance highlighting local strengths and weaknesses. They provide expertise in OS and OSC and will translate EOSC directions to local policies and strategies.

How it is/will be sustained?

The D2.6 – National OSC initiatives report provides a comprehensive overview of sustainability recommendations for NOSCI:

NOSCI, depending on their economic, governance and technical contexts, strive to find operational practices that represent their current stakeholder constitutions as well as a

future body of national OS stakeholders (research communities, research funders, policy makers...).

Understanding how the NOSCIs could impact and transform the established knowledge value creation and facilitate at the national level the transfer of innovation process is key for developing new sustainable open science governance models.

Sustainability considerations are entwined with the NOSCIs' post-establishment progression. Therefore, at this stage, the NI4OS-Europe project framed NOSCI sustainability-related challenges through the realization of two activities, the distribution of an internal reporting survey focused also on acquiring information on the sustainability concerns of the NOSCI partners, and the actualization of a meeting dedicated to assisting the NOSCIs in sketching a 'Business Canvass' to serve as a guideline/map. Both activities aimed at ensuring the alignment of future NOSCI actions and NOSCI sustainability. In the latter stage of this section, we present the findings of the two aforementioned activities and conclude by highlighting key points, followed up by a list of recommendations to complement the main NOSCI sustainability takeaways.

NOSCI feedback summary on sustainability considerations

The answers received from the business canvass and reporting survey related to the sustainability of NOSCI indicate the diverse readiness of the countries to support the development of open science.

A NOSCI is envisaged as a coalition of national organizations that have a prominent role in the EOSC evolution. Consequently, NOSCIs are positioned also as the administrative centre for the coordination, management, and monitoring of the OS activities in their respective countries, forgoing constitutional barriers and harnessing the opportunity to liaise with other national organizations that share similar targets (NOADs/HPC nodes). The creation and promotion of synergies, to tackle the OS challenges that exist both nationally and European/EOSC level will be addressed through efficient management of infrastructures, services, development policies and skills that are necessary for integral technical, procedural and legal operations. In that regard however, it is apparent, that on one hand, there is a lack of awareness of Open Science principles among broader communities, coupled with the inadequate government support that appears as a recurring theme for several NI4OS-Europe NOSCIs. On the other hand, recent efforts have impacted policy developments, as Open Science priorities are included in the upcoming national research programmes for the majority of the NI4OS-Europe countries. This is important as new national strategic directions of R&I open the possibility for NOSCI financing in the future. In most cases, however, there are no strict political or governmental obligations to provide this kind of support. Therefore, NI4OS-Europe - NOSCI partners are shifting their attention to future EOSC projects as a means of further international support. Considering that, no EU calls for supporting regional contributions to EOSC are planned for the next two years, ergo it must be stated clearly that to ensure the NOSCIs' short-term sustainability, national-level support should be prioritized across the countries. At this stage, some NOSCI activities are being performed on a voluntary basis and some of the planned activities will be based on the in-kind contribution of NOSCI's members. It is clear that in the future similar commitments should be supported by concrete financial mechanisms that emanate from EU and national OS strategic planning, while also NOSCI sustainability should be addressed at some extent at the EOSC administration level.

Perspectives from the NI4OS-Europe partners

In continuation of the sustainability considerations discussed above, this section aims to provide an overview of lessons learnt from the perspective of the NI4OS-Europe partners who have actively contributed to the establishment of NOSCIs in their countries. It summarizes the main takeaways that emerged from all steps of the process (the initial planning, official set-up and first steps of the fifteen NOSCIs) and is based on many open-ended responses, that were received in the context of the regular NI4OS-Europe WP2 feedback activities and dedicated internal survey. Analyzing the responses, a clear thematic clustering can be observed. The areas that have emerged as the most prevalent, according to the responses by the NI4OS-Europe partners, are related to open science awareness, NOSCI setup and organizational aspects, communication, outreach and stakeholder engagement, alignment with EOSC-Association, and NOSCI sustainability.

In a summary of our thematic analysis of responses, it can be stated that:

In the wider SEE region, it is observed that NI4OS-Europe partners are among the core service providers to EOSC. It has to be stressed that currently, almost one-third of the services within the EOSC Marketplace have been provided by the NI4OS-Europe project partners. It is evident that the contribution of NOSCIs when it comes to the exploitation of EOSC onboarded tools and services is valuable and therefore NOSCI stakeholders-institutions and people engaged should be supported to continue their work.

One observation among the majority of partners is related to the existence, direction and maturity of national Open Science (OS) plans/targets and how this has affected the formation of NOSCIs. Linked to this, is the fact that the NOSCI formation has been hindered by the lack of understanding and low prioritization of OS aims across the research communities.

Partners identify various OS needs at the national level that should be financed and sustained, and which are also of interest to the NOSCIs. The provision of services and infrastructure is undoubtedly an integral part of the OS/NOSCI ecosystems. Additionally to this, activities related to training, dissemination, and awareness to reach researchers and broader end-user audiences, are areas where NOSCIs can play a frontline role. Several countries have or are about to launch new national research programs with Open Science principles establishment and policy development being a central part of them. This goes in line with the intent to substantially complement EC funding for EOSC by national funding linked to specific investments and actions. Even though the national funding streams do not yet include the option to fund and invest in cross-border activities, NOSCI partners have identified the importance of aligning the NOSCIs course of action with the higher-level EOSC-Association-centered coordination by creating links and fostering active synergies through the incentivization of NOSCI members' participation in EOSC related initiatives.

In similar magnitude, the majority of NOSCI partners expressed their concerns regarding uncertainty on the long-term sustainability of the NOSCIs since the governance of the relevant authorities deemed to support the NOSCIs is directly affected by volatile political factors. Another often-mentioned consideration that directly links to the long-term sustainability of the NOSCIs was the need to expand the existing networks of national stakeholders through mapping/landscaping activities followed up by targeted and effective communication and outreach actions, as well as the establishment of feedback mechanisms that will contribute to keeping the involved parties connected and the

NOSCI's plans and processes inclusive. One positive outcome that has been reported by the majority of partners is related to the advancements in the formulation of national OS plans and strategies in the last three years. In this period, NI4OS-Europe engaged more than 2.500 individuals of various profiles (researchers, funders, policymakers, and service providers) in outreach, training and awareness activities.

Finally, it is worth mentioning that the formal ratification (MoU signings) to solidify the preceding setup and organizational activities that solidify the interested parties' commitments, was also viewed as a topic of significant importance for the realization of the NOSCI's, especially in the case of bottom-up initiatives.

Target communities:

Researchers, Academics, Librarians, Educators, Policy-makers, Funders

3.1.3. FAIR and ORDM tools

This section originally covers one Key Exploitable Result, the FAIR and ORDM tools. Since during the project runtime NI4OS-Europe was involved in developing and onboarding many tools the EOSC community may benefit from in the future, we are going to detail each tool in this category. Each tool is part of the FAIR and ORDM tools KER.

3.1.3.1 EOSC RoP Legal & Ethics Compliance Tool (RoLECT)

Description:

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.

EOSC RoP have been analysed into a set of questions and 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 take advantage of this information to take the necessary mitigation actions before onboarding their resources to EOSC.

Target users may be service providers, researchers and research organisations. The RoLECT platform will eventually evolve to automatically check the validity of the provided resources for at least the obligatory steps of the assessment.

RoLECT is fully operational and stable and will be aligned with the forthcoming input from the EOSC RoP Task Force.

Why does it need to be sustained?

It is unique so there is no other integrated tool focusing on legal and ethical aspects of the Rules of Participation (RoP) in the EOSC. RoLECT is easy to use. It distils expert knowledge on legal and ethical issues and offers step-by-step guidance (RoLECT wizard) to perform a self-assessment exercise. It may reduce production and maintenance costs

by mitigating the need for specialised counselling. It reduces response time to adapt to changes in the RoP. In a way, it provides a quick and clear way of understanding the various aspects of the RoP a research product must comply with if aiming for EOSC onboarding. It embraces openness, transparency and inclusiveness in practices. The legal and ethical aspects taken into consideration can be reflected to other context and the tool can be adopted to be used in other domains.

How it is/will be sustained?

NI4OS-Europe's aspiration is that this resource and the others being developed by the project will be part of a helpful toolkit for all EOSC providers even after the project's end. One important aspect related to making the resources sustainable is the fact that NI4OS-Europe offers all its tools as open source solutions available through GitHub so that they can be taken up by the communities that are interested in using and further developing the tools.

ATHENA RC team closely follows and contributes to the EOSC RoP Drafting Group and updates in RoP will be reflected in the tool, thus supporting its sustainability and future exploitation.

Target communities:

Service providers; Researchers; Research organisations in general

3.1.3.2 Repository Policy Generator (RePol)

Description:

RePol – Repository Policy Generator is an open-source web application that helps the user create and maintain a comprehensive and clear repository or privacy policy. Generated privacy policies are suitable for any kind of online service. A step-by-step wizard and self-explanatory forms guide the user through the policy-defining process. By choosing among available options, the user shapes a policy document with clauses formulated in line with the current best practice. With the resulting policies, the resource owner can more easily align the service with GDPR requirements as well as those for onboarding and participation in open-science infrastructures.

The produced document may be downloaded as an XML file and additionally customized or edited before it is published with the service or repository. Individual policy elements are provided in a machine-readable format, allowing for an automated interpretation of created policies and metadata extraction by registries, catalogues and various operational, data discovery and workflow tools.

RePol specifically aims to help service owners in meeting the requirements of participating in and onboarding to EOSC. This extensible web application can be configured to generate any type of policy document, due to the versatile nature of its configurable forms and document templates.

Why does it need to be sustained?

RePol helps people and service providers make service management easier. The produced policies are well-written, clean and carefully edited.

Technically, this tool can easily adapt to the evolution of expectations from policies. At the same time, it allows its users easily upgrade their previously generated policies. However,

for policy templates to be kept up-to-date with the newest policy trends and fashions, they must be occasionally carefully updated.

Policies that are defined and produced with RePol include a machine-readable description of policy elements. These elements can be also included in the development and standardisation of machine-interpretable actionable policies used in the establishment of workflows that integrate several loosely coupled services managed by different providers and operators.

How it is/will be sustained?

RePol has been incorporated into the RCUB pool of production VM that are continuously monitored. The technical administrators observe the daily snapshots and alerts and they are committed to restoring them within 24 hours after a failure.

The UoB/RCUB is committed to maintaining it in operation for the next six years unless some new relevant application scenarios or additional funding schemes are established. If, after three years, its use is extended to new use cases or communities requiring software adaptations, or change of directly used software technologies, its operation will be ensured for the following three years. During the described 6 to 9-year period, RCUB will ensure the availability of a developer familiar with this software. Corrective, preventative, perfective maintenance and environmental adaptive maintenance will be ensured. After the end of the guaranteed operation, RePol will be supported on a best-effort basis.

For the tool's long-term sustainability and technical evolution, it must seek and embrace new opportunities, such as those described above and in the SWOT analysis.

Target communities include repository service operators (managers, administrators, developers) and operators of other services dealing with standardised policies (such as privacy and data protection policies), organisations needing to define their umbrella service policies.

Since its initial release, RePol has been continuously updated based on users' feedback and analysis of service policies listed in the NI4OS-Europe AGORA catalogue. This work will continue including efforts to promote the tool and refine the policy templates. The UoB has used RePol to maintain policies of its publication and data repositories (currently 35) and to develop its institutional privacy policy. Its output was the basis for the institutional privacy policy of the Serbian NREN AMRES, which may also use it to draft more detailed privacy policies for some of its services. By creating new templates, it can be easily adapted for new applications.

These use cases and RePol's versatility create a strong drive to sustain RePol beyond and after NI4OS-Europe, in addition to its current good visibility and potentially even wider use within EOSC and other open-science-related initiatives and projects in which the UoB is or will be involved.

Target communities:

Researchers, Academics & Librarians, Educators

3.1.3.3 License Clearance Tool (LCT)

Description:

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.

It offers two distinct workflows, allowing the user to initiate a clearance either by providing the licenses of the internal resources and selecting among a list of compatible licenses or starting with a target license and assessing if this license can be used or not based on the internal resources' licenses. Finally, each license has been classified using 3 basic groups of characteristics: Permissions, Prohibitions and Obligations and a set of license elements for each category, enabling users to further filter the compatible licenses.

The LCT user may register or use it as a guest. The data provided by the guest is not preserved after the report is produced. For the authenticated user, the content and all parts of the procedure are kept in the licensing clearance history and user history, allowing them to resume the work or share the work and data with others.

Why does it need to be sustained?

LCT addresses individuals and/or organizations with or without prior legal knowledge. It helps users to understand the licenses under which their (derivative) works can be shared and assists them to make their choice.

It's easy to use: it provides an intuitive wizard that guides users to select a target license. It minimizes the costs associated with a full copyright clearance process. It provides information for all the supported licenses through a dedicated page. It reinforces the process of IPR clearance, facilitating the reusability of resources released under a well-defined and compatible license.

How it is/will be sustained?

NI4OS-Europe's aspiration is that this resource and the others being developed by the project will be available even after the project's end. One important aspect related to making the resources sustainable is the fact that NI4OS-Europe offers all its tools as open-source solutions available through GitHub so that they can be taken up by the communities that are interested in using and further developing the tools. Integrated into the NI4OS-Europe Catalogue, LCT can be used for clearance of licensing-related issues during the

onboarding process. ATHENA RC aims to maintain and continue developing the tool in the coming years, as users have expressed interest in using it. Opportunities for the further development of the tool are currently being explored to support additional licences besides the 73 open-source licences already supported.

Target communities:

Librarians; Data stewards; Researchers; Legal department staff; Research organisations in general

3.2. National or local-level key outputs

The project took efforts to support the pre-existing tools and materials developed by partners. These results are not the initial results of the NI4OS-Europe project, but results of the partners of the project, which we channelled into EOSC to improve the environment. The outputs mentioned here are usually specified to a particular scientific field, built as an open platform, or serve as educational material on EOSC or Open Science. We would like to assess what kind of national or institutional (local) output/result/tool was created within the framework of the NI4OS-Europe project, which the interested parties would like to continue even after the end of the project.

The sustainability of these outputs will be managed by partners as well, to provide useful services to the EOSC community in the future. The list of the sustained outputs can be viewed in Appendix A.

3.3. Other key outputs

3.3.1. Long-term preservation of project deliverables and data

National Initiatives for Open Science in Europe [Zenodo community](#) was created at the very beginning of the project. All relevant project outcomes are uploaded here for dissemination and sustainability.

3.3.2. NI4OS-Europe website

Description:

The website serves as a central source of information about the project structure, liaisons, activities and outcomes and it constitutes an essential tool for the project marketing and communication activities. It also provides access to the NI4OS-Europe training platform, social media accounts and a subscription option to the project news. The website is periodically assessed and restructured to reflect the project's progress and to promote effectively its role and outcomes. NI4OS-Europe website is GDPR compliant.

Why does it need to be sustained?

The official website is the cornerstone for regional information related to EOSC and OS, it also provides links to project exploitable outcomes such as the NI4OS training platform, NI4OS-Europe catalogue, and documentation (deliverables, newsletters & informative

brochures). In this respect, it is essential to keep the website content active, therefore the project website will continue to be accessible.

How it is/will be sustained?

GRNET will continue to keep the NI4OS-Europe website active for regional communities to be able to access the activities, achievements and outcomes of the project. This way the information produced during the project's lifetime will remain available, and easily accessible and will provide useful guidance to similar projects.

Target communities:

Researchers, academics & librarians, policy-makers, project partners, EOSC & related projects

Contributing institution(s):

National infrastructures for research and technology (GRNET S.A.), Debreceni Egyetem

4. Challenges and opportunities for sustainable planning

Currently, EOSC is in a transition phase [7], it is continuously developing and changing to exploit all opportunities the digital era offers for sustainable research infrastructure in Europe. Since the business model of EOSC is not accessible at the time of this report, it is a challenge to meet needs that aren't quite formed yet. Also, we are not able to plan the development of the tools created for researchers and service providers, since we are not able to predict how the industry will change as new demands for tool improvement rise from user communities. Developments for already existing or new tools would not be possible without allocating budgets and human resources to the process. Another funding-related challenge is that the development activities can be project-based, and the innovations introduced within these projects may result in duplication of ideas or instability in the research service market. Moreover, the global status of politics and economics in Europe affects the costs and investments in the development of EOSC.

EOSC aims to overcome several challenges, such as the fragmentation of European research due to its national funding structure, which is also identified in the SRIA.

Although, if NOSCI can be successfully continued, and could be channelled into EOSC systematically, it would grant governance coverage on a national level, for Open Science to be a default approach in Europe. NOSCI is an effort to integrate scientific data into the European research processes and infrastructure, enhance collaborative research aspects and modern RDM methods, and introduce new innovative solutions to scientific communities.

4.1. Sustainability recommendations for NOSCI

The D2.6 – National OSC initiatives report provides a comprehensive overview of sustainability recommendations for NOSCI:

In the following segment, we provide a list of NOSCI sustainability recommendations of utmost importance for the NOSCI, categorized into the following thematic areas:

- Management, operation and sharing of resources
- Liaison and networking
- NOSCI's future role

Management, operation and sharing of resources

NOSCI is in the first phase of their operation. Existing resources for the current NOSCI's operation are available due to the partners' in-kind contribution and are provided free of charge so that the NOSCI can carry out their baseline activities. These resources remain the property of the partners who provide them, ensure short-term sustainability, and enable a smooth transition into the next, more mature, development phase.

Important related aspects are:

- The long-term funding directed to research infrastructures should be considered as a support mechanism to enable service providers to cover their costs.

- NOSCI partners should be in the position to accurately calculate their operational and maintenance costs so that in the mid-term the acquisition of resources, that will derive either from the national OS strategic orientation funding or EU sources, could be funnelled to the NOSCI operation efficiently.
- Labour and employment needs, at present are not connected to the NOSCI's main activities, and this is another topic that could be addressed in the future at an EOSC Association level, since national representativeness, promotion of OS activities and marketplace facilitation are core activities that demand resources.
- National funding of R&I should take into account the cross-border service provision. Alternative paying schemes where commissions are paid either by member states directly or by national nodes (aided by national funds) should be examined to relieve barriers in the cross-border service provision.
- Regarding the transitioning out of the NOSCI establishment phase, for the vast majority of NOSCI cases, the NOSCI members should jointly decide on fitting overarching business models that will allow the NOSCI to generate revenues through its activities.
- The MoU or other legal/official statutory document should clearly describe the roles, commitments, responsibilities, rights, as well as processes on the modus operandi. This will transfuse transparency that will minimize conflicts among members and will incentivize new possible members to easily assess and decide their participation.
- Funding alternatives in the forms of pay-per-use, subscriptions, commissions, advertisements, or other non-public revenue streams like fundraising/crowdfunding, could be examined on an individual NOSCI basis as supplementary options to enhance the sustainability of NOSCI.
- NOSCI are advised to form teams dedicated to Open Call participation as an additional approach to access funding.
- Drawing parallels with good practices of ESFRIs or ERICs should be examined in the NOSCI context as a way to establish a joint European resource model that could ultimately enable economies of scale.
- Funding models deployed in the LUMI [10] and NORDUnet [9] contexts can also provide prime examples of fitting alternative business model paradigms.

Liaison and networking

EOSC is a multi-actor endeavour that relies on the collaboration and coordination between the EOSC Association and related stakeholders, the research communities, and the countries. Networking within the national and European research and policy frameworks is an organic feature of NOSCI. It is an essential task for several reasons: (1) they establish themselves as inclusive actors of national research ecosystems during the initial steps, and (2) their positioning ensures their future role.

- In the current governance phase of EOSC, as this is expressed through the Tripartite collaboration, the EOSC Association increasingly invests in the support of national collaboration structures, as the way to build EOSC capacity across Europe. "The EOSC Tripartite Governance [12] is a concept of strategic coordination

between the EU represented by the Commission, the EOSC Association, and the Member States and Associated Countries involved in the EOSC Steering Board to resource and support the implementation of the EOSC environment in Europe, advancing an open science system and aligning national and EU policies to improve the production of FAIR research output” [11]. In addition to the SB representatives, NOSCI are the apparent collaboration structures at the national level for the EOSC Association. Thus, this reciprocal relationship between the EOSC Association and the NOSCI should be further nurtured, as it ensures a win-win situation.

- At all stages of their operation, NOSCI should remain in close liaison with OS actors and research communities and channel their voice, spanning all issues that concern research communities: research transparency and integrity, resource sharing, trustworthy data sharing, upskilling researchers and OS actors, policy and research coordination in the country and at European level, just to mention a few.
- Close relation with national authorities responsible for OS is fundamental. Not only for fortifying the NOSCI as the forefront initiatives for the promotion of OS at the national level but even more for ensuring that proper attention is given to the advancement and implementation of OS policies in the country, along with the proper support, incentives and funding.

NOSCI future role

NI4OS-Europe follows the mandate to support the establishment of National Open Science Cloud Initiatives in South-East Europe. To reach this goal the project aimed at developing related methodologies and tools supporting existing related activities culminating in the NOSCI establishment and operation in partner countries. By design, these initiatives have been inclusive targeting any interested OS actors in all countries beyond the NI4OS-Europe consortium and setting a future path for their autonomous operation.

Acknowledging the fact that NOSCI operate in a variety of national contexts, the following aspects should be considered concerning their future:

- The existence of a strategic document is pivotal for the setting up and the success of a NOSCI. Such a document should contain rules and recommendations in the form of commitments and actions at the macro level.
- The continuous involvement of NOSCI in the development or update of national plans for OS is essential.
- NOSCI on an individual basis could gradually settle on a legal form that utilizes formal instruments beyond the MoU, to enable the NOSCI commercial activities.
- A NOSCI should be responsible for communicating advancements and needs from and to the EOSC Association. It should keep national stakeholders up to date with EOSC developments and spread awareness.
- The NOSCI should strive to achieve multi-actor stakeholder participation, from a variety of sectors aiming to also operate as a national cross-sectoral OS centre where synergies between the involved parties are fostered. That can lead to profitable relations on an individual basis that also can strengthen the sustainability of the NOSCI on a strategic level.

- The NOSCI could impact the EU OS preparedness level if they can include in their action plans training, knowledge exchange and skills development for their communities. In that regard, NOSCI should continue to provide support in the onboarding of existing and future service providers of EOSC.

Ultimately, the NOSCI's role of either as a forefront conductor or auxiliary support structure that will facilitate the promotion of OS targets and priorities at a research community level, or as clusters that contribute to policy-making, NOSCI advancement will also depend on how EOSC administration envisages their future role and actively supports them with direct resource provision, and central top-down coordination.

5. Conclusions

NI4OS-Europe acted as a core supporter of the EOSC service portfolio, made commitments to the EOSC governance and ensured inclusiveness on the European level for enabling global Open Science. The project federated the existing EOSC-relevant services in the 15 target countries, mapped the national OSC landscape and built National Open Science Initiatives (NOSCI) to support the EOSC governance. During the project's lifetime, an entire horizontal service platform was created that engaged demonstrators with thematic and generic services, as well as repositories. NI4OS-Europe was also involved in the support of ORDM/FAIR compliance of repositories and certification schemes. To align with EOSC policies and the uptake of FAIR data, a variety of tools were developed. To engage users, a Training Platform was established, and many dissemination events were organised to share best practices on the topic.

All project outcomes were finetuned during the project based on the feedback on project activities. Our purpose was to meet the expectations of the user communities and for this, we created different feedback forms for different outputs, where we could gather information on impressions and user experiences regarding services and activities.

This report explains the sustainability of project outcomes on two levels: the matter of project activities and project results. These outcomes were explored as EOSC Level Key Exploitable Results, and National or Local Level Key outputs. The results on the EOSC level were divided into three categories: onboarding services, community and upskilling results, and FAIR and ORDM tools.

Concerning the onboarding services the AGORA service portfolio management tool, the pre-production environment and the AAI service will be sustained on a best-effort basis and only on the regional level. The AGORA service is fully integrated into the EOSC Platform and with the EOSC Resource Catalogue, it is used for the onboarding processes, and it is necessary to support the system further. The pre-production environment is targeting the service providers, also used in the onboarding process. The AAI service is already integrated into the EOSC ecosystem, and regional end users already have been using it for some time.

In the Community and Upskilling Results category, the future of the Training Platform and the NOSCI are discussed. The created materials for training are valuable and reusable results, and since training activities are a significant cornerstone for the implementation of FAIR principles and EOSC, these materials may serve as inspiration/resource for other training activities for future projects. The NOSCI are a coalition of national organisations for promoting synergies at the national level for organising participation in EOSC, also supporting the development of national Open Science policies. These are key activities for advancing research in Europe.

The third category is the FAIR / ORDM tools, which are developed services for end users, such as helping researchers to publish FAIR and open models, generating policies for repositories, or facilitating and automation of copyrights. These services need to be maintained so end-users could benefit from them.

Finally, the NI4OS-Europe website needs to be kept reachable, as it shares valuable information not only on the project but downloadable materials and links to other useful services. Deliverables are preserved through the Zenodo community.

Appendix A List of all possible national or local level key outputs

Tools

ClimCost

Description: Providing comprehensive and reliable computer simulations of climate changes on regional/local scales and evaluation of their impacts on ecosystems and quality of life.

Why does it need to be sustained?

The service produces reliable, comprehensive, and detailed evaluations of possible regional/local climate changes and their consequences for different global change scenarios. Metrics and tools for evaluating some of the climate change impacts on the environment and quality will be available. Making use of vast computing resources, the service will enable scientists to perform an in-depth assessment of the climate change impacts that cannot be achieved with the desired accuracy using local computing resources. Users are climate scientists and national and municipal policymakers. The high importance of understanding the potential impact of climate change motivates the need to sustain and further develop this tool.

How it is/will be sustained?

The tool will be further developed and maintained by the teams from IICT-BAS and NIGGG-BAS, seeking funding from national sources and looking for collaboration at the European level.

Target communities:

Researchers, Policy-makers, Climate scientists

Contributing institution(s):

Institute of Information and Communication Technologies, Bulgarian Academy of Sciences
National Institute of Geophysics, Geodesy and Geography, Bulgarian Academy of Sciences

Accounting service

Description: The accounting service collects, analyzes, and then provides information about the usage of services for example HPC usage, storage data, and virtual machines data. The service provides information only related to NI4OS/EOSC services and is available to the project management team and the service administrators.

Why does it need to be sustained?

The accounting service has been important in collecting information that is suitable for understanding the usage needs, patterns, and requirements, on one hand, and for presenting usage data to policymakers, on the other hand.

How it is/will be sustained?

We plan to continue maintaining the service, with input data collected at least from our national EOSC services.

Target communities:

Resource administrators/owners, policymakers

Contributing institution(s):

Institute of Information and communication technologies, Bulgarian Academy of Sciences

CHERE service and repository, RS2C service

Description: CHERE Tools stands for Cultural Heritage Repository Tools and represents a set of web-based tools aimed at people working in cultural heritage preservation and digitization, but is not limited to those uses as individual services can be used in a variety of ways.

Why does it need to be sustained?

We have users that actively use the system for cultural heritage digitization and as a repository.

How it is/will be sustained?

We will continue providing support and training through our efforts.

Target communities:

GLAM (galleries, libraries, archives, museums)

Contributing institution(s):

University of Banja Luka

Digital repository

Description: Digital repository of Academic Archives from the University

Why does it need to be sustained?

It needs to be sustained because it is the first such repository among national public universities in the country of Bosnia and Herzegovina; enables visibility of research results; it is transparent; results of the research are available to the whole community.

How it is/will be sustained?

It will be under institutional maintenance.

Target communities:

Researchers

Contributing institution(s):

University of Banja Luka

SciRoHub

Description: SciRoHub is a mirror of the Copernicus Open Access Hub restricted to the Romanian territory.

Why does it need to be sustained?

The mirror is useful for reducing the load on the main Copernicus Open Access Hub, and also reducing the network congestion caused by the transfers of large data files which are specific to satellite images.

How it is/will be sustained?

By continuing to support this service, we continue the collaboration with other organizations that are interested in this domain.

Target communities:

Researchers

Contributing institution(s):

National Institute for Research and Development in informatics – ICI Bucharest

Reduced-Precision Chemical Kinetics in Atmospheric Models

Description: Modelling atmospheric composition and climate change on a global scale remains a great scientific challenge. Earth system models spend up to 85% of their total required computational resources on the integration of atmospheric chemical kinetics. We refactored a general atmospheric chemical kinetics solver system to maintain accuracy in single precision to alleviate the bottleneck in memory-limited climate-chemistry simulations and file input/output (I/O) and introduced vectorization by intrinsic functions to increase data-level parallelism exposure. The application was validated using seven standard chemical mechanisms and evaluated against high-precision implicit methods. We reduced required integration steps by $\times 1.5$ –3-fold, in line with double precision, while maintaining numerical stability under the same conditions, accuracy to within 1%, and benefiting from halving the required memory and reducing overall simulation time by up to a factor of two. Our results suggest that single-precision chemical kinetics can allow a significant reduction of computational requirements and/or increase of complexity in climate-chemistry simulations.

Why does it need to be sustained?

Reduced-precision chemical kinetics can allow a significant reduction in computational requirements and/or increase of complexity in climate-chemistry simulations.

How it is/will be sustained?

We will employ several NI4OS generic services in different aspects of the data lifecycle, from creation to processing, analysis, preservation, access, and reuse. These include generic HPC computing, generic storage, model input data staging and output preservation, and advanced in-situ data management, processing, and workflow management.

Target communities:

One of today's great scientific challenges is to predict how the climate will change from the global to the local scale as atmospheric gas concentrations change over time. The study of chemistry-climate interactions represents an important open research question. The emerging issues of climate change, ozone depletion and air quality, which are challenging from both scientific and policy perspectives, are represented in chemistry-climate models (CCMs). Understanding how the chemistry and composition of the atmosphere may change over the 21st century is essential in preparing adaptive responses and establishing mitigation strategies.

Contributing institution(s):

The Cyprus Institute

SexEst web application

Description: SexEst is a free, interactive, web application designed to estimate sex using cranial or postcranial linear measurements. Users can either enter manually the measurements for single skeletons or upload data for multiple skeletons stored in a CSV file.

Why does it need to be sustained?

This is an application that will be useful to researchers in the fields of forensic anthropology, archaeology, and bioarchaeology and it'll be helpful to remain available to a broad audience that can use it for research purposes

How it is/will be sustained?

We will try to maintain the application that is now running on the Cyprus Institute's HPC machines

Target communities:

Digital Cultural Heritage, Forensic Anthropology, Archaeological Science

Contributing institution(s):

The Cyprus Institute

NI4OS-Europe onboarding dashboard

Description: The main aim of the NI4OS-Europe onboarding dashboard is to track the progress of the providers and resources onboarding process. Besides this, the dashboard gives a more user-friendly view of the resources/providers registered within the resource portfolio management system (AGORA catalogue).

Why does it need to be sustained?

The EOSC is a dynamic environment under permanent development. Therefore, to ensure horizontal implementation of new features from the EOSC core components to the EOSC exchange and vice versa, real-time monitoring of static information stored within the catalogues and information coming from operational tools is crucial. Such tracking is realized with the dashboard.

How it is/will be sustained?

At the national level, the dashboard will be exploited via the national open science cloud initiative TONuS.

Target communities:

Developers of the EOSC technical platform, resource providers, and researchers.

Contributing institution(s):

NI4OS-Europe consortium.

Platforms:

Clowder4DCH

Description: C4DCH is a highly extensible active curation-based research data management platform. Users can link and organize datasets in online collections for the creation of semantically structured data repositories specialized for digital cultural heritage. C4DCH enables users to form an online collaboration environment to support research communities and activities, and disseminate results.

Why does it need to be sustained?

The platform is used for collaboration between researchers and students. Long-term preservation will enable the platform to be enriched with more research datasets and collections which will make it an even more useful resource for existing users and enable us to engage new users from the GLAM industry.

How it is/will be sustained?

By continuing to use it in teaching and other projects which are already building features on it.

Target communities:

Museums, collections, researchers, students.

Contributing institution(s):

The Cyprus Institute

DREAMM

Description: DREAMM is a novel machine-learning tool that predicts the protein-membrane interfaces of peripheral membrane protein, and optionally predicts binding sites near the predicted membrane-penetrating residues in protein conformational ensembles. As an output, the user can retrieve the membrane-penetrating residues in a .csv file and if the user's choice was to predict binding sites, a .zip file will be downloaded including the abovementioned .csv file, the binding pocket predictions, the visualizations, and summarized the binding site clustering results.

Why does it need to be sustained?

Very popular tools are used widely by the scientific community.

How it is/will be sustained?

We hope to remain in the EOSC portal

Target communities:

scientists, SMEs, students

Contributing institution(s):

Biomedical Research Foundation Academy of Athens

Nanocrystal

Description: NanoCrystal is a novel web-based crystallographic tool that creates nanoparticle models from any crystal structure guided by their preferred equilibrium shape under standard conditions according to the Wulff morphology (crystal habit). Users can upload a .cif file, define the Miller indices and their corresponding minimum surface energies according to the Wulff construction of a particular crystal, and specify the size of the nanocrystal. As a result, the nanoparticle is constructed and visualized, and the coordinates of the atoms are output to the user.

Why does it need to be sustained?

Very popular tools are used widely by the scientific community.

How it is/will be sustained?

We hope to remain in the EOSC portal

Target communities:

scientists, SMEs, students

Contributing institution(s):

Biomedical Research Foundation Academy of Athens

ChemBioServer

Description: ChemBioServer is a web server for filtering, clustering and networking of chemical compound libraries facilitating both drug discovery and repurposing. It provides researchers the ability to (i) browse and visualize compounds along with their physicochemical and toxicity properties, (ii) perform property-based filtering of chemical compounds, (iii) explore compound libraries for lead optimization based on perfect match substructure search, (iv) re-rank virtual screening results to achieve selectivity for a protein of interest against different protein members of the same family, selecting only those compounds that score high for the protein of interest, (v) perform clustering among the compounds based on their physicochemical properties providing representative compounds for each cluster, (vi) construct and visualize a structural similarity network of compounds providing a set of network analysis metrics, (vii) combine a given set of compounds with a reference set of compounds into a single structural similarity network providing the opportunity to infer drug repurposing due to transitivity, (viii) remove compounds from a network based on their similarity with unwanted substances (e.g. failed drugs), and (ix) build custom compound mining pipelines.

Why does it need to be sustained?

Very popular tools are used widely by the scientific community.

How it is/will be sustained?

We hope to remain in the EOSC portal

Target communities:

scientists, SMEs, students

Contributing institution(s):

Biomedical Research Foundation Academy of Athens

FEPprepare

Description: FEP prepare is a web server, which automates the set-up procedure for performing NAMD/FEP simulations. Automating free energy perturbation calculations is a step forward to delivering high throughput calculations for accurate predictions of relative binding affinities before a compound is synthesized, and consequently, saves enormous time and cost.

Why does it need to be sustained?

Very popular tools are used widely by the scientific community.

How it is/will be sustained?

We hope to remain in the EOSC portal

Target communities:

scientists, SMEs, students

Contributing institution(s):

Biomedical Research Foundation Academy of Athens

Ingredio

Description: Ingredio is a mobile phone app with which users are informed in seconds about the potential hazards of food and cosmetics products. Novel algorithms using artificial intelligence are used to mine the worldwide peer-reviewed literature and institutional databases (e.g. NIH/European Commission).

Our application is aimed at informing the growing share of consumers who want to know what is contained in the products they use and embrace healthy eating and cosmetics without toxic chemicals. We inform consumers whether the ingredients of a cosmetic or food product are safe or have potential hazards and if they are of natural origin. Our app can be used without geographical restrictions for chemical ingredients listed in English.

Why does it need to be sustained?

Very popular tools are used widely by the scientific community.

How it is/will be sustained?

We hope to remain in the EOSC portal

Target communities:

scientists, SMEs, students

Contributing institution(s):

Biomedical Research Foundation Academy of Athens

GRENA – GCloud IaaS platform

Description: GCloud provides an opportunity to create an efficient virtual Data Center, where you can build and manage servers, network infrastructure, security and useful applications according to your requirements and with minimal effort. Also, we offer various useful services and tools for more efficient software development, management and hosting processes.

In addition, the advantage of our service is the maximum efficient charging policy for resource usage. We count charges per minute only for those resources that are being used at the current moment.

Why does it need to be sustained?

GCloud infrastructure and services were developed by the highly qualified technical staff of the Georgian Research and Education Networking Association GRENA. Infrastructure is based on the modern powerful DELL servers and located at GRENA data centre in Tbilisi, Georgia.

How it is/will be sustained?

Ministry of Education and Science is already interested in these resources and we are discussing with them how to support Open Science in Georgia.

Target communities:

Research and education community

Contributing institution(s):

Georgian Research and Educational Networking Association GRENA

Center of Experimental Biomedicine – Electroencephalography pattern study

Description: EEGHUB collected a large volume of the Electroencephalogram-Brain Electrical Activity data of epileptic and ADHD patients and healthy population in Georgia and share data with international partners at KTH Royal Institute of Technology (KTH), Stockholm, Sweden and Lesya Ukrainka Eastern European National University (EENU), Lutsk, Ukraine Eastern European National University (EENU), Lutsk, Ukraine.

The service is free for users following the FAIR (Findable, Accessible, Interoperable, and Reusable) principles. The service has a convenient search engine, which allows users to identify any recordings that correspond to specific requirements. The recordings are easily accessible and can be downloaded for further exploitation. For opening the EDF files EDF browser is used.

Why does it need to be sustained?

Studying the nature of alteration of basic characteristics of EEG (Electroencephalogram-Brain Electrical Activity) in healthy subjects and patients with different disorders of the nervous system (NS) is important for understanding both normal and pathological brain conditions. In addition, the accumulation of the comparison of EEG in healthy subjects and patients with different disorders of the central nervous system (CNS) helps to develop criteria for a more adequate assessment of the degree of brain dysfunction.

How it is/will be sustained?

Ministry of Education and Science is already interested in these resources and we are discussing with them how to support Open Science in Georgia

Target communities:

Research and education community

Contributing institution(s):

Center of Experimental Biomedicine

National Science Library – repository of publications

Description: "Digital Repository of Georgian Scientific Works" is the national level Open Access digital repository. It was created by Tbilisi State University National Science Library and Georgian Integrated Library Information System Consortium (GILISC) in 2018. This service increases the visibility of the Georgian scientific community's research and the materials within it are centrally stored and preserved. Since 2022 the repository is available in European Open Science Cloud (EOSC).

Why does it need to be sustained?

The repository aims to provide open access to publications and scientific works of researchers from Georgian educational organizations, with the researcher's pages, projects, and organization units.

How it is/will be sustained?

Ministry of Education and Science is already interested in these resources and we are discussing with them how to support Open Science in Georgia

Target communities:

Research and education community

Contributing institution(s):

National Science Library

Institutional repository for scientific publications

Description: The Publications repository is built on the DSpace-CRIS platform. At this stage, it includes a sample set of data regarding Researcher profiles (180, with minimal info for external coauthors), Journal publications (159), Conference materials (137), Events, and Journals.

Why does it need to be sustained?

The repository has an important role in the Open Science policy of the institute. Continuous consolidation activity is envisaged for both expanding the current content and enlarging the coverage with relevant CRIS entities (projects, departments).

How it is/will be sustained?

At the institutional level, it will be available in the ICIPRO cloud infrastructure. At the local level, it may be considered a reference for research-performing organizations interested to implement this kind of Opens Science tools. Also, our experience in implementing and administrating this solution will be available in the RO-NOSCI cooperation framework.

Target communities:

ICI researchers, Research funding organizations to assess performance indicators related to scientific publications, R&D partners, and the research community at large.

Contributing institution(s):

National Institute for Research and Development in Informatics – ICI Bucharest

Open Science and EOSC in Practice (Hungarian: Nyílt Tudomány és az EOSC a gyakorlatban)

Description: e-learning material covering most topics of training material developed by KIFÜ

Why does it need to be sustained?

Demand from the community

How it is/will be sustained?

Maintain and extend during the EOSC Future project using local and international funds. Exchange ideas with Skills4EOSC project.

Target communities:

Researchers, PhD-students

Contributing institution(s):

Governmental Agency for IT development (KIFÜ)

Open Science news site

Description: A news site about open science

Why does it need to be sustained?

Significant number of page visitors

How it is/will be sustained?

Continue in EOSC Future and beyond

Target communities:

Anybody interested in Open Science

Contributing institution(s):

Governmental Agency for IT Development (KIFÜ)

Open Mapping Application (OMApp)

Description: OMApp is a cloud application for automatic image mosaicking and georeferencing. The application is designed to support multiple users, where each user can upload a set of captured images through the web interface, start their processing, and preview created maps. Processed images can also be downloaded in standard open formats. OMApp uses several open-source image processing tools and libraries, where the most computationally demanding of them can perform multi-core parallel processing, allowing better use of cloud resources.

Why does it need to be sustained?

OMApp is an open alternative to already available cloud-based commercial software. In addition, it has advantages compared to commercial desktop software, such as significantly faster image processing and thus faster obtaining of final outputs. OMApp also serves as a map hosting, providing an overview of the photographed areas at a higher resolution compared to the available satellite imagery. As such, it may be of long-term interest to the different research communities.

How it is/will be sustained?

OMApp enables long-term and continuous monitoring of areas of interest, as well as the development of various applications based on the created maps. Therefore, it will be mainly used by students and researchers from domains such as precision agriculture, environmental monitoring and protection, civil engineering, machine learning, etc.

Target communities:

Researchers from different areas (precision agriculture, environmental monitoring, civil engineering, image processing...), research/innovation institutions and SMEs.

Contributing institution(s):

University of Montenegro

IoT Cloud Platform

Description: IoT Cloud platform is an open web platform designed primarily for researchers interested in remote data collection, visualization and analysis, but also for end-user application developers. Within the vast offering of different IoT solutions, IoT Cloud platform stands out with its unique attractive capabilities, including:

- Integration of different open-source tools for data analysis purposes (Octave, R, Python)
- Possibility to write custom code for data analysis in a web browser
- Versatility with respect to the types of supported hardware (Arduino, Raspberry Pi, Libelium Plug and Sense, mobile devices, PCs, etc.)

- Possibility to deploy the platform on the other hosts
- Customization options according to the user requirements, especially in the sense of data analysis and visualization.

Why does it need to be sustained?

IoT Cloud platform is a very useful research tool for different areas, where remote data collection is conducted and their analysis and visualization are necessary. It enables data collection from different types of hardware platforms and can be customized to perform data analysis and visualization following the user's needs. IoT Cloud platform has been already used by the researcher from UoM for environmental monitoring and monitoring of some industrial machines, thus proving its effectiveness and usability. In that manner, we found that in future, it can be used by different research teams.

How it is/will be sustained?

IoT Cloud platform is hosted at UoM servers in the Center of Information System. We have human resources who care about keeping services available and if any problem in service operation occurs, a service developer is available. This platform has been promoted to the UoM partners and Open Science stakeholders in Montenegro and some interest already exists for its further exploitation.

Target communities:

Researchers interested in remote data collection, visualization and analysis, but also for end-user application developers in the different areas of IoT services.

Contributing institution(s):

University of Montenegro

National Research Cloud Infrastructure

Description: ASNET-Cloud provides Infrastructure as a Service (IaaS) to academia and stakeholders based on OpenStack middleware. Additionally, ASNET-Cloud provides customized virtual environments to researchers and end-users to make their work easy. The users launch virtual machines (1-64 CPU cores) via a dashboard distributed in the following three zones (596 CPU cores in total)

Why does it need to be sustained?

To provide sustainable infrastructure for local and global user communities

How it is/will be sustained?

To get support from the Ministry at the local level and prepare the EC proposal

Target communities:

Researchers need cloud resources

Contributing institution(s):

Institute for Informatics and Automation Problems of NAS RA

National Digital Library

Description: Open Science turns into a global movement, and the Fundamental Scientific Library creates a vibrant portal of digital collections, to prioritize open and robust access to information and enact policies that advance open knowledge creation. To achieve these goals, we:

- Digitize and provide access to scholarly content and unique cultural heritage materials, making scientific knowledge, methods, data and evidence freely available and accessible to everyone.
- Support the research data lifecycle, especially data preservation and re-use
- Promote innovative international scientific collaborations
- Build a culture of Open Science
- Increase scientific collaborations and sharing of information for the benefit of science and society at large.

Why does it need to be sustained?

As such repositories provide useful digitalized objects

How it is/will be sustained?

State and European Projects

Target communities:

researchers, students

Contributing institution(s):

Fundamental Scientific Library of NAS RA

Institute for Informatics and Automation Problems of NAS RA

Cloud and Storage infrastructure for providing generic service to support Open Science

Description: Computing and storage infrastructure for support operation of open data repositories and other tools that are needed to store, analyse and process research data and support making research data FAIR and research results wider accessible.

Why does it need to be sustained?

The created infrastructure provides basic services to support Open Science at the national level

How it is/will be sustained?

Operation of the created infrastructure will be in continuation supported by basic national R&D funding; in perspective is planning to form National Programme for e-Infrastructures operation and development support

Target communities:

Research teams from universities and research institutes that are participating in the national and international R&I projects; national HiTech companies; providing services to other European institutions via EOSC Marketplace.

Contributing institution(s):

RENAM Association, State University of Moldova, Institute of Mathematics and Computer Science

Other related outputs:

E-course Research Data Management (Croatian: Upravljanje istraživačkim podacima)

Description: The course is designed in such a way that anyone can follow it, and does not require the participants to have the necessary prior knowledge and skills. During the course participants, acquire knowledge about the basic steps, terms and methods of managing research data.

Enrolment and duration of the course are not time-limited, and participants can attend the course at their own pace. All units of the course are open at the same time, so participants can go through the units, as they like

Participants who have finished all lessons in the course and passed all knowledge tests are awarded a certificate of course completion and a digital badge.

The course follows all phases of the research data life cycle and is divided into six units: Introduction to research data management, FAIR data and principles, Naming, organization, versioning of research data files and formats, Documentation and reliable storage of research data, Management of personal and sensitive research data and Publication and Reuse of Research Data.

The course is available in the category "Courses about platforms, tools and good practices in the research data life cycle" on LMS Moodle in the Croatian language.

Why does it need to be sustained?

The e-course needs to be sustained so that researchers, librarians, and people from the higher education system have free and open educational materials and resources, which will help them with research data management and research data lifecycle during their work.

How it is/will be sustained?

We plan to maintain an e-course and disseminate it among researchers, librarians, and participants from the higher education system. From 2021 until December 2022, the e-course enrolled 217 participants and 31 of them gained certificates and digital badges for successful completion of the e-course. SRCE plans to develop more e-courses about research data management to educate the Croatian community about the importance of research data management, FAIR principles and open science.

Target communities:

The course is for researchers, students, faculty, librarians, and data enthusiasts who want to learn more about managing research data throughout the data lifecycle.

Contributing institution(s):

SRCE – University of Zagreb University Computing Centre, University Library Rijeka, the University Library Split, the City and University Library Osijek and the National and University Library in Zagreb.

OS training and workshops for University PhD students

Description: In discussion with the University PhD School it has been decided that there will be regular (per semester) training and workshops organized to promote OS principles among PhD students and early-stage researchers

Why does it need to be sustained?

To have continuous training and opportunities to promote OS among early-stage researchers at the University level.

How it is/will be sustained?

Trainers will be found among the NOSCI@MK community, the activities are voluntary for the part of the trainers, while the logistics support will be covered by the PhD School.

Target communities:

PhD students and early-stage researchers

Contributing institution(s):

Ss. Cyril and Methodius University in Skopje

Rewards and Incentives for ORDM and FAIR

Description: Set of recommendations for supporting ORDM and FAIR practices

Why does it need to be sustained?

This is a live set of recommendations that has to evolve with the dynamics of science and research dissemination practices.

How it is/will be sustained?

We will explore, revise and extend the set of recommendations for supporting ORDM and FAIR in terms of assessment, evaluation and promotion of scientists and institutions.

Target communities:

Researchers, research institutions, funders, policymakers, librarians

Contributing institution(s):

Rudjer Bošković Institute, University of Belgrade and all partners

Training material

Description: Training material on the following topics: introduction to open science, open access, publishing hands-on, handling research data, financial aspects of open science, next-generation research assessment, EOSC, EOSC services, Open Science cafe, KIFU services.

Why does it need to be sustained?

Demand from the community.

How it is/will be sustained?

Maintain and extend within EOSC Future and use local and international funds. Exchange ideas with Skill4EOSC.

Target communities:

researchers, professors, PhD students, decision-makers

Contributing institution(s):

Governmental Agency fo IT development (KIFÜ)

Slovenian Open Science Community Web Portal

Description: Official website of the Slovenian NOSCI (Slovenian Open Science Community), available at <https://odprtaznanost.si/>. Currently, the website offers news regarding EOSC and open science in the national, European and global context, which are also delivered via a mailing list to the NOSCI members and the interested public.

The portal will also implement a catalogue of Slovenian services contributing to open science and serve in publishing NOSCI outputs and documentation, administrative information, and important events.

Why does it need to be sustained?

The portal will act as a central point of reference for open science and EOSC-related news, training, services and tools and NOSCI outputs for Slovenian open science stakeholders. The aim is to establish a unified, complementary system of open science in Slovenia in the field of services, infrastructures and training to improve the working conditions of researchers, encourage the dissemination, exchange and reuse of knowledge through open access, develop open science-related skills and set up a training system for target users.

How it is/will be sustained?

The maintenance of the NOSCI activities will be supported by the ministry responsible for science after the confirmation of the new action plan (pending) related to the new Resolution on the Slovenian Scientific Research and Innovation Strategy 2030.

Target communities:

Higher education and research institutes, national research and e-infrastructure nodes, researchers, policymakers and funders, libraries, publishers, scientific and professional associations, and citizen science stakeholders.

Contributing institution(s):

University of Maribor Library (UMUKM), Academic and Research Network of Slovenia (ARNES)

Hands-on workshop: Touching on Data and Open Source Software for Open Science; Guide: Software and free and open source software in open science

Description: Workshop developed to tackle the challenges of reproducibility in terms of open-source software development for the research. The supplementary guide, suitable for stand-alone reading, describes software in science, FOSS and open science, the use of software in OS practices, actual software used, the attitude of researchers, finding research software, and tools for the social sciences. It provides recommendations for supporting FOSS adoption and software development and visibility in science, It also describes and compares FOSS licences and covers licence selection, compliance and compatibility, and licence impact on the community, software quality, longevity and sustainability. It also outlines the licence management process and suggests a few software composition analysis and licence selection tools.

Why does it need to be sustained?

Software development during research, archiving and dissemination is an integral part of the replicability and reproducibility issues in research.

How it is/will be sustained?

We will further develop a workshop program that was proven in practice and extend it as needed. The workshop will be offered to researchers on demand and within the conference events.

Target communities:

Researchers, students, librarians

Contributing institution(s):

University of Belgrade (workshop and guide), Ruđer Bošković Institute (workshop)