



**E-RIHS**

EUROPEAN RESEARCH INFRASTRUCTURE  
FOR HERITAGE SCIENCE

## E-RIHS IP

### European Research Infrastructure for Heritage Science IMPLEMENTATION Phase

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#### D5.4 E-RIHS ERIC Catalogue of Services

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## ABSTRACT

The E-RIHS Catalogue of Services (CoS), available at <https://catalogue.e-rihs.eu/>, offers a simplified, interoperable, and FAIR-aligned platform for accessing and managing E-RIHS services. Building on earlier E-RIHS-related efforts within EU projects, the current version represents an advancement of the previous experiences, integrating innovative features aligned with the latest interoperability standards and enhanced user experience.

The CoS operates as a stand-alone web platform, featuring a user-friendly frontend for service discovery, selection, and proposal submission, alongside a robust backend for proposal management, Key Performance Indicators monitoring, and data handling. Its core components include dynamic service descriptions, a sophisticated filtering and search system, and a detailed proposal submission workflow that supports co-creation and multi-service access requests. Integration with external platforms such as ORCID and adherence to controlled vocabularies further facilitate seamless user interaction and data consistency.

The CoS also includes advanced dashboards tailored for various user roles — researchers, reviewers, and service managers — streamlining processes from proposal submission to access conclusion and post-access duty delivery. Continuous training initiatives, including webinars and digital handbooks, will allow users to engage effectively with the platform while fostering interdisciplinary collaboration and knowledge exchange. Moreover, thanks to the Laravel and Elasticsearch technologies at its base, the platform ensures scalability, efficiency, and precise service recommendations powered by natural language processing.

Future developments will leverage semantic and AI technologies to enhance usability, multilingual accessibility, and interoperability, transforming the CoS into an enriched knowledge ecosystem.

By integrating cutting-edge technology with a user-focused design, the E-RIHS CoS enhances the heritage science community, fostering accessible, efficient, and collaborative research opportunities across Europe and beyond.

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## ABBREVIATIONS

ACRONYMS	EXPANSION
AAT	Art & Architecture Thesaurus
API	Application Programming Interface
ARCHLAB	ARCHive LABoratory: E-RIHS access platform that brings together organized scientific information in largely unpublished datasets from archives of prestigious European museums, galleries and research institutions ( <a href="https://www.e-rihs.eu/e-rihs-catalogue-of-services/">https://www.e-rihs.eu/e-rihs-catalogue-of-services/</a> )
ARIA	Access to Research Infrastructure Administration
CIDOC CRM	Comité International pour la Documentation Conceptuaò Reference Model
CLARIN ERIC	Common Language Resources and Technology Infrastructure ( <a href="https://www.clarin.eu">https://www.clarin.eu</a> )
CoS	Catalogue of Services of E-RIHS
DIGILAB	DIGItal LABoratory: E-RIHS access platform that provides remote access to heritage science data, supplemented with digital services and tools within a virtual research environment (under development)
EDM	Europeana Data Model
EMBRC ERIC	European Marine Biological Resouce Centre ( <a href="https://www.embrc.eu">https://www.embrc.eu</a> )
EOSC	European Open Science Cloud
ERC	European Research Council
ERIC	European Research Infrastructure Consortium
FIXLAB	FIXed LABoratory: E-RIHS access platform that brings together fixed research facilities and associated scientific experience of their staff that develop and maintain sophisticated state-of-the-art instrumentation for advanced diagnostics and archaeometry ( <a href="https://www.e-rihs.eu/e-rihs-catalogue-of-services/">https://www.e-rihs.eu/e-rihs-catalogue-of-services/</a> )
GNU GPL	GNU General Public License
H2IOSC	Humanities and cultural Heritage Italian Open Science Cloud funded by the European Union – NextGenerationEU – NRRP M4C2 – Project code IR0000029 - CUP B63C22000730005 ( <a href="https://www.h2iosc.cnr.it">https://www.h2iosc.cnr.it</a> )
HS	Heritage Science
Instruct-ERIC	European Research Infrastructure Consortium focused on providing services for structural biology research ( <a href="https://instruct-eric.org">https://instruct-eric.org</a> )
IPERION HS	Integrating Platforms for the European Research Infrastructure ON Heritage Science (H2020, GA n. 871034, 2020-2024)
IT	Information Technology
JSON	JavaScript Object Notation
KPIs	Key Performance Indicators
MOLAB	Mobile LABoratory: E-RIHS access platform that brings together European laboratories offering state-of-the-art mobile equipment and related competencies, for in-situ non-destructive measurements of artworks,

ACRONYMS	EXPANSION
	collections, monuments and sites ( <a href="https://www.e-rihs.eu/e-rihs-catalogue-of-services/">https://www.e-rihs.eu/e-rihs-catalogue-of-services/</a> )
MSCA	Marie Skłodowska-Curie Actions
NLP	Natural Language Processing
ORCID	Open Researcher and Contributor ID ( <a href="https://orcid.org">https://orcid.org</a> )
PARTHENOS	Pooling Activities, Resources and Tools for Heritage E-research Networking, Optimization and Synergies (H2020, GA n. 654119, 2015-2019)
PID	Persistent Identifier
R	E-RIHS Reviewer
RIIs	Research Infrastructures
SKOS	Simple Knowledge Organisation System
SM	E-RIHS Service Manager
SSHOC	Social Sciences and Humanities Open Cloud ( <a href="https://sshopencloud.eu">https://sshopencloud.eu</a> )
SSO	Single-Sign On
TM	E-RIHS Team Member
UGL	E-RIHS User Group Leader
UH	User Helpdesk of E-RIHS
UX	User Experience

# 1. INTRODUCTION

This document – produced by a core team at CNR (INO-*National Institute of Optics* as leader of the dedicated E-RIHS IP task *T5.3 Upgrading the Catalogue of Services platform on the E-RIHS website* alongside ISPC-*Institute of Heritage Science*, and SCITEC-*Institute of Chemical Sciences and Technologies “Giulio Natta”*) in collaboration with ICT company Net7, and in constant dialogue with partner institutions of E-RIHS – describes the advancements achieved in the design and development for the E-RIHS ERIC Catalogue of Services (CoS), accessible at the following link: <https://catalogue.e-rihs.eu/>

The Heritage Science community is very broad and multidisciplinary (e.g., conservation, natural sciences, humanities) and it is inscribed in different contexts (environments) with heterogeneous domains of knowledge. E-RIHS is constituted by laboratories and archives from research organisations, museums and other institutions in the Heritage Science domain, established mainly in European countries, but also in other geographical areas.

The E-RIHS Catalogue of Services (CoS) is a web-based platform for facilitating potential users to discover physical and digital services provided by partner institutions. It is built on the foundation of previous European projects such as the IPERION HS CoS, extensively described in a deliverable from the E-RIHS Preparatory Phase project (Meghini et al., 2020).

E-RIHS gives access to different kinds of scientific services through four types of platforms:

- **ARCHLAB** – provides access to organised scientific information in largely unpublished datasets from scientific archives and samples of prestigious European museums, galleries, and research institutions.
- **FIXLAB** – provides access to large instrumentation in the premises of the laboratories of the partner institutions. The FIXLAB services aim to address the major questions raised by the materiality of cultural heritage artefacts in terms of their genesis, manufacturing processes, alterations, conservation, and preservation.
- **MOLAB** – consists of key laboratories across European countries providing coherent access, under a unified management structure, to a set of mobile equipment and related competencies, for in-situ non-destructive measurements of artworks, collections, monuments, and sites.
- **DIGILAB** – provides remote access to Heritage Science data, supplemented with digital services and tools within a virtual research environment (under development) .

The E-RIHS Catalogue of Services supports excellence-driven access and thematic calls, with users can access E-RIHS services through specific terms and conditions described in the E-RIHS Access Policy (Etgens, Laclavetine & Petitcol, 2024).

The CoS is structured to allow data ingestion from the EOSC and SSHOC marketplaces.



## 2. LEARNING FROM THE CATALOGUE OF SERVICES OF OTHER RIS

Today, several Research Infrastructures (RIs) within different fields have created CoS to showcase and allow researchers access to resources (datasets and software) and scientific services, exploiting the advantages of information re-usability and cutting-edge analytical instrumentation. To this aim, one of the most challenging aspects of creating a reliable CoS – suitable for a wide range of potential users – is setting interoperable systems and standardised and normalised metadata concerning datasets and services.

To assess the current state of CoS within RIs, a mapping of the existing Catalogue of Services at the European level was done and reported in the previous E-RIHS IP deliverable *D5.3 E-RIHS ERIC Catalogue of Service: Approach and Advancement (0.1)* (Benassi et al. 2023).

### 2.1 Exploring the ARIA System

To complement the previous revision, an in-depth exploration of the catalogues of other RIs was recently conducted. To this aim, the E-RIHS catalogue team met with a partner institution of LaserLab Europe, a research infrastructure focused on optics, offering laser facilities for various applications, including Heritage Science. During the meeting, the E-RIHS team learned about the ARIA (Access to Research Infrastructure Administration), a CoS management platform used by nine RIs, some of them reported in the table below, including EMBRC and Instruct-ERIC. These infrastructures use ARIA to manage proposals, reviews, and service access.

RI	Field	Website
LaserLab Europe	Optics: Laser and photonics	<a href="https://www.laserlab-europe.eu/">https://www.laserlab-europe.eu/</a>
EMBRC, European Marine Biological Resource Center	Biology	<a href="https://www.embrc.eu/">https://www.embrc.eu/</a>
Instruct ERIC	Biology	<a href="https://instruct-eric.org/platform-catalogue">https://instruct-eric.org/platform-catalogue</a>
ReMade@ARI, Recyclable Materials DEvelopment at Analytical Research Infrastructures	Material Science	<a href="https://remade-project.eu/">https://remade-project.eu/</a>

Table 1: RIs using the ARIA system.

The general workflow of the ARIA system includes 5 steps:

1. **Call:** Managed by the CoS, information is disseminated through mailing lists.
2. **User Proposal:** A custom online form guides users in selecting equipment and services.
3. **Proposal Evaluation:** Reviewers and moderators are automatically assigned, with proposal status updates.
4. **Project Visit:** The provider can manage the visit booking process and track visits and service quality through surveys.
5. **Reporting and Statistics:** The system automatically provides statistics on users, reviewers, and other metrics.

Regarding the different roles and relative dashboards available, each facility has 1-2 facility managers in charge of moderating the interaction – through the communication panel inside the dashboards – between the users, the operators (instrument scientists or technology operators) and the Administrators through the entire workflow.

The system consists of two main components: a backend and a frontend, each playing a specific role in its functionality.

The backend is primarily used by Administrators who manage proposals and oversee access processes through dedicated dashboards. Instead, users interact with the system's infrastructure, known as CoS, where they can browse and select various services, prepare and manage their proposals, and create post-access reports.

Moving to the frontend, potential users register and create their profiles directly on the ARIA system, accessible through the CoS website. Instead, the infrastructure Administrators create their profiles within a separate area of the ARIA system that operates independently of the CoS.

The ARIA system offers several features tailored to Administrators' needs. One key feature is the *External Access* dashboard, which provides a detailed list of all proposals. This list includes important information such as the Persistent Identifier (PID) of the proposal and its title, the type of service requested, the facility involved, and the user's name. Additionally, it tracks each proposal path, records completion dates, and collects feedback. Another significant feature is the *Access Reporting* dashboard. This function provides comprehensive statistics on the services rendered, with data categorised by country, type, and technology. Besides, Administrators can download or print these statistics, making the analysis and documentation of the information regarding infrastructure activity easier.

As it has been delineated here and will be better described in the following paragraphs, the ARIA system structure has numerous similarities with the system developed for the E-RIHS CoS, such as the back and frontends, the series of dashboards and the different roles present. Therefore, exploring it is an opportunity to learn from other realities, and understand the main issues and advantages faced when offering services as a research infrastructure. This also represents an example, helpful for the further improvement of E-RIHS CoS.

### 3. THE NEW E-RIHS CATALOGUE OF SERVICES MODEL

The first Catalogue of Services (CoS) model of the heritage science community was developed during the E-RIHS Preparatory Phase (Meghini et al., 2020) and tested in the IPERION HS project. It was a conceptual data model built starting from the knowledge gathered in the PARTHENOS European project and it was a successful advancement compared to the tools and frameworks previously available to the Heritage Science community. Thanks to this positive experience and the following publication of the SSHOC and EOSC marketplaces respectively in 2021 and 2022, the E-RIHS community decided to update the model according to the new interoperability and FAIR standards and implement it with new innovative features to facilitate the discoverability of the services and the user experience.

Interoperability was a fundamental principle guiding the development of both the E-RIHS Catalogue of Service and proposal submission system. The system's primary entities, including services and catalogue components, were structured according to the schemas provided by partners, ensuring compatibility and compliance with international standards. These schemas align with those defined in the CORDRA<sup>1</sup> framework, which facilitates metadata management and knowledge sharing across different platforms. The system interfaces directly with CORDRA through APIs, allowing seamless data exchange between the proposal submission platform and E-RIHS Metadata Knowledge-Base. This integration ensures that information related to services, proposals, and users can be accessed and shared across multiple platforms, enhancing the overall effectiveness and collaboration potential of the research infrastructure. Additionally, the system supports integration with other external platforms, such as ORCID to facilitate user authentication and access management. By leveraging these external systems, the proposal submission platform can provide a unified and secure experience for users, reducing the need for multiple logins and streamlining the overall workflow.

The new E-RIHS CoS model was preliminary described in the deliverable of E-RIHS IP *D5.3 E-RIHS ERIC Catalogue of Service: Approach and Advancement* (Benassi et al., 2023). This deliverable D5.4 refers to the advancements of the work carried out in these last months as part of the Implementation Phase project. The current CoS has been developed as a stand-alone web platform that includes a frontend designed to describe and allow users to select E-RIHS services and a backend system for managing and monitoring proposals from submission to the access conclusion.

The E-RIHS CoS is available at the following link: <https://catalogue.e-rihs.eu/>.

The frontend is composed of:

- An authentication/registration system;
- A full and dynamic description of the services;
- A submission system with a list of selected services and an application form to be filled out;
- A NLP search engine developed with Elasticsearch (see § 4.1.1).

The backend is composed of:

- A system of dashboards with different levels of permissions;

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<sup>1</sup> Cordra: An open architecture for digital repository systems. Available at <https://www.cordra.org> [accessed 16 Dec. 2024].

- A tool for monitoring KPIs and creating statistics;
- And a data managing system for all the files.

All these elements have been aligned and organised to answer the FAIR standards and reflect the new approach to a “research need-oriented catalogue” (see D5.3; Benassi et al., 2023).

Before creating the E-RIHS Catalogue of Services, it was necessary to establish the basis of its digital environment. An E-RIHS community was created on GitHub (<https://github.com/E-RIHS>) as a repository to make available and develop different resources and tools. Subsequently, an E-RIHS knowledge base community was created to serve as a repository of information about services and resources (<https://data.e-rihs.io/>). The knowledge base is powered by CORDRA, a platform for building and managing digital objects. CORDRA is designed to support the creation, management, and sharing of digital objects, and to provide a flexible and extensible platform for building digital repositories.

Within this community, the “schema” repository was developed to host completed Heritage Science metadata gathering JSON schema. Work and discussion relating to the development of these schemas is being carried out within: <https://github.com/E-RIHS/hs-interoperability>.

A “schema” is a collection of metadata describing a single entity, as listed below:

Schema	Brief description
Service	This schema is intended to model the metadata and details required to document and describe service or access providers within E-RIHS. These services will be offered by one or more funding programmes and exploited in one or more research projects.
Organisation	It represents the research institution, museum, etc. to which one or more persons can be affiliated. It contains information regarding the name, address, geographical coordinates, website, etc.
Person	It represents a person affiliated with a specific organisation. It contains information such as name, biography, country, role, etc. The role is particularly important since it defines who will be contacted (Contact person or Service Manager) when a User selects a service.
Technique	This schema is intended to model the metadata and details required to document and describe techniques that are used within access offerings in E-RIHS.
Equipment Tool Software	It represents the Equipment, Tool or Software from more than one equipment employed. It describes the potential results obtained (output).
Method	It describes the procedure on how the Tool/Equipment/Software is set-up and used. It is expected to be a default standardized description reusable to define the service offered by different Service Managers.
Software	It represents the Equipment, Tool or tool form from more than one equipment employed. It describes the potential results obtained (output).
KPI	This schema is intended to model the metadata and details required to document particular key performance indicators (KPIs) as defined by E-RIHS, capturing actual data.

*Table 2: List of the schemas available in GitHub.*

A Service is composed of different schemas: a Provider (an Organisation plus one or more Service Managers), a Tool or a set of tools, and a Method.

The “Method” schema represents an innovation compared to the previous data model. The “Method” entity describes the way a specific equipment is employed by a Service Manager to offer a particular Service. This entity could be the same for different Service Managers, yet its preparation needs a certain level of standardisation and the designation of the actor or institution in charge of the definition of this entity.<sup>2</sup>

Each schema contains information about a specific entity, and it is partially implemented with controlled vocabularies. The controlled vocabularies were developed in OpenTheso<sup>3</sup>, a multilingual and multi-hierarchical thesaurus manager, released with a GNU GPL licence. OpenTheso facilitates a collaborative approach to building and managing controlled vocabularies. This is a crucial feature in a multidisciplinary community like E-RIHS. An OpenTheso E-RIHS community was created and is available at the link: <https://vocab.e-rihs.io/>.

The system also provides open APIs, which are used by the CoS to maintain the controlled lists updated (<https://vocab.e-rihs.io/openapi/doc/>).

### 3.1 System Architecture and Requirements Analysis

The task’s initial phase focused on gathering stakeholders’ requirements, defining a flexible system architecture, and establishing a scalable development approach. The architecture was designed for future expansion, supporting seamless integration of new features to adapt to evolving needs.

Stakeholder interviews and a detailed mapping of the functional requirements ensured that every aspect of the system matched real-world workflow needs, including catalogue navigation, proposal submission, monitoring, and review processes.

To gain a comprehensive understanding of stakeholders’ needs, detailed discussions were conducted with researchers, administrators, and potential users.

These interactions helped in identifying specific pain points in the existing system and provided valuable insights into the desired features and functionalities of a modern catalogue of services and proposal submission system.

The information gathered through these engagements served as the foundation for creating a requirements specification document that guided the subsequent design and development phases.

The system architecture was implemented using Laravel, a powerful PHP web application framework, and Elasticsearch, a distributed search and analytics engine.

The use of Laravel enabled efficient development and easy maintenance of the different modules of the system.

This approach ensured scalability, reliability, and modularity, which was critical for handling the various aspects of catalogue and proposal management, such as user authentication, data storage,

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<sup>2</sup> This feature, which allows different Service Managers to select the same method), will be implemented shortly. Currently, Service Managers can only select the methods they are personally described.

<sup>3</sup> OpenTheso: A collaborative web platform for managing, sharing, and publishing multilingual thesauri and controlled vocabularies. More details at <https://opentheso.huma-num.fr/opentheso/> [accessed 16 Dec. 2024]

catalogue searching, peer review, and notifications. Elasticsearch provided the system with efficient and powerful search capabilities, enabling users to quickly and accurately locate services and resources.

## 3.2 The CoS Frontend

### 3.2.1 AUTHENTICATION SYSTEM

As it was already explained in the deliverable D5.3 (Benassi et al., 2023), the CoS is composed of a frontend (Users' Interface) and a backend (dashboards). The former helps the user to discover and select resources and services, while the later allows the different actors to interact with the Catalogue of Services.

To register and log in to the E-RIHS platform, users can follow a simple process. They can log in using their ORCID account (<https://orcid.org/>). For those who do not yet have an ORCID account, it can be easily created during the registration process. This requirement reflects E-RIHS's commitment to open science as part of the ESFRI research infrastructure, which promotes open access policies and fosters collaboration within the research community.

Alternatively, users can create an E-RIHS account by providing their email address, setting a password, confirming it, and completing a CAPTCHA verification. They must also accept the terms and conditions to activate their account.

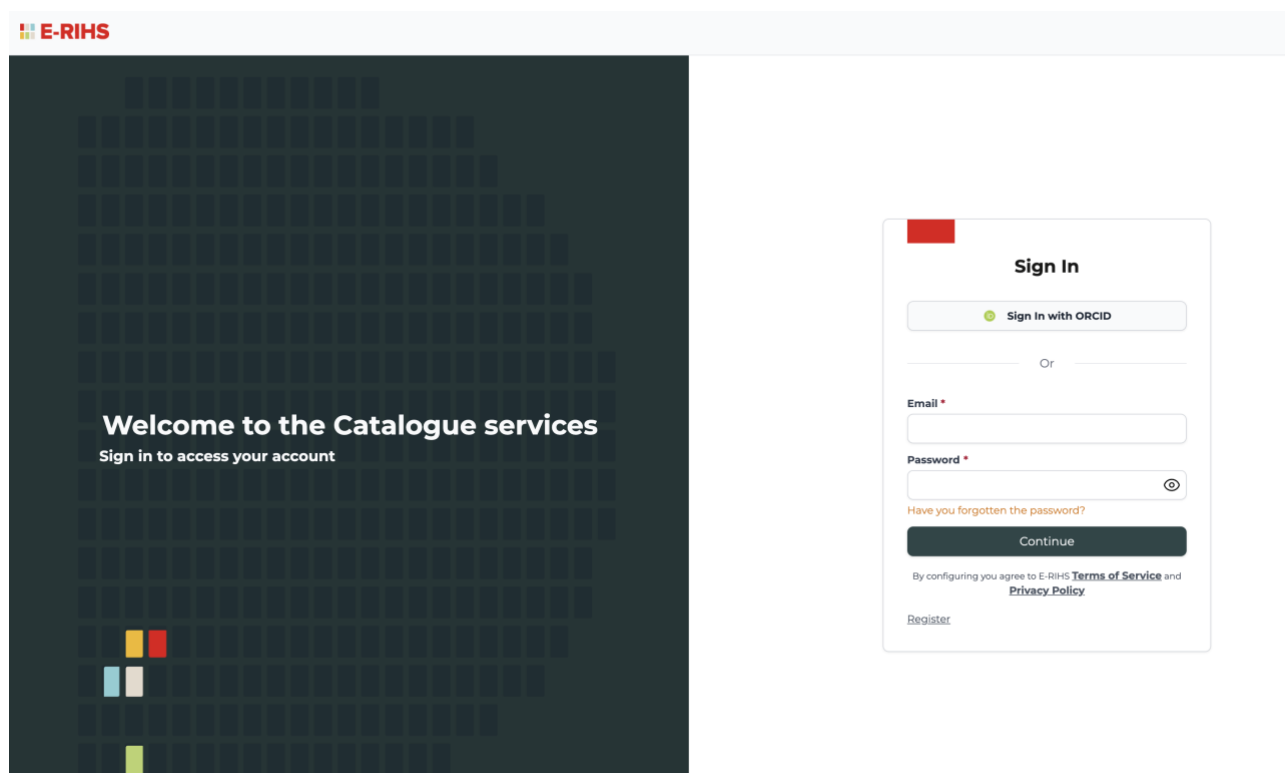


Figure 1: Landing page of the Catalogue of Services (CoS).

All users have the “User” permission level at the initial registration. The User Helpdesk (UH) is notified via email each time a new User is created. According to the role that the User has, the UH can update their role to “Reviewer” (R) or “Service Manager” (SM). These roles can coexist with the simple User role, allowing individuals to manage multiple responsibilities and submit proposals.

Because ORCID does not uniformly provide certain information, users who want to submit a proposal must complete the "Detailed personal profile", as required by the European Commission for statistical purposes. Consequently, the new application form asks users to fill in fields such as country, nationality, birth year, and position, to ensure consistency.

Once the detailed profile is completed, users can access their personal dashboard. Here, they can find their detailed profile, documents (including images and reports), the roles assigned and the status of their proposals.

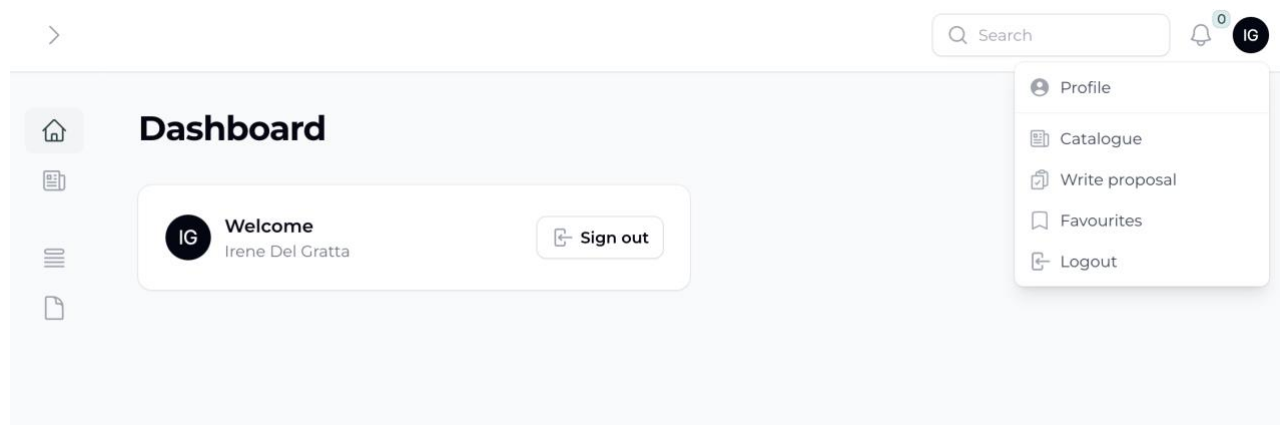


Figure 2: User dashboard.

### 3.2.2 THE COS STRUCTURE: A FULL AND DYNAMIC DESCRIPTION OF THE SERVICES

The landing page of CoS is structured to show and browse the E-RIHS access offer. On the left, a set of filters contributes to selecting one or more services according to the user's needs: platforms, organisations, countries, techniques, materials, fields of application, and objects.

Clicking on the title or the arrow, Users can explore a Service, select it, and put it in the online basket or save it for later.

Each Service is described from a selection of items:

- Service title
- Description
- Platform
- Techniques
- Tools (if applicable)
- Organisation
- Service contact person
- Organisation contact
- Fields of application
- Materials
- Reference
- Service limitations

The Tool/Equipment are described as follows:

- Title
- Organisation
- Last checked date
- Description
- Output and data types
- Impact on object or sample
- Acquisition/Target areas
- Impact on object or sample
- Working distances

#### Service Manager/Contact person

- Name
- Email

#### Reference

- Publications
- Photo/Video
- Success Stories (that are links to “Post access duties” reports that will be published in the Zenodo E-RIHS community - <https://zenodo.org/communities/e-rihs/>).

### 3.2.3 THE APPLICATION FORM

The User Group Leaders (UGLs) can submit a proposal only when a call for access is open, and they have enriched their profiles with all the information requested. Otherwise, the system allows one to select services but not to write a proposal.

Once UGLs select one or more services, they can write a proposal.

< Go back to catalogue

#### Confirm services

Please note that only one proposal can be submitted at a time as a User Group Leader. Ensure that all services you intend to request are included with this proposal. If the proposal is still in draft, you must complete and submit it before starting a new one.

Add more services

##### Scanning VIS-NIR multispectral reflectography

Multispectral imaging analysis offers amazing possibilities for diagnosis and study of artworks. Depending on the radiation used (e.g., visible VIS, infrared IR), the reconstructed images may reveal information that cannot be retrieved from a simple observation of the object. Results obtained are of extraordinary importance not only for the documentation of the artwork's conservation status, but also for its preservation and memory. In particular, VIS radiation allows for spectrophotometric characterization of the painted surface entailing colour variation analysis, which may turn definitely useful for restoration purposes - e.g. for monitoring colour changes due to either the cleaning or aging. NIR radiation, thanks to the transparency of most pigments in this spectral region, enables the visualization of features underneath the painted surface, such as sketches of underdrawing, pentimenti and retouchings. The Multispectral Scanner is revolutionary in the field of VIS-NIR reflectography, as it provides a set of high-resolution images, simultaneously acquired at different wavelengths in a huge spectral region, ranging from 395 to 2500 nm. The stack of images, which are self-registered and aberration-free, facilitates the study of painting materials and hidden details, enabling to shed light on the artist's technique and realization stages.

Platforms: Molab

Tools: Multispectral scanner

Techniques: Scanning vis-nir multispectral reflectography (395 - 2500 nm)

Organization  
National Institute of Optics | Italy

Remove

1 Service[s]

Write a Proposal

Figure 3: “Write a Proposal” feature.



The application form is designed to guide users throughout the proposal process. By completing it online, it becomes easier to gather information regarding their research needs, access details, and other aspects essential for both feeding the recommendation system and tracking key performance indicators (KPIs).

The application form drives UGLs to give detailed information about the proposal and is divided into different sections:

**Services summary** – UGLs can provide descriptions of the objects they request to be analysed. They are also required to upload the necessary permissions and provide details regarding logistical preparations, potential risks, and safety hazards.

Figure 4: “Services summary” overview.

**Proposal and workplan** – UGLs must provide a detailed scientific description of the project, along with relevant information needed for reviewers to conduct through scientific evaluation.

Figure 5: “Proposal & workplan” section.

**Partners** – In this section, UGLs can add team members involved in the proposal. Only team members with an account and an enriched profile can be added. UGLs may also appoint one or more deputies to manage the proposal and receive the automatic emails.

PROPOSAL

If you need assistance with completing the application form, you can:

1. Hover over the question mark icon to view additional information.
2. Watch the instructional video at the following (link)
3. Contact the User Helpdesk via email at: [userhelpdesk@e-rihs.eu](mailto:userhelpdesk@e-rihs.eu).

Services summary Proposal & workplan Partners Additional information Terms and conditions

Short Curriculum vitae of the User Group Leader Max 300 words, words left: 29

Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged. It was popularised in the 1960s with the release of Letraset sheets containing Lorem Ipsum passages, and more recently with desktop publishing software like Aldus PageMaker including versions of Lorem Ipsum. Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged. It was popularised in the 1960s with the release of Letraset sheets containing Lorem Ipsum passages, and more recently with desktop publishing software like Aldus PageMaker including versions of Lorem Ipsum.

User Group participants involved in this proposal: (2)

Partner	Email	User group leader
Lalla Lellero	<a href="mailto:laura.benassi@ino.cnr.it">laura.benassi@ino.cnr.it</a>	<input checked="" type="radio"/> Yes <input type="radio"/> No
Select an option		<input type="radio"/> Yes <input type="radio"/> No

Add team member

Only users with a complete profile can be added as partners, if you don't see a user, please contact them and have them complete their profile.

Back Next

Save as draft

Figure 6: “Partners” section showing how to add team members.

**Additional information** – This section informs about relationships with other EU projects, training activity, and industrial sponsorship.

**Terms and conditions** – UGLs must accept all the “Terms and conditions” files: Access policy, personal data policy, and data management plan.

### 3.2.4 ACCESS WORKFLOW

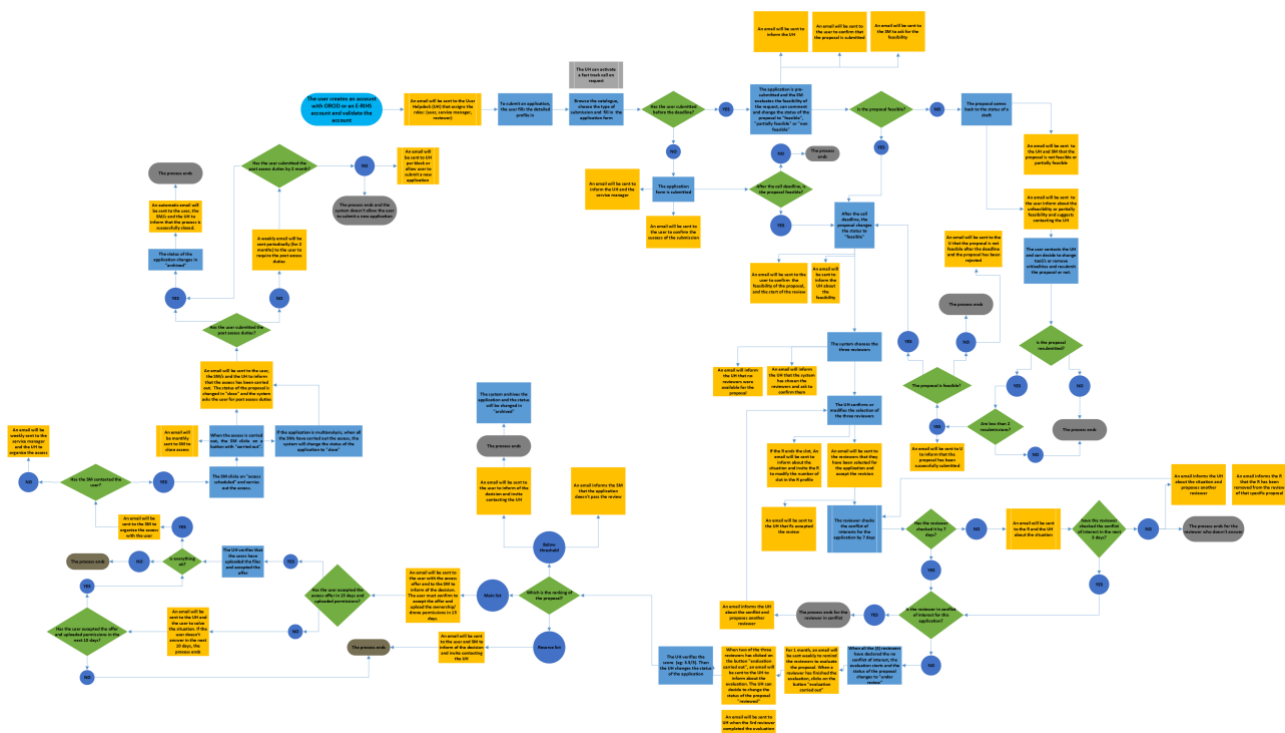


Figure 7: E-RIHS workflow for access calls, from proposal submission to implementation.

As outlined in the *E-RIHS Access Policy* (Etgens, Laclavetine & Petitcol, 2024), E-RIHS provides continuous access through open calls for excellence-driven access, with two cut-off deadlines annually, occurring every six months. Additionally, market-driven access, matchmaking services, and wide access are available. Further access opportunities may be activated under specific circumstances (e.g., ERC, EU Partnership, or MSCA projects). The workflow shown in Figure 7 pertains to excellence-driven access calls.<sup>4</sup>

The E-RIHS CoS can be freely navigated online; however, users seeking to apply for access to the E-RIHS services are required to create an account and enrich their profile with information (see § 3.2.1. *Authentication System*, for instructions on creating a new account and registering on the E-RIHS Catalogue of Services).

Registered users can have a role as a User Group Leader (UGL) or as a Team Member (TM). The UGL is responsible for managing one proposal at a time per each call. UGLs can appoint a deputy to share the management of the proposal. UGLs cannot submit a new proposal until they have submitted the post-access duties requested for the previous one.

UGs can select one or more services from different platforms and different providers and submit a multi-analysis proposal approaching the research needs from different points of view.

<sup>4</sup> Link to the original Visio file can be accessed at the following link: [E-RIHS Workflow 1.7](#) [accessed 16 Dec. 2024].

Once submitted, the proposal must pass through the feasibility assessed from the service provider/s involved in the proposal. The SMs can comment the feasibility; their comment can be read by the UH and the Reviewers (Rs) of the proposal.

A proposal can be feasible, unfeasible or partially feasible (in the case of a multi-services proposal). If a proposal is unfeasible or partially feasible, UGLs are invited to contact the User Helpdesk (UH) or the Service Manager/s (SMs). This path encourages the co-creation of proposals through a stronger collaboration between them. UGLs have the opportunity to edit the proposal (e.g., change or remove selected service(s) or address the critical issues indicated by the SM) and re-submit it. This can be possible only once and must occur before the call deadline. At the deadline, proposals deemed feasible at the first step are confirmed as such, while the proposals submitted for the second time must pass through the feasibility evaluation again. If deemed feasible, they continue the process; otherwise, they are rejected and UGLs must wait until the next cut-off of the continuous call framework to submit a new proposal.

After the feasibility step, the review process starts and an algorithm selects three Reviewers for each proposal, matching some metadata and keywords defined in the proposal and the Reviewers' profiles. In case the algorithm is unable to choose the proper Reviewers in the database of independent experts, the UH can intervene manually.

Reviewers can agree to review the proposal and check for possible conflicts of interest for the selected proposal through the dashboard system. This procedure must be carried out within 7 days (these passages are under the control of the UH). If the Reviewers do not check the conflict of interest by 7 days, a reminder is sent to them to request an answer within additional 3 days. If the Reviewers fail to check the conflict of interest in the maximum time available (10 days) or if the Reviewers have a conflict of interest for the proposal, the system or the UH will choose another Reviewer(s).

When all three Reviewers confirm having no incompatibility with the proposal, the evaluation starts, and the proposal changes the status to "Under review".

The Reviewers evaluate the proposal according to the evaluation criteria defined in the E-RIHS Access Policy (Etgens, Laclavetine & Petitcol, 2024) and, in the end, click on the button "Evaluation carried out" (if the button is not pressed, an email will be sent weekly for one month). When two of the three Reviewers finish the evaluation and click on "Evaluation carried out", an email is sent to the UH to inform them about the status of the proposal. The UH can force the process and click on the status of the proposal in "Reviewed". At this point, the UH verifies the scores, and based on it, changes the status of the proposal/s in one of the following categories: "Below threshold", "Main List" or "Reserved list".

If the proposal is "Below the threshold", the process ends, and in the dashboard system the application changes its status to "Archived".

If the proposal is on the "Reserved list", the proposal cannot be granted but it stays active until a new call opens.

If the proposal is in the "Main list", UGLs receive an email with the access offer. They must go to their dashboard and commit different actions, such as accepting the offer and uploading the ownership or drone permissions within 10 days. The UH checks that Users have accepted and uploaded the correct files. Once all the requirements have been satisfied, the UH clicks on a button and the SM can schedule the access. Otherwise, the proposal is archived if the UGLs fail to provide the documentation after 16 days.

Upon the UGLs' acceptance, the SMs will contact UGLs to organise the access (an email is sent periodically to SM to remind them to contact the user to organise the Access). In the SM dashboard, once the access is scheduled, SM clicks on "Access scheduled". SM and users carry out the access. Once carried out, SM clicks on the button "Access carried out". An email is sent weekly until SM has clicked on "Access carried out". At this point, the proposal changes the status to "Close". In the case of a multi-service proposal, the status is changed to "Close" only when all the SMs click on "Access carried out".

When the status of the proposal passes to "Close", UGLs are required to submit a report called "Post access duties" in the next two months starting from the date of proposal closure.

When UGLs submit the post-access duty, the proposal changes the status to "Archived", and an automatic email is sent to User, SM, and UH to inform them that the process is successfully closed, and the process ends.

Until UGLs do not submit the post-access duty, the system sends a weekly email to ask to submit it for 2 months. If UGLs do not submit the post-access duties in due time, the process ends, and the system doesn't allow UGLs to submit a new proposal.

Each change/action in the dashboard corresponds to automatic emails sent to confirm or request further actions to be taken. The automatic emails are sent according to the role defined in the dashboard and facilitate the process for all from the submission to the conclusion of the access experience.

The UH is the only authorised to change the text of the automatic emails.

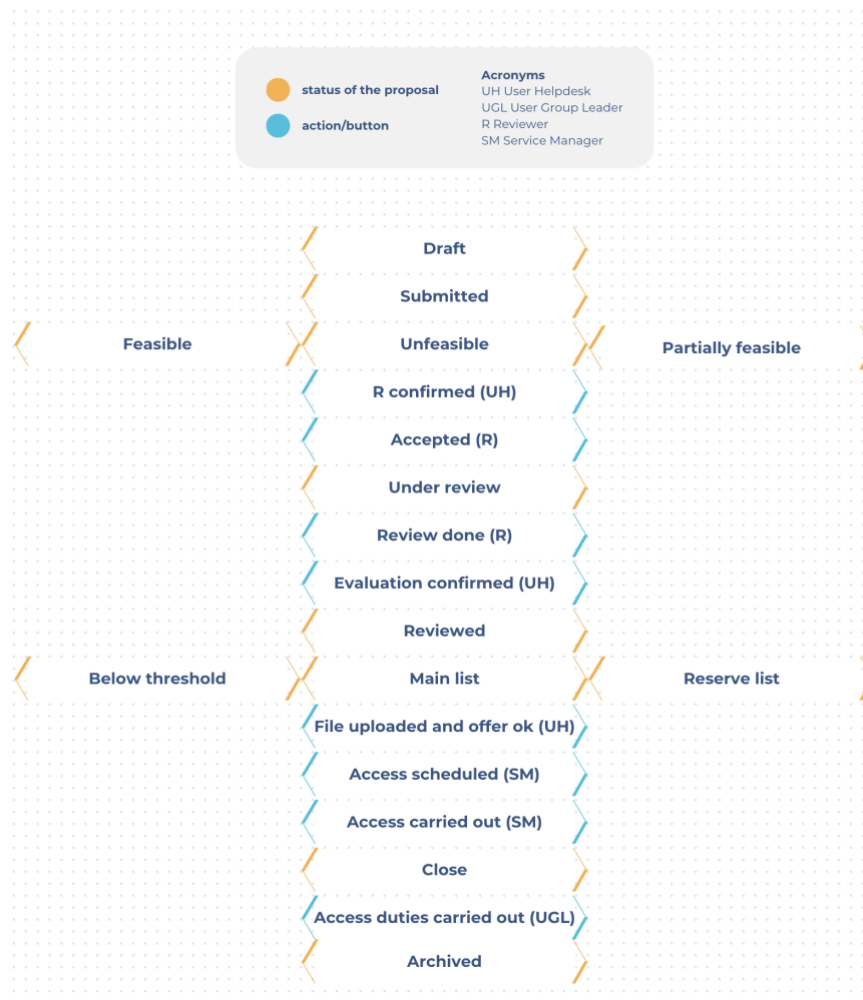


Figure 8: Proposal states and buttons in the dashboards.

### 3.3 The CoS Backend

#### 3.3.1 THE E-RIHS DASHBOARDS SYSTEM

Dashboards are a visual representation of a process, in this particular case a service accessed by a user and offered by an institution partner of E-RIHS. The system helps monitor the process from the submission of a proposal to the post-access duties and gathers useful information that can be used to improve the CoS system and user experience. The current E-RIHS dashboards system has been enhanced compared to the IPERION HS catalogue.

The dashboard design focused on usability and intuitiveness, offering users a streamlined experience that makes it easy to access all key features. The user interface was developed using modern web technologies to ensure compatibility across various devices, including desktops, tablets, and smartphones. This approach made the platform accessible to users with different levels of technical expertise and ensured that they could complete their tasks with minimal effort and friction.

The E-RIHS dashboards system is based on the different roles and permissions linked to them. Compared to deliverable D5.3 (Benassi et al., 2023), changes and improvements have been done to the system, particularly, the role and dashboard of the access coordinator have been eliminated.



Figure 9: Different roles in the dashboards.

Here below the different roles are explained in detail:

- **User (U)** – This is the basic access level. The dashboard offers a standard set of features, which can be expanded when the UH assigns additional roles and permissions. Users can update their personal profiles and manage their own proposals.
- **User Helpdesk (UH)** – The UH can moderate the submission process and assign the different roles through this dashboard. Additionally, the UH can communicate and share information with Users, Reviewers and Service Managers.
- **Reviewer (R)** – Only profiles designated as Reviewers by the UH can access this dashboard. Reviewers can access the proposals submitted and evaluated them. New proposals are automatically assigned to Reviewers through a keyword-matching system. Reviewers can set the number of reviews they want to conduct in a year. Once that number is reached, the system will exclude them from new reviews.  
The dashboard of the reviewer is completely new. Once Reviewers have been selected by the system, within 10 days they must declare that they don't have or have a conflict of interest for that specific proposal by clicking a button in the dashboard. In case of conflict of interest, Reviewers are deleted from the review of the proposal and substituted by another. In case of non-conflict of interest, they can proceed with the evaluation, following the criteria defined in the Access Policy. At the end of the evaluation, the system displays both the scores for each criterium and the overall average score of the proposal to the UH who must rank all the proposals.
- **Service Manager (SM)**, i.e., the service contact person – This dashboard is for the contact person who manages access at a facility (provider). The main activity is to assess the feasibility of the proposal and organise and carry out the access in a co-creation process with the User.

In general, each action taken in the different dashboards is registered in the “Application history”. This feature is particularly relevant for the UH, allowing to track each step of the process and keep all stages under control.



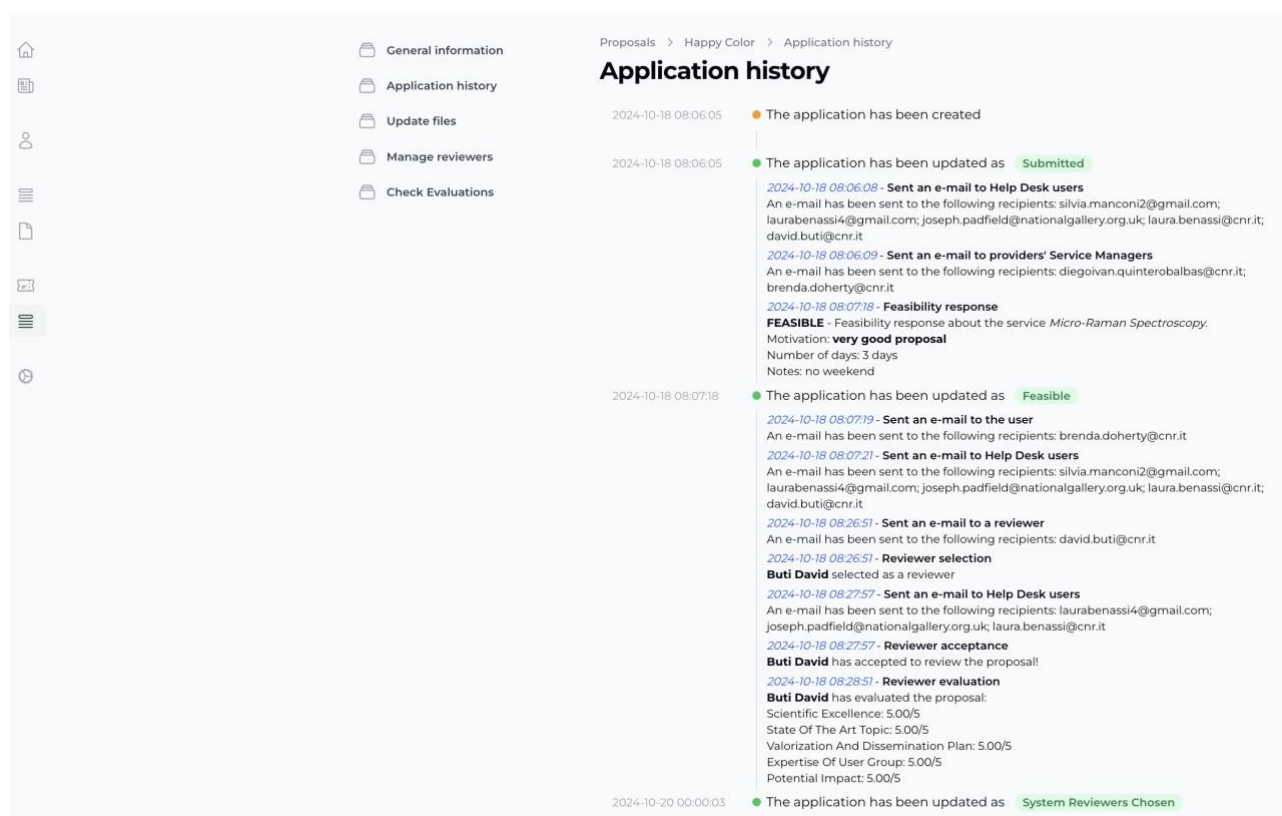


Figure 10: “Application history” feature.

### 3.3.2 A TOOL FOR MONITORING KPIs AND CREATING STATISTICS

The dashboard of the UH will be equipped with a Business Intelligence tool to facilitate the monitoring of KPIs related to the access and to contribute implementing any adjustment strategies.

The tool will extract the following data:

#### Proposals

- submitted in total
- submitted per call
- submitted per country
- accepted (=in main list) in total
- accepted (=in main list) per call
- accepted (=in main list) per country
- in reserve list in total
- in reserve list per call
- by gender in total
- type (new - long term - resubmission) in total
- type (new - long term - resubmission) per call
- status in general



- status per call
- rate of acceptance in total
- rate of acceptance per call
- by scientific disciplines in total
- by scientific disciplines per call
- by scientific disciplines accepted

**Users**

- total number of users
- total number of users who submitted a proposal
- precise number of users per proposal

**Tools (name e ID n.)**

- number of requests for each tool in total
- number of requests for each total per call

The data are visualised with graphs and maps. All the data and file are downloadable as image or pdf.

## 4. THE USER EXPERIENCE OF THE CATALOGUE OF SERVICES

### 4.1 Enhancing the Understanding of the Users' Research Questions

A set of filters introduces users to the choice of services. In addition to the recommendation system, users can filter results based on the following items:

- Platforms
- Organisations
- Countries
- Techniques
- Materials
- Fields of application
- Type of Objects.

Another recent improvement to the E-RIHS CoS is the development of a recommendation system designed to help users select the most suitable equipment and methodology to meet their research needs. This system is still under development and requires a large amount of data to function effectively as inputs for the algorithm.

The first and most important step in developing the recommendation system is gathering the data at its base.

To expand on the concept of the recommendation system in the E-RIHS CoS, it is important to highlight the role that data plays in its development. A recommendation system, much like those used in e-commerce or streaming platforms, works by analysing large datasets to identify patterns and make personalised suggestions. In the case of E-RIHS, this system will process data related to available equipment, methodologies, and previous research projects to provide tailored recommendations to researchers. All data processing is carried out in full compliance with EU regulations. This approach simplifies the decision-making process for users, helping them select the most suitable tools and techniques to meet their specific research needs effectively. However, to function accurately and provide high-quality suggestions, the system needs a robust data foundation. This includes detailed records of past research projects, equipment performance, methodological outcomes, and user feedback. The more data the system has, the more precise and useful its recommendations will be.

As development continues, the system will evolve to become an invaluable resource for researchers, saving time, reducing errors, and improving the overall quality of research conducted through E-RIHS. This process requires collaboration from users who input their data and feedback, further enriching the recommendation system's ability to learn and improve over time.

#### 4.1.1 A NLP SEARCH ENGINE DEVELOPED WITH ELASTICSEARCH

The IT design team prioritised the development of a robust, modular system architecture, selecting appropriate technologies to build an independent platform that interfaces with external services like ORCID. Initial development efforts focused on coding the core functionalities of the system, establishing a secure and resilient database, and implementing the business logic. An SSO authentication system was integrated, enabling user login via ORCID. The CoS structure was

designed to comply with EOSC specifications, with a user interface guiding users through an intuitive service selection process, supported by a powerful Elasticsearch-based backend to ensure fast and accurate search. User interface development aimed at creating a consistent and personalised user experience. The registration module and User Dashboard were optimised to ensure easy navigation and access to key features. Initial usability tests ensured that the interface is both clear and accessible, balancing individual functionalities with a cohesive overall user experience.

The team has already begun collecting data through a pilot application and from E-RIHS providers, with the goal of establishing a foundational dataset for training an AI-driven recommendation system. The system is designed to respond to natural language queries, enhancing its accessibility and usability.

To align with the EOSC guidelines, a comprehensive search and filtering system was implemented using Elasticsearch. This provides users with powerful search capabilities to quickly identify services relevant to their research needs, thereby enhancing both efficiency and usability.

The search mechanism is engineered to process large data volumes with high efficiency, providing quick and accurate results— a critical feature for users dealing with an extensive range of research services. Advanced filtering options have been incorporated into the search functionality, enabling users to refine search results based on criteria such as service type, research area, location, and availability. This level of granularity helps users identify the services that best match their specific research requirements.

In addition to basic keyword searches, the CoS's search functionality supports faceted navigation, allowing users to explore services based on various attributes. This feature fosters an intuitive discovery process, even for unfamiliar with specific keywords or terminology.

The Elasticsearch-based implementation ensures that the system can scale effectively as the number of services and users grows, maintaining consistent performance and reliability.

## 4.2 Optimising the E-RIHS CoS: UX Testing Insights

User interface development aimed at creating a consistent and personalised user experience. The registration module and User Dashboard were optimised to ensure easy navigation and access to key features. Initial usability tests were conducted to ensure that the interfaces are clear and accessible, focusing on both individual functionalities and the overall user experience.

During the early stages of the project, a detailed prototype was created by the IT team to visualize the key workflows of the system and to gather initial feedback from the E-RIHS team. The prototyping process focused on creating a consistent and coherent user journey, starting from registration to catalogue exploration and proposal submission. The prototype was shared with the E-RIHS team in charge of developing the CoS, and a series of review sessions were conducted to gather feedback on the proposed workflows, navigation structures, and design elements. This collaborative approach ensured that the final design aligned with the needs and expectations of the end users.

An intermediate user testing phase involved a significant number of participants to ensure the system is robust and reliable. The testing covered multiple aspects of the platform, including the proposal submission workflow, the efficiency of catalogue filtering and search mechanisms, and the overall intuitiveness of the dashboard navigation. Reviewers and administrators evaluated the peer review system, testing the proposal evaluation and approval workflow. These insights helped ensure that all functionalities are performing as intended under real-world conditions.

In October 2024, the first version of the dashboards system was released. Following this release, the IT team conducted a thorough code review and a comprehensive testing phase, including penetration tests and rigorous security assessments to ensure the platform meets high standards of security and reliability.

A release management plan was defined to ensure a smooth transition from development to operational deployment. After the release, users received training and technical support to facilitate the adoption of the new system (see § 4.3 *Building Skills in E-RIHS: Training on the Catalogue of Services*).

Throughout the testing phase, continuous monitoring and performance evaluations were prioritised to ensure efficient platform operation. Users' feedback have been collected, and data from system usage analysed to identify areas that require improvements. This was crucial to ensure that the system would be intuitive and easy to use for all target audiences, including researchers, facilities, reviewers, and administrators. Based on this ongoing feedback, the system is regularly updated to address any issues and to optimize its performance.

Additionally, continuous communication with users will ensure that the system evolves to meet their needs as they change over time, ultimately enhancing the overall user experience.

During UX testing, questions have been addressed to the users on general usability, specific functionalities, dashboards and interface design, system performance, feedback and improvements, and overall experience.

The questions helped gather both qualitative and quantitative feedback from users, ensuring that any issues or improvements needed can be effectively identified and addressed.

The User interface was developed with a focus on accessibility and responsiveness, ensuring compatibility across various devices such as desktops, tablets, and mobile phones. Modern web development frameworks were used to create an interface that is visually appealing while being efficient and lightweight. The UX strategy emphasised reducing complexity, providing clear guidance at each step, and minimising the number of clicks needed to complete any action.

The insights gained from the prototyping and intermediate testing phase were directly incorporated into the development cycle, leading to continuous improvements in the interface. This iterative design process enabled the IT team to address usability issues early on and enhance the overall user experience, resulting in a platform that is intuitive and enjoyable to use.

### 4.3 Building Skills in E-RIHS: Training on the Catalogue of Services

The services, offered by E-RIHS ERIC, foster the exchange of knowledge and interdisciplinary collaboration among heritage professionals. The idea of co-creation constitutes the core of the E-RIHS services' contribution to the field of heritage science and beyond it. Dealing with the Catalogue of Services, potential users enrich their professional knowledge at all stages of their projects: from identifying the necessary tools and consulting the Catalogue of Services, through the process of developing the proposal, during its implementation and at the final reporting.

The process of co-creation and interdisciplinary training accompanies the internal collaboration within the user's team (often constituted by art historians, conservators-restorers, curators, etc.) and between the user's team and the service provider.

In order to enhance the users' experience of the Catalogue of Services, different initiatives have been organised:

- Online training sessions with User Helpdesk, Service Managers, Users and Reviewers,
- Digital handbooks for Users, for Service Managers and Reviewers.

Additionally, further training initiatives could be organised on demand.

Training on the use of E-RIHS ERIC Catalogue of Services will include guidance handbooks for the Users<sup>5</sup>, the Service Managers and the Reviewers (Benassi, Manconi, & Quintero Balbas, 2024):

### Training for Users

To ensure smooth usability of the Catalogue of Services, the Users will have access to guidance materials with all the necessary information on how to:

- search the catalogue and choose the most appropriate services for the proposal;
- submit the proposal online enabling its correct evaluation;
- implement and conclude the access in line with the E-RIHS post-access duties requirements.

### Training for the Service Managers

The role of the Helpdesk is essential, especially at the submission and reporting stages of the access. For this reason, the helpdesk staff will be trained specifically to guide the user in:

- search of the catalogue and the choice of the most appropriate services;
- technical issues when presenting the proposal for concluding the access.

Training format developed in H2IOSC.<sup>6</sup>

### Training for the Reviewers

The Reviewers play a crucial role in the evaluation process, based on scientific excellence.

- The reviewers must assess a general non-conflict of interest and a specific non-conflict of interest for each proposal assigned to them.
- Training guidelines explain how to assess the non-conflict of interest and approve confidentiality policy and how to proceed with the evaluation of proposed assigned.

In order to improve user's experience with the E-RIHS services, the HS Academy educational initiative will include also series of webinars specifically developed on the topics of scientific interest for potential users. The training webinars are designed to provide training on the heritage science methods, techniques and related services available in the catalogue, guiding users in engaging effectively with the research infrastructure.

By enhancing knowledge exchange and networking of the heritage science community, the HS Academy attracts more potential users, which are more informed about the services offered and the scientific background of available methods.

The HS Academy webinars provide the targeted training for free to the whole heritage community on the following subjects:

- latest technological advancements available through the MOLAB and FIXLAB platforms, as well as their previous and potential new contributions to the field;

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<sup>5</sup> The guidelines for Users will be available on the E-RIHS website. The guidelines for Service Managers and for Reviewers are available on Zenodo-E-RIHS community (see Benassi, Manconi & Quintero Balbas, D.I., 2024), <https://zenodo.org/records/14500623> [accessed 17 Dec. 2024].

<sup>6</sup> Humanities and cultural Heritage Italian Open Science Cloud project. More details at <https://www.h2iosc.cnr.it> [accessed 16 Dec. 2024].

- previous and potential new contributions of the ARCHLAB services to the field;
- opportunities for access to digital resources and services provided by the DIGILAB platform, once it becomes fully operational.

Since the launch of the IPERION HS (2020-2024) and E-RIHS IP projects (2022-2024), webinars and user meetings have been held regularly online. From April 2021, live webinars have been offered, initially accessible to registered participants, with recordings later made freely available on the E-RIHS YouTube channel (<https://www.youtube.com/c/ERIHSEU>).

These webinars continue and they are planned to expand further and all the post-event training materials to become widely accessible to the heritage sector. Sustainability of the HS Academy training materials, of high interest to the users of E-RHIS CoS, will be ensured through the ongoing and future FAIRification procedures applied to all E-RIHS training resources.

## 5. FUTURE PERSPECTIVES

The E-RIHS Catalogue of Services (CoS) is a dynamic tool that requires ongoing consolidation within the community. It is essential to gather feedback for potential improvements regarding the user experience and needs and ensure the catalogue is continuously updated with the latest technological advancements, particularly concerning AI-related features.

**Ongoing developments.** Once the E-RIHS digital platform and resources are consolidated, certain decisions – such as the use of CORDRA – may be revisited and reassessed. Further developments may be planned in collaboration with other research infrastructures, such as CLARIN, or with European or national initiatives, such as EOSC or H2IOSC.

**Multilingual accessibility.** Currently, the Catalogue of Services is available only in English. However, an integrated multilingual tool could enable users to query the catalogue in their preferred language and receive relevant responses. E-RIHS could activate a collaboration with the CLARIN research infrastructure to enhance multilingual accessibility and interoperability of metadata and concepts within E-RIHS research services. Leveraging CLARIN's expertise in automatic translation and semantic technologies, E-RIHS could establish a framework that facilitates multilingual metadata visibility on platforms like OpenTheso or Kosmos in SKOS format. The collaboration could involve two main levels: (i) Metadata translation - translating metadata fields into multiple languages (starting from those of the E-RIHS National Nodes), making use of semantic frameworks to ensure that metadata are consistently represented across languages. This process will involve automatic translation services with manual validation to ensure accuracy and quality; (ii) Query translation - enabling multilingual search capabilities, enabling users to query in their preferred language and access relevant metadata seamlessly. With the consulting of CLARIN, E-RIHS could develop a workflow that includes automated translation for various thesauri, followed by manual review. This workflow would encompass steps such as term extraction, domain corpus analysis, and validation, allowing terms and definitions to be translated and published as a controlled vocabulary. Moreover, CLARIN could provide consultancy in this process, helping E-RIHS with domain term extraction, validation of English terms and creation of definitions, translation of terms and definitions into different languages, and publishing these translations as a controlled, linked vocabulary that reuses existing vocabularies where possible (e.g., AAT, EDM, CIDOC). This initiative would not only support multilingual configurations of the E-RIHS Catalogue of Services but also promote broader engagement with the scientific community by ensuring language inclusivity.

**AI and semantic technologies integration.** The future integration of semantic and advanced artificial intelligence technologies into the E-RIHS CoS represents a significant opportunity to enhance the accessibility, interoperability, and usability of services and resources available to the scientific community and the cultural heritage sectors. The use of semantic standards, such as the SKOS format, could improve interoperability between the E-RIHS CoS and other digital platforms in the cultural heritage field. This would enable data and information to be easily connected and enriched, providing a more complete context and facilitating new discoveries and correlations between resources from different sources. Non-generative AI technologies, such as machine learning and natural language processing, could be used to automatically analyse the catalogue's content and enrich metadata, allowing for a more precise classification of resources and the addition of relevant information. This will improve the indexing and visibility of resources within the catalogue. Once more data and metadata are available in the CoS, AI technologies could also be used to implement intelligent recommendation systems that suggest relevant resources based on user searches or profiles. For example, a researcher might receive suggestions for services or tools

relevant to their project, facilitating the selection process and increasing the catalogue's effectiveness. This feature was only partially developed in the current version of the CoS. Advanced data analysis supported by AI could provide predictive insights into user behaviour and resource utilisation and could offer a more detailed understanding of the scientific community's needs, allowing E-RIHS to tailor its services more precisely. The integration of semantic technologies could transform the E-RIHS CoS into a true knowledge ecosystem, where data is not only accessible but also logically and coherently connected. Adopting semantic and AI technologies for processes such as data management, categorisation, and metadata updating can improve operational efficiency and ensure greater consistency and timeliness of information within the CoS.

All these improvements could be supported by participation in EU or national projects, reinforcing collaboration, knowledge-sharing, and co-creation within the E-RIHS community and the European Research Area (ERA).



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