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Global Open Research Commons: Enabling Curation for the Next 20 Years

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Abstract

This paper addresses the requirements for long-term preservation through a system lens. Rather than focussing on specific technical elements that are needed for curation, this paper considers all the system elements that need to be put in place, and intentionally maintained, to ensure curation for the long term.

This paper begins by making the argument that curation requires attention to preservation over time. The need for preservation, in turn, requires both sustainable data content and sustained infrastructure. These infrastructures consist of many elements, both social and technical, all of which need attention.

Then, this paper briefly introduces the concept of the open research commons as a way of conceptualising these elements, before examining in some detail the Global Open Research Commons (GORC) typology of essential elements. This work was developed through a Research Data Alliance Working Group, which started with a definition of a commons as 'a global trusted ecosystem that provides seamless access to high-quality interoperable research outputs and services.' The essential elements in the typology include Information and Communications Technology (ICT) infrastructure, services and tools, research objects, human capacity, rules of participation and access, governance, engagement, and sustainability.

This general approach was then extended by the GORC International Model Working Group to 'review and identify attributes or features currently implemented by a target set of GORC organisations.' The GORC approach has already been used in designing the creation of new commons, characterising existing research infrastructures, and analysing interoperability between commons. Future work, to commence in 2025, will clarify how the International Model might be used and adopted, as well as improve how it is presented.

Our researchers require ongoing access to reliable and sustainable data aggregations. These will need to be curated for reuse and interoperability over the long term to support the integrity of the scholarly record. The GORC groups are working towards an interoperable set of platforms that together build on advances in internet technologies and the consensus and strengths of the research community.

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Curation Implies Preservation

The CODATA RDM vocabulary defines data curation as a

> 'managed process throughout the data lifecycle, by which data/data collections are cleansed, documented, standardised, formatted and inter-related. This includes versioning data, or forming a new collection from several data sources, annotating with metadata, and adding codes to raw data (e.g., classifying a galaxy image with a galaxy type such as "spiral"). Higher levels of curation involve maintaining links with annotation and with other published materials. ... The goal of curation is to manage and promote the use of data from its point of creation to ensure it is fit for contemporary purpose [*sic*] and available for discovery and re-use ... .'
>
> (CODATA, 2024)

Implicit in this definition's reference to 'available for discovery and re-use' is the need to ensure the ongoing nature of this availability and reusability over the data lifecycle. This need must extend to all interlinked digital objects, whose lifecycles may last for decades, particularly in observational datasets or foundational software libraries. Therefore, digital curation implies the need for digital preservation, which is defined as

> 'Series of managed activities necessary to ensure continued access to digital materials for as long as necessary. All of the actions required to maintain access to digital materials beyond the limits of media failure or technological change ... '
>
> (CODATA, 2024).

Preservation Requires Sustainability

If we consider this preservation requirement, it becomes clear that this will require sustainable and sustained data contents and sustainable and sustained data container infrastructure. Without the former, the contents will become unusable for future generations of scholars. Without the latter, the contents will become lost or forgotten. This means that a focus on the sustainability of the ecosystem is needed.

Sustainability is often reduced to a focus on ongoing funding; however, if one zooms out a little, it becomes clear that true sustainability for data infrastructures also requires a commitment to a number of critical non-financial aspects:

- Human capacity needs to be maintained and adapted to the changing demands of the commons. Indeed, people are critical for the operation and maintenance of research infrastructures. They are the holders of tacit knowledge about how to operate and maintain the infrastructures, and their lived experience is essential in informing infrastructure enhancements, both for what is lacking and what is possible;

- The rules of participation and access need to guard against services and data being exploited, which damages the long-term sustainability or reputation of the commons. This could include fake data being uploaded to support research that was not carried out, existing data being changed by malicious state actors, services being taken offline through cyberattacks, or non-authentic services attempting to intercept login credentials;

- Governance structures need to be appropriate to the organisational demands of the commons, and need to be sustainable long-term (or designed to enable transition to different governance structures as needed). This need for governance evolution is critical for infrastructures (e.g., those accumulating observational records) that need to persist for decades;

- Engagement with users needs to be active and to evolve as their needs change over time to ensure a user base that justifies ongoing investment. The best argument for sustaining a commons is the number of researchers who will be affected by its termination;

- Use of standards (and conventions) will reduce wasted effort through wheel reinvention and ensure that the data contents are more accessible to standards-based tools, rather than requiring bespoke solutions. This will reduce the costs of maintenance and the overall cost burden over time;

- The underlying storage, network and compute technologies need to be aligned with the use patterns, as well as being upgraded as equipment ages and new, more cost-effective technologies become available. Infrastructure elements that are allowed to age will need the investment of an increasing proportion of the available funding for the commons over time, causing a challenge for ongoing funding;

- The research objects that include data should be stored in standard formats and migrated over time as needed. Standard formats enable research infrastructures to rely on libraries of existing tools for shared functions, which enables funding to be allocated to rarer bespoke functionality. Migration over time will reduce the barriers to access for new users and increase the potential value of the commons as a whole;

- The services and tools should provide standards-based APIs to enable the easier creation of new tools and easier maintenance over time. In addition, this makes it easier to recruit developers for the commons because they are more likely to have experience with these APIs.

Reuse Requires FAIRness

The reference to 'discovery and re-use' also needs to be unpacked. Enabling the ongoing ability to discover and reuse datasets requires a commitment to all aspects of FAIR (Wilkinson et al., 2016):

- unless the data is findable, it cannot be discovered;

- unless the data is accessible, discovery will only serve to frustrate;

- unless the data is interoperable, it cannot be combined with existing data;

- unless its licensing makes it reusable, the previous three characteristics are irrelevant.

Importantly, ongoing availability for reuse requires an ongoing commitment to maintaining these FAIR characteristics.

Commons Enable Sustainability and Reuse

How should data infrastructures be constructed that enable sustainable data curation in support of reuse?

One approach that has been gaining ground over the last 20 years has been the idea of an open research commons. The term 'commons' derives from the English idea of land held in common and was popularised in the modern sense as a way of referring to shared resources by the ecologist Garrett Hardin in his influential 1968 article 'The Tragedy of the Commons' (Hardin, 1968). The Nobel laureate Elinor Ostrom revisited this idea and demonstrated that practical algorithms exist for the collective use of a limited common resource (Ostrom, 1990). The idea of the commons has since been taken up and applied to a wide range of domains, including fisheries (Berkes et al., 1989), urban planning (Colding et al., 2013) and genomic data (Grossman, 2019). Grossman (2023) lists a number of reasons why research projects might find commons a useful approach.

A research commons can be defined as a research-focused version of a digital commons, where 'informational resources are created and shared within voluntary communities of varying size and interests,' are held as communal, and management is 'oriented towards use within the community, rather than exchange in the market' (Stalder, 2010). Commons are emerging as an important tool for enabling the reuse of different types of data at national and global levels. As more commons are developed, the need for the coordination of these infrastructures on various levels (country, continent, discipline, and sector) and focus (for all or some of the research artefacts) is increasing. Examples include the European Open Science Cloud (EOSC),[1] the Australian Research Data Commons (ARDC),[2] the International Virtual Observatory Alliance (IVOA),[3] and the African Open Science Platform (Participants of African Open Science Platform Stakeholder Workshop September 2018 et al. 2018; AOSP n.d.).

The GORC Typology Defines the Necessary Elements for a Commons

Typology

The Global Open Research Commons Interest Group (GORC-IG) grew out of a Birds of a Feather meeting held as part of the 11th Research Data Alliance plenary in Berlin in March 2018 (Bicarregui, 2018). The goal of the IG was to provide a neutral place where people could coordinate the development of a typology to describe what are referred to as 'Open Science Commons' or 'Data commons' within the research commons umbrella (Treloar et al., 2019). The creation of the IG was a response to growing interest in, and the creation of, various research commons. In addition, it was in response to recognition among digital research infrastructure providers that national and discipline solutions needed a common language with which to address the challenges of interoperability.

First, the GORC-IG examined a range of existing research commons architectures to review current practice. Then, the GORC-IG generated this definition of a commons: 'A global trusted ecosystem that provides seamless access to high-quality interoperable research outputs and services.' Finally, it developed a typology of the essential elements in a commons (Figure 1) and a set of definitions for each of the essential elements.

[1] EOSC: https://eosc.eu/eosc-about/
[2] ARDC: https://ardc.edu.au/
[3] IVOA: https://www.ivoa.net/

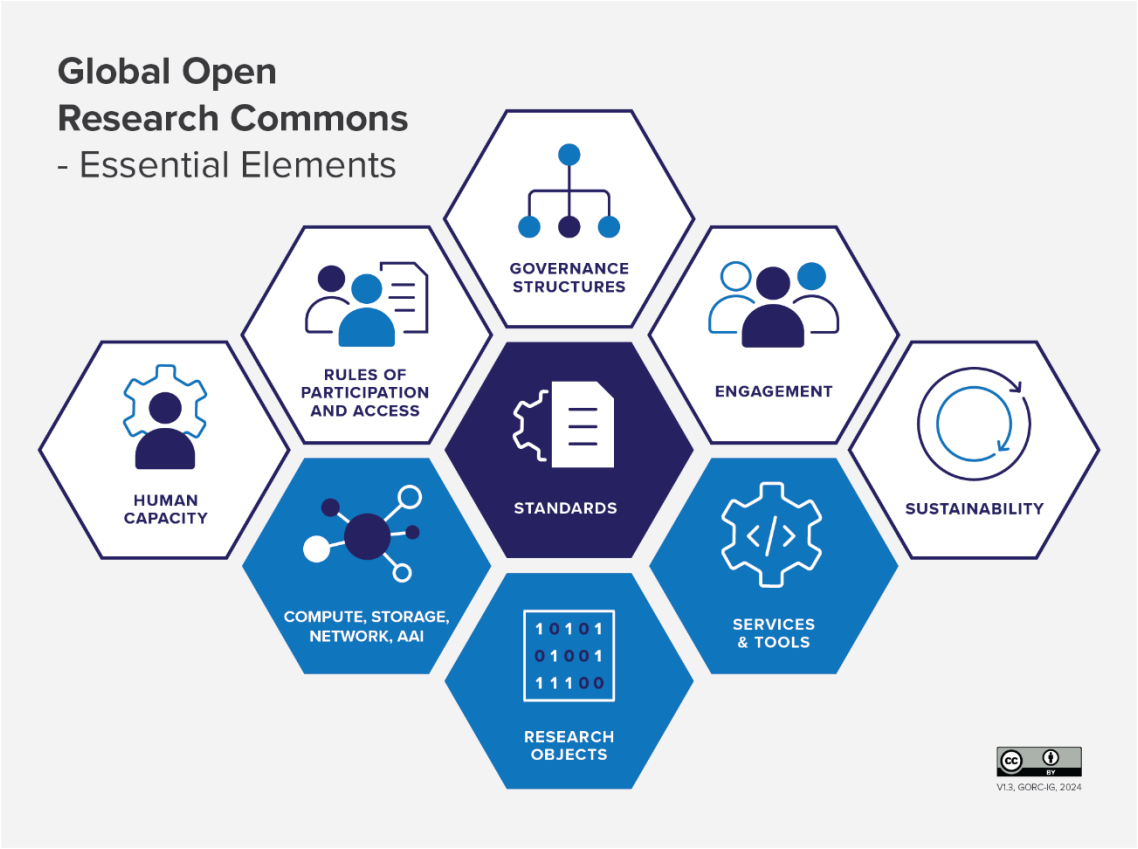

Figure 1. Essential elements of a research commons.

The three elements in blue are the underpinning elements that constitute the parts of the commons with which people interact:

- ICT Infrastructure: the physical components that a computer system requires to function and are necessary to conduct research;
- Services and Tools: Service (as defined by IVOA). A service is any commons element that can be invoked by the user to perform some action on their behalf. Services are usually intended for use by machines. Tools enable researchers to perform one or more operations, typically on data, and often with data as the output. Tools are usually intended for use by humans. In this context, we are explicitly excluding physical instruments;
- Research Objects: These are the outputs of the research process; however, they can also be inputs to later processes. Here, the scope is limited to digital research objects.

The five elements in white are the social or human elements that are needed to make the commons succeed:

- Human Capacity: The ability of the commons to create a human-friendly environment for all stakeholders and community members in all aspects;
- Rules of Participation and Access: The set of policies defining a minimal set of rights, obligations and accountability governing the activities of those participating in the commons;
- Governance: Defining the organisation's purpose and the development of the strategies. Typically, the governance processes will be operated via a series of steering groups or

boards, involving key stakeholders for the commons such as funders, national services and community representatives. Note that data governance is classified under the rules of participation and access element;

- Engagement: Methods used to interact with the broad stakeholder community to involve them in activities;

- Sustainability: Models and agreements made on how to ensure the viability and continued or transitioned operations of the commons, including funding and resourcing activities, in a way that can be sustained over the long term.

The central element in dark blue represents the central importance of standards at the core of any commons. Originally, this element was standards and interoperability, indicating that interoperability was a core goal, and standards a key enabler. As some of the use cases described in the following sections have been explored, interoperability needs to be considered in all of the elements, particularly because this applies to interoperability between commons. This will be explored in future work.

This typology was presented to the RDA community as a draft supporting output in early 2023, revised in July 2023 to respond to community comments, and accepted as a supporting output in August 2023 (Jones et al., 2023). In addition to the typology and providing a forum for conversations about commons, the GORC-IG is working towards a roadmap for the global alignment and integration of research commons.

To date, feedback on the typology indicates that this is a complete list of the essential elements needed by a commons and that this representation is a very useful way of considering the infrastructure decisions required to ensure ongoing sustainability, as well as an agreed set of elements that can be used when considering questions of interoperability.

International Model

The GORC International Model Working Group (GORC-WG) worked under the auspices of the GORC-IG in support of the development of an interoperability roadmap. The mission of the GORC-WG was to 'generate a set of pertinent attributes to identify common features across commons' and 'review and identify attributes or features currently implemented by a target set of GORC organisations and when possible, identify how they measure their user engagement with these features' (Payne, Leggott, & Treloar, 2021). This International Model (IM), the realisation of that mission, can be thought of as an organisational structure or framework that captures observations of commons elements, attributes, and key performance indicators (KPIs) from real world implementations currently in use or expected in research commons. One of us (Woodford) led the development of the IM.

The model is based on the GORC-IG typology outlining the essential elements of a commons (Jones et al., 2023), as shown in Figure 1. The model further refines these essential elements by defining categories and subcategories of the essential elements, as well as attributes and features of these entities. The items in the model were identified from a range of sources, including a speaker series and related documentation, a literature review, and a community consultation process. The model was endorsed by RDA as a supporting output in October 2023 (Woodford et al., 2023) and as an RDA recommendation in November 2024 with adoption use cases.

In its current version (V1.1), the model is a spreadsheet available in static and online formats that are open for comments and suggestions from users. It is divided across tabs based on the GORC-IG essential elements, in addition to a glossary and a set of KPIs and metrics. Each item in the model has a main statement or label, an extended description, examples, consideration level, and primary sources. The consideration level is intended as a guide for users of the model, allowing the items to be filtered based on whether they are 'core' considerations that every commons should consider, 'desirable' considerations that should be considered by established

commons or those looking to expand, and 'optional' considerations that may be considered by commons with particular interest in those areas.

Sustainability is a dedicated essential element in the model as well as a consideration throughout the model. In the essential element, sustainability focuses on three main categories of plans, schemes, and implementations for: (1) resourcing and capacity building in the medium and long-term, including business models, human management, and knowledge retention; (2) medium and long-term stewardship, contextualisation, usability, and accessibility of research objects, services and tools, such as through transition and scalability plans that consider the ICT infrastructure, human resources, and operations; and (3) building community trust and maintaining it in the long term. This last category emphasises sustainability in other elements of the commons, and is evident in the model in the following elements in particular.

Governance and leadership has sustainability considerations spread across five categories: (1) commons intent and definition; (2) commons strategic planning, which includes the development of roadmaps, risk and financial frameworks, and community relations; (3) organisational structures, designs, ways of working, and capability maturity level for the aims and context of the commons, which includes iterative review and improvement considerations; (4) internal commons policy development, implementation, and review, including internal documentation management and preservation; and (5) governance rules, principles, and enforcement of quality for research objects and services and tools, including adherence to principles, such as Findable, Accessible, Interoperable, Reusable (FAIR) (Wilkinson et al., 2016), Collective Benefit, Authority to Control, Responsibility, Ethics (CARE)(Carroll et al., 2020) and Transparency, Responsibility, User-Focus, Sustainability, Technology (TRUST)(Lin et al. 2020). TRUST, in particular, emphasises sustainability, with FAIR and CARE emphasising aspects of preservation.

Rules of participation and access are characterised by the definition of the commons community, with two main categories: (1) a set of policies defining a minimal set of rights and obligations for the commons community; and (2) a set of policies defining minimal accountability for the commons community.

Engagement is characterised by structured, coordinated, and implemented communication and engagement plans and mechanisms, media, or channels. In addition, documented and public processes of the commons maintain a high level of transparency with stakeholders and the community applied to four categories: (1) community input and feedback; (2) active promotion to intended audiences to participate in the commons; (3) incentivisation to intended audiences to participate in or with the commons, such as through consultations, events, and funding competitions; and (4) engagement with other research commons, research infrastructure hosts, research institutions, and research funders, such as via active research projects.

Human capacity has sustainability considerations that are spread across five categories: (1) internal capacity, including accounting for turnover, backfill, and maintaining a high level of transparency for internal operations through documentation; (2) skills for planning, managing, and assessing service delivery, for example, to ensure commons future-proofing and relevance as technology and research needs change; (3) skill requirements for the commons community, for example, through documentation such as user guides and wikis; (4) ease of use for the commons community; and (5) training and education hosted, provided, and/or contributed to by the commons for individuals and groups in the commons community, which may focus on curation procedures and practises.

Interoperability emphasises that the main categories of technical, organisational, and legal interoperability require ongoing sustainability of the commons.

Standards and conventions is characterised by the sustainability of these practises and applications, including community-supported standards and conventions for: research objects content, format, and access method; metadata content, format, and access method; semantic object content, format, access methods, and mappings; applications, software, and services and tools, such as reproducible builds; quality, such as for appraisal decisions and quality assessments; adding and maintaining persistent identifies (PIDs); authentication and authorisation protocols; catalogues of digital objects; regulatory and ethical compliance; and for supporting and describing

mechanisms, infrastructure and plans for specific workflows, use cases, and interexchange within the commons.

The ICT infrastructure, including web interfaces, scaling, and regular reviews and updates, has specific considerations for environmental sustainability as well as maintenance, upgrades, and replacements for hardware and software addressing network, compute, storage, foundational operating system(s), and authorisation and authentication infrastructure.

Services and tools are characterised by their sustainability, such as via review, maintenance, and FAIR assessments. Services and tools includes research object repositories, discovery services, services and tools for direct research tasks, such as consultations and platform as a service for analysis, research data management, and acquisition, workflow and middleware services and tools, PIDs, vocabularies and semantic objects, data management, catalogues of services and tools such as a registry of repositories, authentication and authorisation, and helpdesk.

Research objects are characterised by the accessibility and (re)usability of publications and research documentation, research data, research software, semantic objects, and collections. The accessibility and (re)usability of research objects is directly tied to curation, preservation, and indirectly to the sustainability of the hosting commons.

The KPIs and metrics include specific metrics for budget change and operations cost-efficiency within the theme of commons governance and policy. Additional themes of KPIs and metrics include engagement with stakeholders, feedback and satisfaction of stakeholders, infrastructure and technology, and stakeholder engagement with commons infrastructure and technology.

GORC Typology Supports Three Classes of Use Case

How can the GORC typology and IM assist when designing sustainable open research commons that support the ongoing curation of FAIR research objects for interoperability and reuse? This section discusses three use cases, with illustrative examples. The examples are chosen from those known to the authors, and should not be assumed to be a complete list.

Creation of New Commons: REASON and BioFAIR

The ResEArch CommonS fOr Norway (REASON) is a funding proposal submitted to the Research Council of Norway in November 2023 (Conzett & Macneil, 2023). REASON is a proposed generalist research infrastructure for Norway that complements and supplements existing domain-specific/specialised infrastructures. It involves five Norwegian and nine international partner organisations across Europe, the US, and Canada. This proposal was explicitly structured around the 10 essential elements of the IM (Conzett & Macneil, 2024), which, for the first time, provides a globally accepted template for research commons. Aligning with GORC, it demonstrates alignment with a larger international agenda. The GORC-IM was stated by the proposers as an essential reference model to use when structuring the proposal. REASON proposes making comprehensive use of the GORC elements and building a range of services and tools within these elements. In addition, the proposers saw an essential role for REASON in a future national EOSC node in Norway. Unfortunately, this proposal was not funded. Therefore, it is not possible to comment on how the GORC model would have been used to implement REASON.

BioFAIR is a UK Research and Innovation (UKRI) funded data commons for biological and biomedical sciences based in the UK (UKRI, 2024). Originally proposed by ELIXIR-UK in 2020, BioFAIR aims to enable access to life science data across research institutions and existing data infrastructures by providing end-to-end FAIR research data management and analysis capabilities (BioFAIR, 2023). At the 20th Research Data Alliance plenary in Gothenburg, Sweden, there was a call for the publication of intermediate GORC outputs so that the typology of essential elements

and the IM drafts could be used ahead of their official endorsement to strengthen the BioFAIR funding and business proposals. With funding secured and the project underway, BioFAIR is now structuring its development around the GORC-IM and will provide the first test case for ground-up development using the model.

Characterisation of Existing Infrastructure: SURF

SURF is a cooperative for research institutions in the Netherlands and the major provider of research data infrastructure[4]. Since 2023, they have used GORC to promote a commons approach to enhance the coordination of an existing fragmented infrastructure landscape, provide a point of connection to European and international initiatives, and shape alternatives to commercial providers. SURF was already considering how best to connect national initiatives to EOSC and saw the IM as a way of taking an inventory of current activities using a common language derived from the essential elements. They generated topics and questions from the model to be used in semi-structured dialogues with participants across institutional, consortia, and pan-European settings.[5] They found that the IM was very helpful to undertake an initial landscape inventory and identify common activities and challenges among different national initiatives and nodes. The model helped to unveil attributes that had not been considered and suggested possible implementation options. In addition, they found that the model exposed ways in which all elements of the activities were related, as well as prompting discussions about aspects that had not originally been considered by workshop participants.

Analysis of Interoperability: EOSC

The ambition of the EOSC is to create a federated and open multidisciplinary environment where researchers, industry, and members of the public can publish, find, and reuse data, tools, and services for research, innovation, and educational purposes. In pursuit of this, the European Commission has been considering how to construct an interoperability framework (European Commission 2021) and how to construct an EOSC EU Node.[6] The EOSC interoperability framework and related publications were key resources for the development of the IM. Recently, European Commission staff in the Open Science unit have been using the GORC elements to break down the larger interoperability challenges into discrete aspects. The early stages of this two-way relationship between GORC and EOSC were developed at the FAIR-IMPACT workshop at the 23rd Research Data Alliance Plenary in San José, Costa Rica, focussing on interoperability challenges and solutions in a global context (RDA, 2024). In addition, SURF in the Netherlands has been using the IM to position SURF as a Pilot National Node within the EOSC Federation,[7] identifying which existing infrastructure and services providers are best placed to contribute to the implementation of the essential elements in the model.

In a related activity, a recent EGI discussion paper (EGI, 2024) uses the GORC elements to consider the EOSC contribution to an open research commons and how to characterise the contribution of the EGI as an EOSC node.

In the same spirit, the German National Research Data Infrastructure (NFDI),[8] refers to GORC as an important element in their strategy towards interoperability and connection to EOSC (Bernard et al., 2024, p. 24): 'The Global Open Research Commons (GORC) is emerging as a model that other international infrastructures are using to shape their activities at policy, technical, interoperability and monitoring level.' and 'The GORC can provide a framework to ensure interoperability of Base4NFDI with international infrastructures' (ibid).

[4] SURF: https://surf.nl/en
[5] EOSC: https://eosc.eu/wp-content/uploads/2024/03/5-NL-EOSC-NTE-SURF-Hoogerwerf-Sesink.pdf
[6] EOSC: https://open-science-cloud.ec.europa.eu/
[7] EOSC: https://eosc.eu/eosc-about/building-the-eosc-federation/
[8] NFDI: https://www.nfdi.de/association/?lang=en

Future Work

In the dynamic world of digital research infrastructure, there cannot be a static or definite model for all possible considerations for research commons. Further landscape and literature analyses are needed, as well as supporting outputs, to assist in the use of the model and how it may be used in conjunction with other existing models and frameworks.

One strand of work relates to the typology and model. The GORC-WG restarted in 2025 within RDA to start tackling new avenues of work and support existing and new adopters of the model. Clear initial needs are revisions to the IM, such as consistent wording and descriptions, adoption support, mapping with relevant frameworks, and moving the IM into a more visual, interactive container. Developing the analysis from the GORC-WG that was not included in the model is another priority, including work on identifying types of commons, how the speaker series participants were represented in the IM, and thematic subsections of the model. Thematic subsections of the IM, or 'slices', would provide only the relevant items across the model for that particular theme, such as research data management and curation, which have already been determined to have relevant representations across essential elements. This will also lead to creating discipline and commons-type specific profiles of the model, which will lead to creating implementation maps (i.e., how did research commons implement items in the IM). These goals are addressed in the developing charter for the GORC International Implementations WG (GORC II WG), which will address:

1. Identifying and defining implementations of the GORC-IM that may then be referenced as examples for commons development (Deliverable 1), specifically profiles;

2. Improving usability by creating an interactive container for the GORC-IM that includes documentation, thematic subsets of the model (slices), and mappings with existing frameworks, models, vocabulary, and principles (Deliverable 2);

3. Ensuring updated relevance to current literature and community considerations on commons and research infrastructure by continuing our literature analysis and subsequent updates to the IM (Deliverable 3).

Setting a maturity level on the adoption of considerations or implementations within the model is also of interest; however, it is currently a future priority.

Another relates to extending the model. As various supporting outputs are developed, the model will consistently be re-evaluated and future versions will be released, in particular, a version 2.0 including research hardware (Miljković et al., 2024) and physical instruments. As profiles and new versions of the model are developed, special attention will be paid to addressing emerging topics in digital research infrastructure, including the use and misuse of artificial intelligence, data security, big data, and equity, diversity, inclusion, and accessibility (Pérez-Jvostov, Sahrakorpi, & Zhang, 2024).

The third strand of work relates to using the model to work towards the ultimate goal of a truly global open research commons. Here, the discussions within the EOSC will be a very useful testbed. One idea being explored is what it would mean to define adapters between the same element in two different existing commons. Because the essential elements are drawn from social and technical domains, the adapters will need to be varied in scope and approach. Identifying or creating adapters between the technical elements will be a non-trivial exercise, but one where existing solutions could be reused or reconfigured. For the social domains, 'conceptual adapters' might be required, with different compliance levels for each element. The RDA-CODATA Legal Interoperability of Research Data: Principles and Implementation Guidelines (RDA-CODATA Legal Interoperability Interest Group, 2016) is an example (although at the level of data objects, rather than entire commons), which could be used as a starting point. These are very nascent ideas and will receive further exploration and testing against real world examples in planned future work.

Conclusion

The GORC-IM provides a list of commons components (entities) and characteristics to be considered when undertaking the development or assessment of a commons of any kind, at any stage. The model does not mandate what should be implemented or in what way. The decisions on what is relevant and where resources should be invested will vary depending on the environment and priorities of the implementer. The hope is that the model will provide actionable information for organisations as they make their decisions about what and how to focus and develop their infrastructure.

This paper supports the development of individual commons and supports the work required to make the commons interoperable. The GORC-WG outputs provide an agreed language and model to describe commons components and a firm foundation for the GORC-IG as it seeks to create a roadmap for commons integration. Increasing interoperability between commons will increase their individual as well as collective value. However, this move towards increased value from connecting multiple commons also emphasises the need for ongoing curation at the level of each commons and an intentional focus on sustainability.

To address current and future challenges, especially at the accelerated pace necessitated by the multiple global crises facing humanity, this researcher requires access to sustainable aggregations of data. These will need to be curated for reuse and interoperability over the long term to support the integrity of the scholarly record. This work envisions an interoperable set of platforms that build on the advances in the internet and the consensus and strengths of the research community. It learns from the past, is grounded in the present, and looks to the future.

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