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Update of the Study on the readiness of research data and literature repositories to facilitate compliance with the Open Science Horizon Europe MGA requirements

Final Report

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Summary

This report and the associated inventory represent the output of a study commissioned by the European Research Council Executive Agency (ERCEA) on the request of the European Research Council (ERC) Scientific Council and conducted between September 2023 and September 2024 by an independent expert. The research presented here is meant to update the "Study on the readiness of research data and literature repositories to facilitate compliance with the Open Science Horizon Europe Model Grant Agreement (HE MGA) requirements", published in 2023 (from now onwards the "2023 Study") [1].

The 2023 Study was intended to:

- create a better general understanding of the availability and nature of repositories in different fields of research, for both literature and research data;
- identify trusted[1] repositories across different fields of research and highlight those that are most widely used by ERC-funded researchers;
- assess to what degree the identified trusted repositories facilitate compliance with the HE MGA [2] requirements related to Open Science, in particular regarding the metadata of deposited research outputs;
- enable the ERC Scientific Council to provide well-founded guidance to ERC Grantees as to which repositories will allow them to fulfil the Open Science related obligations of their grant.

Given the rapidly evolving repositories landscape, the current study is meant to provide an update to the previous research, by collecting and presenting recent data, clarifying definitions and accounting for possible previous glitches.

In particular, the assessment and classification methodology has been revised. We now explicitly refer to the need for the repositories to have separate metadata fields for the information required and differentiate between requirements for data and literature repositories. Moreover, three new categories were introduced to classify the readiness of repositories to allow HE beneficiaries to comply with their Open Science obligations: Exemplary, Essential, and Close to Essential Readiness Levels.

As in the 2023 Study, the candidate repositories for assessment were chosen based on their relevance to ERC domains/panels and historical usage by ERC grantees. We started from the 2023 Study list and included some additional repositories based on feedback received from the community of repositories managers.

In this study, 241 repositories were analysed, and 186 repositories were identified as trusted. The repository readiness to facilitate compliance with the HE MGA Open Science requirements for metadata was also further assessed.

[1] according to the definition given in the Horizon Europe Annotated Model Grant Agreement [3] on page 373

This study provides evidence of the challenges in performing this assessment, which HE beneficiaries will also necessarily encounter, as some concepts are hard to gauge even for individuals with large experience in this field.

Notions such as “community endorsement”, “international recognition” and “certification” need a broader common understanding. Moreover, the study confirms that policy requirements for the preservation, curation, and security of repository contents lack common standards and best practices.

The study reveals that current certification standards often do not align with the essential characteristics of trustiness for repositories as stated in the HE Annotated Model Grant Agreement (HE AGA) [3]. It also suggests that the list of examples for certifications could be expanded.

Concerning how repositories facilitate compliance with the Open Science Horizon Europe MGA requirements, the results of this update largely confirm those obtained in 2023.

However, through a revision of the methodology of the 2023 study, this update offers a more in-depth analysis of how the repositories currently meet the HE MGA requirements, providing a more comprehensive understanding of the present landscape.

Out of the 241 repositories analysed in this study four repositories, i.e. <intR>²Dok, DANS, HAL, and Zenodo, meet the “Essential” readiness level requirements, allowing compliance with all mandatory metadata requisites for both data and literature. An additional repository, AUSSDA, meets such requirements but only accepts data deposition.

Two repositories (HAL and AUSSDA) meet all the mandatory and recommended criteria for metadata mentioned in the MGA for literature repositories (Exemplary readiness level).

As was the case for the 2023 study, it is worth reminding that:

This update and its related inventory aim to provide:

- A tool for use by HE beneficiaries to easily find a repository that facilitates compliance with the HE MGA Open Science obligations, the inventory of identified trusted repositories
- A revised methodology for assessing repository readiness for facilitating compliance with the HE MGA requirements
- An analysis and related discussion of a set of selected repositories and their capacity to support HE beneficiaries to satisfy the HE MGA requirements concerning Open Science.

This update and related inventory are not intended to provide:

- A definitive and exhaustive list of repositories that facilitate compliance with the HE MGA Open Science requirements. Data collection for the initial inventory was skewed towards the resources available during the study, and this is still reflected in the updated inventory. We expect the inventory to grow over time and to evolve, so as to be of even more value to HE beneficiaries.
- A tool to assess repository FAIRness. Although some FAIR-related aspects are part of the repository features that are assessed, a holistic FAIR perspective is not within the scope of this study.
- A formal certification mechanism

1. Introduction

Under Horizon Europe, one of the pivotal open science requirements is the immediate deposition of every peer reviewed publication stemming from funded projects in a trusted repository for scientific publications, in immediate open access and under an open licence. This deposition must occur at the latest at the time of publication and must include a specific set of open metadata as well as information necessary for validating the publication's conclusions. A similar mandate applies to all digital research data generated during the project, necessitating timely deposit in a trusted repository.

In 2022, the European Research Council Executive Agency (ERCEA) commissioned a group of four experts to conduct a comprehensive study on the availability of repositories that support compliance with the Horizon Europe Model Grant Agreement (HE MGA) [2]. The study aimed to understand the repository landscape through extensive desk research and surveys targeting selected repositories. The resulting report and its annexes were subsequently published on Zenodo in March 2023, under the title "Study on the readiness of research data and literature repositories to facilitate compliance with the Open Science Horizon Europe MGA requirements" [1].

The 2023 Study was viewed by about 11.000 distinct users and downloaded more than 7.000 times. Figure 1 shows the impact metrics on Zenodo as of July 2024.

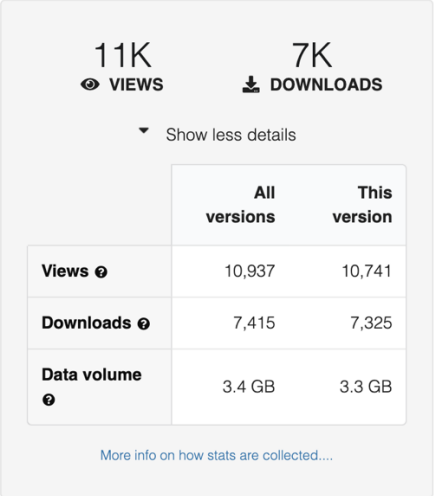

Figure 1. Stats collected in July 2024 related to the 2023 Study published on Zenodo in March 2023.

Given the impact of the 2023 Study, the feedback received, and the rapidly evolving repository landscape, a year after the initial study the ERC Scientific Council decided to request an update. The objective of the current study is to update the 2023 Study.

This Update is meant to deliver the following:

1) **An updated inventory of identified trusted repositories for different fields of research**

- An inventory covering all three ERC domains (Life Sciences, Physical and Engineering Sciences, Social Sciences and Humanities), subdivided by (suitably chosen groups of) ERC evaluation panels[2]. The inventory should also indicate when a repository is open to content from any scientific area. Although the focus is on domain-specific repositories, other repositories, such as institutional repositories are not excluded *a priori*.
- A presentation and motivation for the criteria used for inclusion in the inventory, alongside the methodology employed for the identification of repositories that fulfil those criteria
- A discussion of the most frequent / most important reasons for a repository to not fulfil the criteria to be considered a trusted repository

2) Assessment of repository readiness to facilitate compliance with the Horizon Europe MGA requirements

- Indication of the extent to which the trusted repositories included in the inventory facilitate compliance with the HE MGA requirements related to Open Science, in particular concerning the metadata of the deposited research outputs
- Indication for each individual requirement in the HE MGA whether the repository allows ERC-funded authors to comply
- Identification of discipline-specific or domain-specific repositories with the required qualities in the different research areas associated to the ERC panels
- Indication of:
    - options for metadata access (e.g., through an API)
    - metadata standard used
    - when relevant, specific type of literature accepted by the repositories
    - presence of the repository in OpenAIRE[3]

The report is subdivided into sections covering introduction, methodology, analysis of data gathered, and conclusions. The analysis section includes an overview of trusted repositories, repository readiness for compliance with HE MGA metadata requirements, and repository classification.

This report also includes the following annexes that represent the underlying data of the update and provide a useful list and documentation for the HE beneficiaries:

- ANNEX 1: The inventory of identified trusted repositories as a spreadsheet, with separated sheets for data and literature repositories
- ANNEX 2: The survey questions used to collect information about the repositories included in the update that led to the inventory realisation
- ANNEX 3: The curated results of the survey and information collection that was used as source for the update and related analysis
- ANNEX 4: The methodology used to assess repositories with regard to the Horizon Europe Annotated Model Grant Agreement (HE AGA) [3] trusted repository definition and the metadata requirement

[2] https://erc.europa.eu/sites/default/files/2023-03/ERC_panel_structure_2024_calls.pdf
[3] https://explore.openaire.eu/

2. Methodology

This Update builds extensively upon the robust methodology established in the 2023 Study, incorporating valuable feedback, and introducing targeted enhancements to improve the overall framework. It was designed to address the constructive comments received from the research community and other stakeholders, ensuring that the revised methodology is more comprehensive and capable of capturing nuanced aspects that were previously sometimes overlooked. This approach not only reinforces the solid foundation laid by the original study but also significantly enhances the precision and depth of the analysis, providing a more accurate and detailed understanding of the repositories examined.

The definition of the term “repository” that was used is the one provided in the latest version of the HE AGA:

> ‘Repositories’ are online archives, where researchers can deposit digital research outputs and provide (open) access to them. Repositories help manage and provide access to scientific outputs and contribute to the longterm preservation of digital assets. They can be institutional, operating with the purpose to collect, disseminate and preserve digital research outputs of individual research organisations (institutional repositories, e.g. the repository of University X) or domain-specific, operating to support specific research communities and supported/endorsed by them (e.g. Europe PMC for life sciences including biomedicine and health or arXiv for physics, mathematics, computer science, quantitative biology, quantitative finance and statistics; Phonogrammarchiv for audio-visual recordings the CLARIN-DK-UCPH Repository for digital language data or the European Nucleotide Archive or databases of astronomical observations operated by the European Southern Observatory, among others). There are also general-purpose repositories, such as for example Zenodo, developed by CERN. Personal websites and databases, publisher websites, as well as cloud storage services (Dropbox, Google drive, etc) are NOT considered repositories. Academia.edu, ResearchGate and similar platforms do not allow open access under the terms required and therefore are also NOT considered repositories.
>
> *Horizon Europe Annotated Model Grant Agreement, V1.0, 01-05-2024, Page 373 [3]*

In September 2023 a webinar was organised to present the 2023 Study results to the repository managers who had been involved in the study. During the webinar the group of independent experts presented the outcomes and answered specific questions by the attendees.

89 repository managers attended the webinar and were able to provide their feedback, including the request for a study update and possible expansion of the number of repositories included in the study. Feedback gathered during the webinar and via other channels (emails and dedicated meetings) were taken into consideration to enhance the study methodology.

In the following, a list of changes to the methodology with respect to the initial study is provided:

- The list of investigated repositories was updated, and new repositories were included based on feedback from the initial survey and community comments following the publication of the 2023 Study results.

- A new survey was designed to address previous shortcomings and collect recent data. The new survey, which was longer and more detailed, provided more in-depth explanations to the questions, and to how the repositories' responses would be used to shape the assessment and the classification.

- New definitions for the classification categories were introduced to better capture the degree of readiness of researched repositories.

- The certifications mentioned in the survey by repository managers were analyzed in detail to ensure they met the relevant criteria. During this process, a distinction was made between formal certifications and community endorsements.

- A more in-depth analysis was performed to assess whether the repository allows depositors to provide information on the persistent identifiers (PIDs) of any research output or on any other tools and instruments needed to validate the conclusions of the publication or related to the data deposited.

- A clarification was included about repositories harvested by OpenAIRE, distinguishing this from the OpenAIRE compliance mentioned in the 2023 Study.

All repositories in the updated list were contacted several times to ensure the data collected could well depict the repositories' characteristics.

Updating the list of repositories

In updating our repository list, we began with all repositories from the previous study and incorporated several additional ones that were included following feedback received after the publication of the 2023 Study. From this preliminary list, we excluded repositories that had requested removal (1 repository), those identified as closed to content access and collections that did not permit user uploads (8 repositories), and those repositories for which websites were either unavailable (7 repositories) or had been hacked (1 repository), which we verified at multiple time intervals.

A total of 241 repositories were included in this study as opposed to the 220 ones analysed in the 2023 Study.

Designing the survey for the study

The 2023 Study and this update were both meant to answer two main questions:

- Is the repository trusted, according to the definition in the AGA?
- Does the repository allow to comply with the MGA requirements on metadata?

In both cases, the data we collected on repositories, derived from responses by repository managers to our survey or by desk research, determined the answers.

The survey was sent by the ERCEA, as it had been the case for the 2023 Study; the published text is available as ANNEX 2 of this report.

The principles used to define the questions were not different from the ones used in the 2023 Study.

However, the survey sent for this update was redesigned compared to the one used in the 2023 Study, to better help identify trusted repositories and their metadata structure.

In the survey used for the update, repository managers were first asked to indicate in which category their repository would best fit, i.e. literature or data repository, before deciding the criteria to be used to identify a repository as trusted. Moreover, the feedback received after the publication of the 2023 Study related to metadata requirements led us to reformulate the rationale behind the assessment of this component. Thus, now we specify in the survey that separate metadata fields are requested by the MGA to capture the information identified as mandatory.

The survey was structured into sections, with each section including explanations to assist repository managers in their responses and clarifying how the collected data aligns with the study's objectives. The sections were:

1. Scope
2. General information about the repository
3. Trusted repository identification
4. Metadata structure to support compliance with Horizon Europe Open Science requirements
5. Additional information about the repository
6. Comments and feedback

Key updates in the survey included also new definitions for "Access to content upload" and "Access to repository contents", which previously relied on Re3data ones.

We introduced a field "linked resources Persistent Identifier (PID)" and reported whether a repository is harvested by OpenAIRE (as opposed to the OpenAIRE compliance that was mentioned in the 2023 Study). Additionally, we incorporated new certification types in alignment with HE AGA requirements, such as the Dini certificate, and a revised concept of international recognition for which we no longer rely on the presence in international registries. Specific types of literature, such as pre-prints and books were also included in the list of content types to ensure more comprehensive coverage.

Collecting data for the update

In a first step of the Update, the survey was sent to the list of the managers of the 241 candidate repositories, and 107 responses were collected. Each response was scrutinized, and repository managers were contacted for clarification if inconsistencies were identified. For nonrespondents, desk research was conducted. Nonrespondents repository managers were then contacted to verify the data. After collecting feedback, the complete list of 241 repositories

with their assessments was sent for review to the repository managers, accompanied by a document outlining the assessment criteria both for trustiness and metadata requirements. Feedback was then incorporated, and the final list was circulated among the repository managers, for comments, with the final classification.

3. Analysis of the data gathered

This section presents an analysis of the data gathered for the repositories examined in the study. Each of the 241 repositories included in this update was rigorously assessed for its readiness to allow HE beneficiaries to comply with the HE MGA Open Science requirements. The results of this analysis are outlined below.

Coverage in relation to ERC panels

To evaluate repository coverage in relation to ERC panels, our survey asked repository managers to select all ERC panels related to the content that could be deposited in their repositories. For repositories that did not respond, desk research was used to analyse this feature. The ERC panel structure from 2024[2] was used as a reference. For general-purpose repositories (not related with specific ERC panels), all panels were indicated.

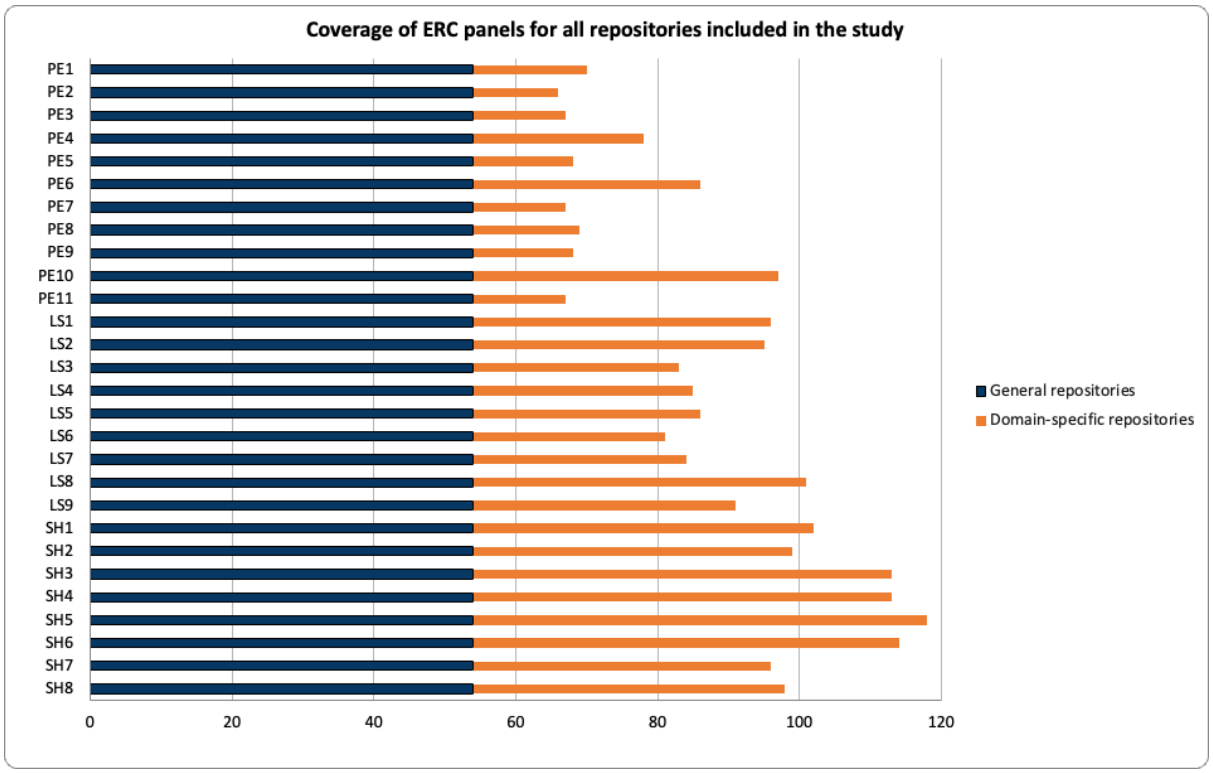

Figure 2. Coverage of ERC panels for the repositories included in the study. General (catch all) repositories are depicted in dark grey to show the existence of repositories that serve specific ERC panels (orange).

Figure 2 illustrates the distribution of the studied repositories across different ERC panels, with general repositories hosting outputs from all panels highlighted in dark grey. This figure reveals that the distribution over ERC panels of disciplinary repositories selected for the study is not homogeneous. Notably, the Social Sciences and Humanities (SH) panels are well represented in this study selection. The Life Sciences (LS) domain panels are also well covered, with repositories well distributed across all ERC panels. Conversely, the Physical Sciences and Engineering (PE) domain panels have the least available repositories represented. In this domain the Earth System Science (ERC Panel PE10) area stands out for having a significant number of dedicated repositories.

Since the 2023 study, a new panel, SH8, Studies of Cultures and Arts, has been introduced. The number of repositories in this update accepting deposits from SH8 related research appears to be in line with that of the other panels in the SH domain.

These findings corroborate results from the 2023 Study with similar takeaways:

- The European Strategy Forum on Research Infrastructures (ESFRI) played a key role in developing domain-specific repositories. ESFRI supports cultural and technical initiatives to increase the number of repositories.
- Life Sciences (LS) and Social Sciences and Humanities (SH) repositories are mostly linked to EMBL-EBI, ELIXIR and CLARIN Research Infrastructures.
- The Earth System Science area benefits from the ESFRI EPOS research infrastructure and the ENVRI-FAIR ESFRI cluster. This research sector has a long-standing culture of data management and sharing, often relying on large datasets like satellite data.
- Not all ERC panels are covered by ESFRI research infrastructures; for instance, PE1: Mathematics lacks such service.

Only 22% of the repositories in this study are general-purpose as shown in Table 1.

	Number of repositories	Percentage
General repositories	54	22%
Domain-specific repositories	187	78%

Table 1 Scope of the repositories in terms of specification of their contents: general purpose repositories and domain-specific (or thematic) repositories along with percentages.

Type of research setting coverage

Repository Research Setting Coverage	Number of repositories	Percentage
General Purpose	54	22%
Institutional	73	30%
Disciplinary	178	74%

Table 2 Research Setting Coverage of the repositories included in the study (General Purpose, Institutional or Disciplinary); the table shows the number of repositories falling in each category, as well as corresponding percentages. Note that percentages do not sum up to 100 as repositories can be associated with more than one coverage type.

Research setting coverage in the study is classified as follows:

- Disciplinary: The repository is focused on a specific discipline or domain, accepting research outputs only within that particular area of study.
- Institutional: The repository is limited to a specific institution, allowing only researchers affiliated with that institution to deposit their research outputs.
- General Purpose: The repository is broad in scope, accepting research outputs from all disciplines and domains.

Repositories may fall into one or more of the described categories, and in the survey repository managers were given the possibility to choose the ones that best fitted their repository.

Table 2 shows that of the repositories analysed, a significant majority are disciplinary, with 178 repositories accounting for 74% of the total. About one third (30%, 73 in total) of the repositories in the update are repositories with institutional coverage. General purpose repositories are less frequent, with 54 such repositories, representing 22% of the total.

These results reflect the diverse repository coverage that was sought-after in the 2023 Study and in this update, to include specialised, institutional, and general-purpose repositories, each playing distinct roles within the research community.

Focus: repositories with International recognition		
	Number of repositories	Percentage
Content type		
Data	112	84%
Literature	40	30%
Software	28	21%
Other content	25	19%
Catch all (Data and Literature)	19	14%
Endorsement by thematic/disciplinary research community		
Yes	117	88%
No or N/A	16	12%

Table 3 Focus on international recognition of the repositories included in the update. The table reports information about the content type and community endorsement for repositories with an international coverage.

The majority of repositories in this update have an international scope (55%, corresponding to 133 repositories) and, as depicted in Table 3, 88% of these declare to be or are identified as endorsed by a specific thematic or disciplinary community (117 repositories). Most international repositories host research data (84%), whereas one third (40 repositories, corresponding to 30%) are literature repositories.

Coverage in relation to content

Type of content accepted	Number of repositories	Percentage
Literature - articles, books, conference proceedings, etc.	109	45%
Data	179	74%
Software/Code	58	24%
Other - media, lectures, etc.	63	26%

Table 4 Repository content type. The table reports the different types of content that repositories in the study can host. As multiple choices could be provided, the numbers do not sum up to the total number of repositories.

The repositories included in this study were also classified based on the type of content they host. To this aim, the different content types were grouped into four categories:

- Literature - articles, books, conference proceedings, and text formats in general
- Data
- Software/Code
- Other - media, lectures, etc.

The results of this mapping exercise are reported in Table 4. 45% of the repositories, equating to 109 repositories, accept literature, while 74% of the repositories, 179 in total, are data repositories. Software/Code is accepted by 24% of the repositories, representing 58 repositories. Additionally, 26% of the repositories, amounting to 63, accept other types of content.

It is noteworthy that the categories "Software/Code" and "Other" each appear in about a quarter of the repositories. However, these types are found in conjunction with literature and data, rather than being the sole content hosted by the repositories.

Given the responses, the repositories were divided into three main categories:

- Catch All - repositories that can host both data and literature, and that are sometimes suitable also for software and other outputs
- Data (no Literature) - repositories that can host data but not literature, and are sometimes suitable also for software and other outputs
- Literature (no Data) - repositories that can host literature but not data, and are sometimes suitable also for software and other outputs

The results of this grouping are detailed in Table 5.

Repository type by content	Number of repositories	Percentage
Catch All - Data & Literature	47	19,5%
Data (no Literature)	132	54,8%
Literature (no Data)	62	25,7%

Table 5 Repositories categorisation in terms of content type. The table reports repositories categorised as Catch all, Data (no Literature) and Literature (no Data).

The updated study methodology allowed us to explore the specific type of content accepted by the 109 literature repositories selected. 60% of literature repositories included in the study are open for deposition of pre-prints, 84% accept post-prints; books are accepted by 70% of surveyed literature repositories, and book chapters can be deposited in 63%. 68% of literature repositories accept conference proceedings and 20% can host project proposals. 17% of literature repositories included in this study can accept other types of literature than the ones depicted above.

Coverage in relation to access to content upload

In this update we have also modified the approach used to classify how repositories provide access to content upload. Previous reliance on the Re3Data classification was replaced by the following categorisation:

- Open to All: Researchers from any community or institution, including Horizon Europe beneficiaries, can upload their research results without restrictions.
- Community/Discipline-Specific: Only research results (data or literature) linked to a specific community or discipline can be uploaded to the repository.
- Institution-Specific: Only researchers affiliated with a specific institution (or group of institutions) are allowed to upload their research results.

- Country-Specific: Only researchers affiliated with institutions based in a specific country are allowed to upload their research results.
- Funder-Specific: Only researchers supported by a specific funder, or group of funders, are allowed to upload their research results, regardless of community or institution.
- Other: There are additional or specific eligibility criteria.

Table 6 presents the coverage in relation to access to content upload for all 241 repositories analysed. Repository managers were asked to select only one of the possible options for uploading content in their repository. More than half of the repositories analysed allow content upload only when linked to a specific discipline or community, while about one-fourth are dedicated to hosting content from specific institutions. Research outputs from researchers affiliated with an institution in a specific country can be uploaded to 9.2% of the repositories, whereas the other categories represent only a small portion of the repositories included in this update.

Access to content upload	Number of repositories	Percentage
Open to all	8	3,3%
Community/Discipline specific	129	53,5%
Institution specific	62	25,7%
Country specific	22	9,2%
Funder specific	9	3,7%
Other	11	4,6%

Table 6 Repositories' access to content upload. The table depicts the coverage in relation to access to content upload (Open to all, Community/Discipline specific, Institution specific, Country specific, Funder specific, Other)

Access to repository contents

Access to repository content	Number of repositories	Percentage
No barriers	209	87%
Authentication/authorisation needed	32	13%
No external access	0	0%

Table 7 Access to repository content. Repositories for which the content is not available to external users, as confirmed by repository managers, were removed from the study.

As done for the categorisation related to content upload, the analysis of access to repository content was revised in this update, and the related survey question was redesigned. We used the following categorisation:

- No barriers: Users can access the content of the repository without barriers.
- Authentication/authorisation needed: Users can access the repository content only after an authentication/authorisation process.
- No external access: The content is only available to internal users managing the repository (internal archive).

As for the access to content upload, only one answer was possible to the related survey question. Those repositories for which the content is not available to external users, as

confirmed by repository managers, were removed from the study. Results are reported in Table 7.

The vast majority of the repositories studied present no barriers to access their content, whereas 13% require some kind of authentication or authorisation.

Curation, preservation, and security policies

Public policy availability	Number of repositories	Percentage
Literature - articles, books, conference proceedings, etc.	64	59%
Data	114	64%
Software/Code	48	83%
Other - media, lectures, etc.	41	65%

Table 8 Repositories that offer a publicly available policy on curation, preservation and security of content, differentiated by content type. Percentages are given considering the total number of repositories in each category and not with respect to the total number of repositories in the study.

151 of the 241 repositories were found to have some kind of policy for preservation, curation and security of their content online.

As also illustrated in the 2023 Study, no standardisation is currently present in the policy structure or presentation, nor in their focus, process, and commitments. We note that this lack of harmonisation is also reflected in where this information is placed on their websites, which complicates the assessment of this part.

Repositories harvested by OpenAIRE

A question on the harvesting of repositories by OpenAIRE was part of the new survey; for non-respondent repositories, the harvesting by OpenAIRE was derived through the OpenAIRE Explore service[4].

Table 9 reports the findings for all repositories included in this update. In general, slightly more than half of all repositories analysed declare to be harvested by OpenAIRE, while it is noteworthy that 35% of such repositories are not harvested, and 13% of repositories declare not to know whether they are harvested by OpenAIRE.

Harvested by OpenAIRE	Number of repositories	Percentage
Yes, my repository is harvested by OpenAIRE	125	52%
No, my repository is not harvested by OpenAIRE	85	35%
Not Yet/Not Sure	31	13%

Table 9 Presence in OpenAIRE for all repositories included in the study. The presence refers to the harvesting by OpenAIRE of the repository contents.

[4] https://explore.openaire.eu/

Number of repositories harvested by OpenAIRE by Content type	Number of repositories
Data (no literature)	42
Literature (no data)	49
Catch All (Data and Literature)	34

Table 10 Repositories harvested by OpenAIRE, differentiated by content type.

For those repositories harvested by OpenAIRE we report the content type in Table 10.

Trusted repositories overview

Trusted Repositories	Certified repository	Community Endorsement	Essential Characteristics	Trusted repository count
Number of repositories	92	116	99	**186**

Table 11 Trusted repositories overview. The table reports the number of repositories that were identified to adhere to the definition of trusted repository given in the HE AGA, along with the reason why the repository was identified as trusted: certification, community endorsement for domain/thematic repository and/or essential characteristics

Based on the definition in the HE AGA, repositories can be classified as trusted for a number of reasons, namely their certification, their endorsement by their reference community, if they are disciplinary, or the fact that they show some specific characteristics. Of the 241 repositories included in the study update, 186 can be considered trusted, as reported in Table 11.

For the repositories in the update, the most frequent reason to consider a repository as trusted was community endorsement: 116 out of 186 repositories were reported to be trusted because of it. Of the 186 trusted repositories, 92 were certified repositories, mostly due to Core Trust Seal (CTS) certification, and 99 were identified as trusted because they fulfil the essential characteristics for trusted repositories as defined in the HE AGA.

Trusted Repositories by type of research setting coverage	Certified repository	Community Endorsement	Essential Characteristics	Trusted repository count
General repositories	11	0	34	34
Institutional	18	5	29	39
Disciplinary	78	116	63	148

Table 12 Trusted repositories overview. The table reports the number of repositories that were identified to adhere to the definition of trusted repository given in the HE AGA, with a focus on the type of research setting coverage (General, Institutional or Disciplinary). The table also reports the reason why the repository was identified as trusted: certification, community endorsement for domain/thematic repository and/or essential characteristics.

As reported in Table 12, most domain-specific repositories can be considered trusted due to endorsement from their community. All trusted general-purpose repositories (34) were found to fulfil the essential characteristics depicted in the HE AGA, and 11 of them also have a certification.

39 institutional repositories were identified as trusted, the majority due to essential characteristics with a small fraction (only 5 institutional disciplinary repositories) showing community endorsement. This study identified also 18 certified institutional repositories.

Disciplinary repositories in the study are considered trusted mostly due to their community endorsement (116 repositories out of 148), whereas 78 disciplinary repositories were found to be certified and 63 to adhere to the essential characteristics described in the HE AGA.

Table 13 presents the overview of trusted repositories in the study divided by the type of content hosted. Literature repositories are mostly considered trusted due to the adherence to essential characteristics, whereas most of data repositories are considered trusted due to community endorsement.

Trusted Repositories by Content type	Certified repository	Community Endorsement	Essential Characteristics	Trusted repository count
Data	83	98	76	148
Software/Code	31	21	41	51
Literature - articles, books, conference proceedings, etc...	21	28	40	62
Other - media, lectures, etc...	20	16	32	40

Table 13 Trusted repositories overview. The table reports the number of repositories that were identified to adhere to the definition of trusted repository given in the HE AGA, with a focus on the type of repository content. The table also reports the reason why the repository was identified as trusted: certification, community endorsement for domain/thematic repository and/or essential characteristics.

Some repositories in the study meet multiple criteria for being considered trusted. This is illustrated in Figure 3, with a Venn diagram. Notably, 66 out of 116 community-endorsed repositories, 80 out of 92 certified repositories, and 69 out of 98 repositories meeting essential characteristics would be classified as trusted if using only the two other criteria respectively.

As reported in the 2023 Study, certification does not always align with the essential characteristics of trusted repositories as described in the HE AGA. Interestingly, 26 repositories meet both certification and community endorsement criteria without fulfilling the MGA essential characteristics. Meanwhile, 29 repositories are trusted due to both certification and MGA essential characteristics without community endorsement. Additionally, 15 repositories fulfil both MGA essential characteristics and are community-endorsed without being certified.

In total, 25 repositories meet all three criteria: certification, community endorsement, and essential characteristics.

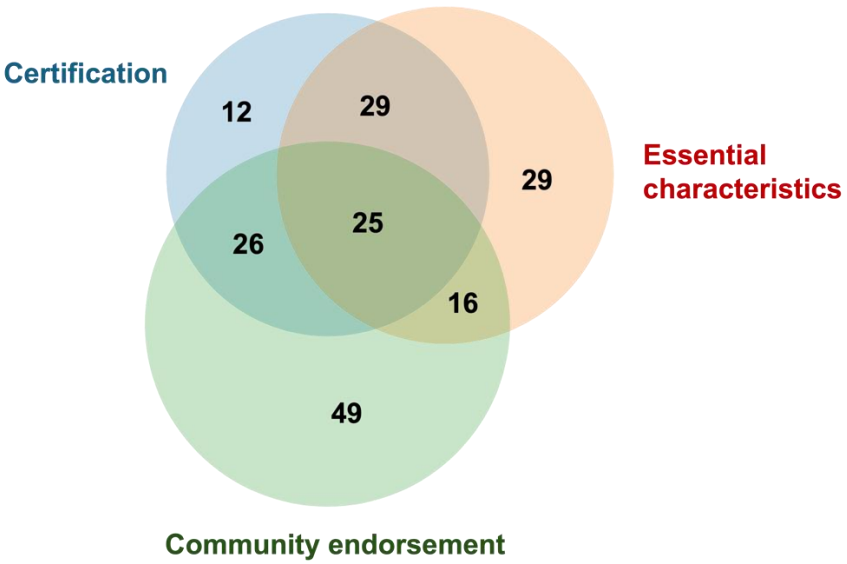

Figure 3 Venn Diagram of trusted repositories depicting the reasons for being considered trusted. The Venn diagram shows clearly how some repositories fulfil more than one criterion (certification, community endorsement, essential characteristics). Created using Meta-Chart[5].

Of the 241 repositories selected to be included in the study, 55 did not meet any of the criteria to be considered trusted.

We analysed the most frequent reasons for not meeting the essential characteristics for being classified as trusted repositories according to the MGA. For those 55 repositories that were neither certified nor endorsed and whose acceptance as trusted repositories thus depended on meeting the essential characteristics, results are shown in Table 14.

The lack of a public policy for preservation, curation and security of the contents is the most frequent reason, followed by not adhering to a specific metadata standard.

	Policy missing	Licence field missing in metadata	No PID assignment	No Machine Actionable Metadata	No Standard Metadata
Number of repositories	35	14	10	15	26

Table 14 Reasons for not being trusted by failing to meet the essential characteristics for trusted repositories. Numbers do not sum up to the total number of non-trusted repositories because some repositories fail to meet more than one requirement. Analysis for repositories that are neither certified nor endorsed.

Of the trusted repositories, see Figure 3, 38 certified repositories and 76 community endorsed repositories failed to meet the essential features necessary for being classified as trusted repositories according to the MGA. The reasons for this are presented in Table 15.

[5] https://www.meta-chart.com

	Policy missing	Licence field missing in metadata	No PID assignment	No Machine Actionable Metadata	No Standard Metadata
Certified repositories missing essential characteristics	27	17	2	5	12
Community endorsed repositories missing the essential characteristics	49	32	7	9	23

Table 15 Reasons for trusted repositories (either certified or endorsed by the community) failing to meet the essential characteristics for trusted repositories. Some repositories fail to meet more than one requirement.

These findings show also in this case that the main reasons for not meeting the essential characteristics for trusted repositories are the lack of a clear policy and the lack of a licence field in the metadata, along with missing adherence to a specific standard for metadata.

Repository readiness to facilitate compliance with the Horizon Europe MGA metadata requirements

In this section, we summarize the extent to which all the 241 repositories considered in the study offer metadata fields allowing HE beneficiaries to comply with the HE MGA Open Science obligations. We also specifically analyse the 186 trusted repositories.

Metadata availability

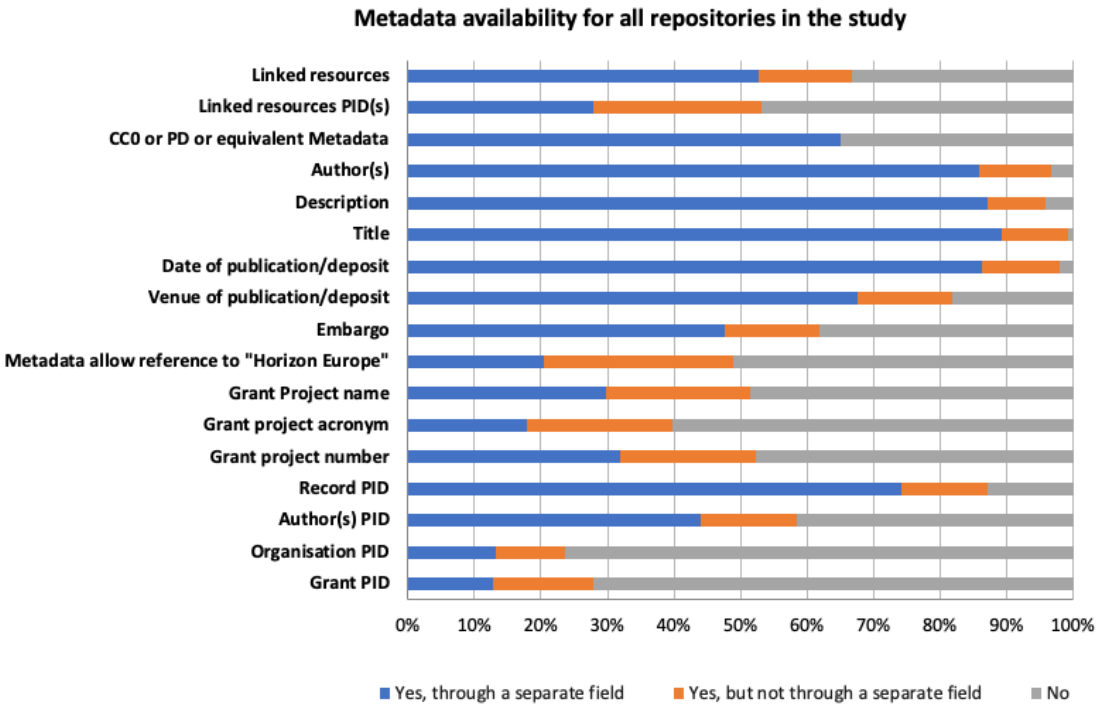

Figure 4 Metadata availability for all 241 repositories included in the study. Note that for CC0 or PD equivalent Metadata, only a Yes or No option was available.

Figure 4 displays a comprehensive overview for all repositories in the study and demonstrates the broad coverage for many of the several metadata requested. When relevant, we also show whether the information is provided through a separate metadata field or not.

Almost all repositories declare to provide metadata for authors, titles, dates of publication/deposit, and descriptions of the objects. Specifically, the “author” metadata field is declared to be provided by 233 repositories, “title” by 239 repositories, “date of publication/deposit” by 236 repositories, and “description” by 231 repositories, out of the total 241 repositories included in this study. A significant number of repositories offer for each of these metadata a separate field, highlighting the structured approach taken by many repositories.

Regarding persistent identifiers (PIDs), the “record PID” (e.g., DOI/Handle) is the most widely supported, with 210 repositories providing this metadata, of which 179 do so through a separate field. Author PIDs (e.g., ORCID) are supported by 141 repositories, with 106 allowing to record this information through a separate field.

The findings also indicate that 157 repositories (73% of the ones in this study) provide their metadata with a CC0 or similar public domain dedication, ensuring open access and reuse.

It is interesting to highlight that only 118 repositories allow reference to Horizon Europe in the metadata, and only 96 repositories provide information on the “project acronym”. Additionally, 126 repositories offer metadata for the “grant project number”, with 77 of these allowing to record this in a separate metadata field.

Regarding “linked resources”, 161 repositories include metadata for linked resources, with 127 allowing this as a separate field. Additionally, 128 repositories provide “linked resource PIDs”, with 67 recording this information in a separate field.

When focussing on trusted repositories only, 186 in this study, the overall picture remains consistent, as shown in Figure 5. Metadata fields for “Organisation PIDs” and “Grant PIDs” are the least present in the trusted repositories studied, whereas fields for “Author PIDs” are present in more than half of all cases. Unsurprisingly, metadata fields for “Record PIDs” are present in most of the trusted repositories analysed.

Based on the data available for this update, both for all repositories and those identified as trusted, it is important to highlight that grant information is often not offered through separate metadata fields, resulting in a lack of machine-actionable, interoperable, and standardized metadata, as requested in the MGA. Notably, about half of the trusted repositories do not offer important grant-related information (such as references to Horizon Europe, grant project name, acronym, number, and grant PID) at all, and even fewer through a separate field. Similar observations apply to all repositories in the study.

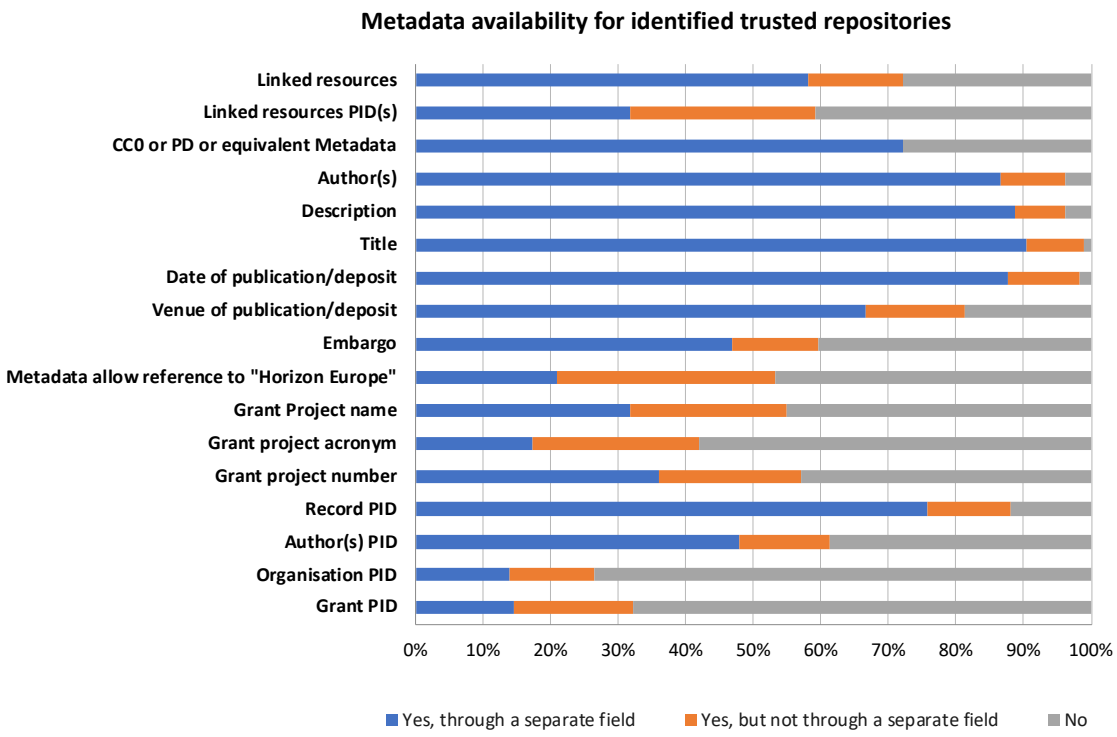

Figure 5 Metadata availability for only the 186 trusted repositories in the inventory. Note that for CC0 or PD equivalent Metadata, only a Yes or No option was available.

For the trusted repositories in the study, we have the following situation:

- Only 39 trusted repositories provide to possibility to include a reference to Horizon Europe, as a separate field, whereas 60 allow so without offering a separate field, and 87 do not provide it at all.
- Grant project names are offered as a separate field by 59 repositories, without a separate field by 43, and not at all by 84.
- The grant project acronym information is captured by 32 repositories in a separate field, 46 repositories allow for the information to be recorded, but not in a separate field, and it is not possible to be recorded in 108 repositories.
- For the grant project number, 67 repositories offer to record this as a separate field, 39 allow to record this together with other data, and 80 do not offer the possibility to record this at all.
- Lastly, for the grant PID, only 27 repositories offer it as a separate field, 33 allow to record this together with other data, and 126 do not offer the possibility to record this at all.

Repositories classification

The new elements introduced in this update allowed to redefine categories for readiness levels to facilitate compliance with HE obligations (see also ANNEX 4 for more details on the procedure used). This new categorisation considers the different requirements in terms of metadata for Literature and Data repositories as well as whether the information is available or not through a separate field in the metadata structure.

Results of the classification are reported in Table 16 for all repositories in the study, and in Table 17 with a focus on repositories that were identified as trusted.

All repositories in this Update	Exemplary Readiness Level	Essential Readiness Level	Close to Essential Readiness Level	Data Inconclusive
Number of Literature repositories	1	4	30	79
Number of Data repositories	2	5	52	127

Table 16 Readiness of repositories in the study to facilitate compliance with the Horizon Europe MGA metadata requirements, with a focus on repositories that can host Literature and those that can host Data. Note that the numbers do not add up to the total number of repositories in the study update as each subsequent category includes the repositories of the previous one, resulting in overlapping group membership.

Only two repositories among the total of 241 analysed in this update show an Exemplary readiness level, i.e. they present all the Open Science HE MGA mandatory and recommended characteristics for literature and/or data repositories. Essential, i.e. mandatory, features are supported by 5 data repositories and by 4 literature repositories.

The “Close to essential” readiness level identifies repositories that are partially able to support mandatory requirements (see also ANNEX 4 for details). These repositories provide separate metadata fields to collect selected basic information and support HE beneficiaries in complying with at least 8 of the remaining 10 mandatory HE MGA requirements in relation to metadata, even if not with a separate metadata field.

In some cases, information collected in this study was not enough to define the readiness level of the repositories: 79 literature repositories and 127 data repositories where thus included in the category “Data Inconclusive”.

Repositories identified as trusted	Exemplary Readiness Level	Essential Readiness Level	Close to Essential Readiness Level	Data Inconclusive
Number of Literature repositories	1	4	22	43
Number of Data repositories	2	5	48	103

Table 17 Readiness of trusted repositories in the study to facilitate compliance with the Horizon Europe MGA metadata requirements, with a focus on repositories that can host Literature and those that can host Data. Note that the numbers do not add up to the total number of repositories in the study update as each subsequent category includes the repositories of the previous one, resulting in overlapping group membership.

In Table 17 we report the assessment of trusted repositories, separately for data and literature, in terms of readiness to facilitate the compliance with the HE MGA metadata requirements, and we can see a similar distribution compared to the one of all repositories included in this update.

Repositories with Exemplary and Essential Readiness levels

We report in the following the details of those literature and data repositories that are trusted and fall into the categories Exemplary and Essential readiness level.

Trusted repository showing Exemplary Readiness Level for supporting HE beneficiaries in complying with the HE MGA requirements in terms of metadata in relation to literature and data:

- Hyper Article en Ligne (HAL) – for both data and literature deposition
- The Austrian Social Science Data Archive (AUSSDA) – for data deposition only

Trusted Repositories showing Essential Readiness Level to support HE beneficiaries in complying with the HE MGA requirements in terms of metadata in relation to both literature and data:

- <intR>²Dok
- DANS Data Station Archaeology
- Zenodo

Three of those repositories have a very strong mandate by Funders (HAL, Zenodo and <intR>²Dok). In the following, we briefly analyse these five repositories.

Name	Hyper Article en Ligne (HAL)
Description and scope	Hyper Article en Ligne (HAL) is the open access repository developed and managed by CCSD (Centre pour la Communication Scientifique Directe), a support and research unit (UAR 3668) of the CNRS. HAL is the French national open archive for literature. It is a general-purpose repository and can also provide data deposition and specific services for code preservation thanks to a collaboration with Software Heritage. It offers more than 140 institutional portals from universities and other research organisations in France. HAL is included in the Second French National Plan for Open Science to be further developed.
Trusted repository	HAL has been identified as trusted because it fulfils all the **essential characteristics** required – Public Policy for Preservation, Curation and Security of the content, PID assignment, Licence field present in the metadata, Machine actionable and Standardised metadata. HAL is not certified.
Readiness to facilitate compliance with the HE MGA	HAL is one of the two repositories in this study that presents an **exemplary readiness level** as it meets all the mandatory and recommended metadata requirements, and it provides the related information through separate metadata fields. Therefore, HAL can fully support HE beneficiaries in the compliance with Open Science mandates under Horizon Europe for both literature and research data.

Name	The Austrian Social Science Data Archive (AUSSDA)
Description and scope	The Austrian Social Science Data Archive (AUSSDA) is a data infrastructure for the social science community in Austria and offer a variety of research support services, primarily data archiving and help with data re-use. AUSSDA is managed by a consortium consisting of the Universities of Vienna, Graz, Linz, Innsbruck, Krems and the OeAW (Austrian Academy of Sciences). AUSSDA also serves as the Austrian representative on the Consortium of European Social Science Data Archives (CESSDA).
Trusted repository	AUSSDA has been identified as trusted because it fulfils all the **essential characteristics** required – Public Policy for Preservation, Curation and Security of the content, PID assignment, Licence field present in the metadata, Machine actionable and Standardised metadata, because it is a **certified** repository and because it is **endorsed by its community of reference** and internationally recognised.
Readiness to facilitate compliance with the HE MGA	AUSSDA is one of the two repositories in this study that presents an **exemplary readiness level** as it meets all the mandatory and recommended metadata requirements, and it provides the related information through separate metadata fields. Therefore, AUSSDA can fully support HE beneficiaries in the compliance with Open Science mandates under Horizon Europe in relation to research data.

Name	Zenodo
Description and scope	Zenodo is the open access repository created in collaboration between OpenAIRE and CERN and was born with the aim to support the European Commission and its open science policies. It is a general-purpose, international catch all repository and can thus be used to deposit both data and literature as well as software through a collaboration with GitHub.
Trusted repository	Zenodo has been identified as trusted because it fulfils all the **essential characteristics** required – Public Policy for Preservation, Curation and Security of the content, PID assignment, Licence field present in the metadata, Machine actionable and Standardised metadata. Zenodo is not certified.
Readiness to facilitate compliance with the HE MGA	Zenodo presents an **essential readiness level** as it meets all the mandatory metadata requirements, and it provides the related information through separate metadata fields. It does not support Grant PIDs as a separate field; therefore, it does not allow beneficiaries to provide all the additional recommended metadata specified in the HE MGA.

Name	DANS Data Station Archaeology
Description and scope	DANS Data Station Archaeology is one of the data stations provided by the Data Archiving and Networked Services, the Dutch national centre of expertise and is a repository for research data. Data Station Archaeology allows users to deposit and search for data within the field of archaeology.
Trusted repository	DANS Data Station Archaeology has been identified as trusted because it is a **certified** repository and because it is **endorsed by its community of reference** and internationally recognised.
Readiness to facilitate compliance with the HE MGA	DANS Data Station Archaeology presents an **essential readiness level** as it meets all the mandatory metadata requirements, and it provides the related information through separate metadata fields. It does not support the provisioning of Organisation PIDs in the metadata, therefore, it does not allow beneficiaries to provide all the additional recommended metadata specified in the HE MGA.

Name	<intR>²Dok
Description and scope	The disciplinary Open Access repository <intR>²Dok (pronounced: 'Inter-Zwei-Dok') is the central publication platform of the specialist information service for international and interdisciplinary legal research set up by the German Research Foundation at the Berlin State Library - Prussian Cultural Heritage. <intR>²Dok hosts both data and literature. It is specialised in the research area covered by ERC Panel SH2 "Institutions, Governance and Legal Systems".
Trusted repository	<intR>²Dok has been identified as trusted because it is **certified** (DINI certificate). It is also **endorsed by its community of reference** and recognised internationally.
Readiness to facilitate compliance with the HE MGA	<intR>²Dok presents an **essential readiness level** as it meets all the mandatory metadata requirements, and it provides the related information through separate metadata fields. It does not support Grant PIDs as a separate field; therefore, it does not allow beneficiaries to provide all the additional recommended metadata specified in the HE MGA.

Other popular repositories

In this section we analyse repositories that the ERC Scientific Council has recommended in its 'Open Access Guidelines for research results funded by the ERC', namely, OAPEN Library for Books and other long-text formats, Europe PMC for publications in the Life Sciences and arXiv for those in relevant areas of the Physical Sciences and Engineering.

Name	OAPEN Library
Description and scope	OAPEN (Open Access Publishing in European Networks) is managed by the OAPEN Foundation, a not-for-profit organisation based in the Netherlands, with its registered office at the National Library in The Hague. OAPEN is dedicated to open access peer-reviewed books and covers all ERC Panels. Like Zenodo, OAPEN was developed thanks to a project co-funded by the EU. OAPEN is recommended by the ERC Scientific Council in its 'Open Access Guidelines for research results funded by the ERC' for book chapters as well as long-text publications such as monographs or edited collections.
Trusted repository	OAPEN has been identified as trusted because it fulfils all the **essential characteristics** required – Public Policy for Preservation, Curation and Security of the content, PID assignment, Licence field present in the metadata, Machine actionable and Standardised metadata. OAPEN is not certified.
Readiness to facilitate compliance with the HE MGA	OAPEN presents a **close to essential readiness level** as it meets all the basic requirements related to literature repositories through a separate field in the metadata (Author(s), Title, Date and Venue of publication), and it supports the beneficiaries in complying with 8 of the remaining 10 mandatory requirements in relation to metadata, even if not always through a separate metadata field. OAPEN does not allow reference to linked resources in the metadata.

Name	arXiv
Description and scope	arXiv (pronounced 'archive', the X represents the Greek letter chi χ) is a free distribution service and an open access archive for scholarly articles in the fields of physics, mathematics, computer science, quantitative biology, quantitative finance, statistics, electrical engineering and systems science, and economics. It is developed and managed by Cornell University. arXiv was the first and is one of the most well-known preprint servers. Elsevier allows authors of articles published in their journals to update preprints that have already been posted on arXiv with the postprint (author's accepted manuscript), without embargo period.
Trusted repository	arXiv has been identified as trusted because and it is **endorsed by its community of reference** and recognised internationally. arXiv is not certified.

Readiness to facilitate compliance with the HE MGA	arXiv does not meet most mandatory metadata requirements specified in the HE MGA, and it does not provide the additional recommended metadata either. arXiv allows to report, through separate fields, Author(s), Description, Title, and Date of publication for the publication. It is not possible to provide information, through a separate field, related to funding nor to provide PIDs, except for the one of the upload. arXiv does not provide a separate metadata field to describe and provide PIDs for linked resources to validate the results of the items deposited.

Name	**Europe PMC**
Description and scope	Europe PMC provides comprehensive access to Life Sciences literature from trusted sources. Europe PMC is a literature repository that hosts publications, preprints and other documents enriched with links to supporting data, reviews, protocols, and other relevant resources. It is hosted by EMBL's European Bioinformatics Institute (EMBL-EBI) and part of the ELIXIR infrastructure. Europe PMC is partnered with PubMed Central (PMC), and endorsed and supported by a group of international science funders, including ERC, as their repository of choice for publications in the life sciences.
Trusted repository	Europe PMC has been identified as trusted because it is **endorsed by its community of reference** and recognised internationally, and because it fulfils all the **essential characteristics** required – Public Policy for Preservation, Curation and Security of the content, PID assignment, Licence field present in the metadata, Machine actionable and Standardised metadata. Europe PMC is not certified.
Readiness to facilitate compliance with the HE MGA	Europe PMC presents a **close to essential readiness level** as it meets all the basic requirements related to literature repositories through a separate field in the metadata (Author(s), Title, Date and Venue of publication), and it supports the beneficiaries in complying with the remaining 10 mandatory requirements in relation to metadata, even if not always through a separate metadata field.

4. Conclusions

The data collection process for this update confirmed the difficulties, already evident in the 2023 Study, that HE beneficiaries face in gathering relevant information to assess whether a repository would allow them to comply with the MGA open science obligations.

There are clear challenges posed by the differences between funder requirements and current repository systems, as well as additional challenges arising from unclear terminology, such as “international recognition” and “community endorsement.”

After careful analysis, including desk research and extensive direct exchanges with repository managers, we observe that most of the repositories investigated are not yet equipped to allow HE beneficiaries to meet HE MGA requirements.

Specifically, out of the 241 repositories investigated, 186 were found to fulfil the HE MGA definition of a trusted repository, including 92 certified repositories, 116 endorsed by specific research communities, and 99 meeting the essential characteristics identified in the HE AGA. Additionally, to allow HE beneficiaries to comply with their open access obligations, specific requirements for metadata must also be met.

Among those analysed, only two repositories, HAL and AUSSDA, demonstrate an exemplary readiness level for respectively literature and data, and data deposition. Those repositories allow the recording of not only mandatory but also recommended metadata in separate fields.

Four of the repositories analysed — <intR>²Dok, DANS, HAL, and Zenodo — allow HE grantees to comply with the HE MGA mandatory Open Science requirements related to data and literature. AUSSDA allows to comply with the HE MGA mandatory Open Science requirements for data deposition. Being international catch-all repositories and accepting content from any research area, Zenodo and HAL provide all HE beneficiaries with at least two options to fulfil their MGA obligations.

AUSSDA recently modified its infrastructure after receiving feedback regarding the HE MGA obligations. Many other repositories adjusted their metadata fields to improve their readiness.

It is also noteworthy that two of the most popular repositories do not allow HE beneficiaries to comply with their MGA open access obligations. In particular, arXiv can be classified as a trusted repository since it is endorsed by its reference community and recognized internationally, but it does not allow the provision of funding information or PIDs (except for the upload PID) through a separate field. Moreover, arXiv does not provide a separate metadata field to describe and provide PIDs for linked resources that validate the results of the deposited items.

Europe PMC is identified as trusted because it is endorsed by its reference community, recognized internationally, and fulfils all the essential characteristics required. However, it presents an almost essential readiness level, meeting all the basic requirements related to literature repositories. Through separate metadata fields, it supports beneficiaries in complying with the remaining 10 mandatory requirements in relation to metadata, though not always through distinct metadata fields.

In general, this report and the accompanying inventory provide, in our opinion, a useful baseline for HE beneficiaries to compare and choose appropriate repositories for data or literature deposition, though the inventory is necessarily an inexhaustive snapshot. However, more comprehensive and accessible information on repository policies, licenses, and metadata standards is highly desirable. The development and adoption of standardized policies would help build trust on a solid foundation. Continued efforts are needed to refine metadata harmonization, conduct gap analyses, and promote standards for FAIR and open research repositories.

This study could serve as a starting point for further updates and improvements, helping to build a common understanding and alignment on terms like “community endorsement” and “international recognition,” and to further develop repository infrastructure to support beneficiaries in meeting grant agreement requirements.

As noted in the 2023 Study, it is important to emphasize that even if a repository does not meet all mandatory metadata requirements, other services can assist HE beneficiaries in providing the necessary information to funders, such as the OpenAIRE Link function or the provision of additional information through the Funding and Tenders Portal.

References

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Annexes

(separate files)

Annex 1 Inventory of identified trusted repositories

Annex 2 Survey text

Annex 3 Study curated results

Annex 4 Assessment criteria