Conceptual Architecture for the Implementation of a Responsible Research Assessment Framework Built on Open Infrastructures

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List of Acronyms

Comara	Coalition for Advancing Research Assessment
WG	Working Group
API	Application Programming Interface
CRIS	Current Research Information Systems
CV	Curriculum Vitae
FAIR	Findable Accessible Interoperable Reusable
DOI	Digital Object Identifier
IT	Information Technology
OA	Open Access
OECD	Organisation for Economic Co-operation and Development
OI	Open Infrastructure
OI4RRA	CoARA Working Group on Towards Open Infrastructures for Responsible Research Assessment
ORCID	Open Researcher and Contributor ID
PID	Persistent Identifiers
RFOs	Research-funding organizations
ROR	Research Organisation Registry
RPOs	Research-performing organizations
RRA	Responsible Research Assessment
SDGs	Sustainable Development Goals
SKG-IF	Scientific Knowledge Graphs Interoperability Framework

Executive Summary

This document has been developed by the **CoARA Working Group on Towards Open Infrastructures for Responsible Research Assessment (OI4RRA)**. It reflects a collective effort to define the building blocks of a modern, fair, and future-proof research assessment system based on Open Infrastructures (OIs).

Open Infrastructures are key enablers of the CoARA principles. They operationalize core commitments such as recognizing a diversity of research contributions, using both qualitative and quantitative evaluation methods, and ensuring transparency and accountability in assessment practices. By supporting machine-actionable and openly accessible data, OIs provide the technical foundation for emerging reforms, such as narrative CVs, context-sensitive indicators, and assessments aligned with institutional missions and societal goals.

To translate the CoARA principles into practice, this document introduces a **Conceptual Architecture** for implementing Responsible Research Assessment (RRA) through a full-stack, interconnected OI ecosystem. The architecture is designed to move beyond traditional, proprietary systems and toward infrastructures that are open, transparent, and interoperable, reflecting the diverse realities of contemporary research and enabling assessments that are fair, contextualized, and aligned with institutional missions.

Bridging the gap between technical implementation and strategic vision, the architecture offers concrete guidance on system integration, optimized data flows, and interoperability protocols. Simultaneously, it provides institutional leaders and funding bodies with strategic insights to enhance transparency and foster cross-border collaboration and integration in research evaluation.

The conceptual architecture is structured into four tiers:

- **Foundation Tier:** Establishes data integrity and interoperability through persistent identifiers and standardized metadata.
- **Publishing Venues Tier:** Ensures the open dissemination and archiving of diverse research outputs.
- **Metadata Aggregation Tier:** Collects and enriches data to build a comprehensive research information network.
- **Assessment Support Tier:** Provides advanced analytics, indicators, and focused functionalities to support contextualized and responsible evaluation.

Key Takeaways

This document makes it clear that **OI are not peripheral supports but core enablers** of a research assessment system that is fair, inclusive, and future-ready. If research-performing and research-funding organizations are to align with the principles of CoARA, they must treat OIs as shared, strategic assets and invest in them accordingly.

First, the architecture shows that responsible assessment can only thrive if it is built on a fully connected system, one where metadata, identifiers, repositories, aggregators, and analytics services work together seamlessly. Investing in one part, while neglecting the others, undermines the whole. Institutions and funders must look beyond their local infrastructures and support the interoperability and sustainability of the entire stack.

Second, sustainability must be redefined. OI are not free, and relying on short-term, project-based funding weakens their long-term viability. What is needed is predictable, long-term funding models shared across institutions, funders, and countries—based on actual infrastructure use, strategic relevance, and mutual benefit.

Third, infrastructure must be co-designed and co-governed. The system cannot be shaped only by a few actors. Stakeholders need to contribute not only financial support, but also requirements, feedback, and leadership. Participating in governance, standards development, and policy alignment is critical to ensure these infrastructures remain fit for purpose and aligned with evolving assessment needs.

Fourth, OI must extend beyond traditional research outputs. To support reforms like narrative CVs and diverse indicators, institutions must ensure that their systems can capture and exchange data on a wider range of contributions, from teaching and training to leadership, public engagement, and societal impact. This includes improving the interoperability of institutional systems and connecting them to the broader scholarly ecosystem.

Ultimately, the message is clear: **a sustainable, fair, and globally interoperable research assessment system will not emerge on its own**. It requires deliberate, coordinated action across the research community. This document sets out the foundation, but the next phase must include practical steps, cost analysis, funding strategies, business model development, and sustainability planning at a global scale. A decisive transition from fragmented, siloed investments to an integrated, full-stack investment model is imperative for establishing a strong and globally interconnected research ecosystem. The time to act is now.

Why Open Infrastructures Are Essential for CoARA-Aligned Research Assessment

Research assessment plays a powerful role in shaping funding decisions, career development, and institutional strategy. Yet, traditional evaluation methods have long been criticized for focusing on narrow metrics such as citation counts and journal prestige. These approaches often obscure the full scope of scholarly contributions, reinforce systemic biases, and incentivize behaviors misaligned with research quality and societal relevance.

There is now broad consensus—reflected in initiatives like the CoARA Agreement, that research assessment must become fairer, more transparent, and more inclusive. This means recognizing diverse contributions such as datasets, software, training, Open Science practices, interdisciplinary work, and societal impact. However, achieving this transformation is not feasible within the confines of closed, proprietary systems.

For decades, assessment has depended on subscription-based citation databases and commercial tools that:

- **Lack transparency**, obscuring how evaluation metrics are defined and applied;
- **Prevent independent validation**, hindering accountability and improvement;
- **Limit access**, excluding researchers and institutions without the financial means to participate fully.

Such infrastructures fundamentally contradict the CoARA principles, which call for openness, equity, and responsible use of both qualitative and quantitative indicators. In contrast, OI offer a path forward. These are transparent, community-driven systems that support interoperability, accessibility, and auditability across the research ecosystem.

OIs are not just technical solutions, they are the foundation for aligning assessment practices with the CoARA vision. They enable machine-actionable, verifiable, and openly available data flows that support narrative CVs, contextual indicators, domain-sensitive evaluation models and other reforms. But to realize this potential, Research-Performing Organizations (**RPOs) and** Research Funding Organizations (**RFOs) must go beyond adopting OIs**. They must **embed them in institutional processes, align investments with global standards, and support their long-term sustainability** through shared governance and funding.

Who Should Read This Document – Why It Matters

This document is intended for research executives, institutional decision-makers, RFOs, RPOs, and policymakers who are committed to transforming research assessment in line with the principles of openness, fairness, and long-term sustainability. It provides a strategic and technical reference to help stakeholders align local infrastructure investments with a globally connected, transparent, and future-proof research assessment ecosystem.

It is a **call to action** for those shaping the research landscape to understand not just what OIs are, but what it takes to make them truly impactful.

Specifically, this document enables stakeholders to understand:

- **The key Components of Open Infrastructures** - What constitutes the backbone of the open research ecosystem, PIDs, metadata standards, repositories, aggregators, and analytical tools, and why shared understanding of these components is essential to building trust and alignment..
- **How Infrastructure Layers Interact** - Understand how the different tiers of OIs interact and depend on each other, from data creation to dissemination and analysis, to deliver transparent, interoperable, and auditable assessment systems. No single layer works in isolation.
- **How to Maximize Institutional Investments** - How to ensure that institutional systems (e.g., CRIS, repositories, OA journals) are not operating in isolation but are designed to connect with global infrastructures, enabling richer, more accurate, and context-aware assessment.
- **Why and How to Invest Beyond Institutional Walls -** The strategic importance of contributing to the global OI ecosystem—not only through sustained funding of foundational services (e.g., PIDs, metadata providers, aggregators, indicator services), but also through non-financial contributions such as defining new requirements, piloting use cases, and fostering standards for interoperability and contextualized evaluation.

By understanding and acting on these pillars, RPOs and RFOs can move from passive users of closed systems to active stewards of a new research assessment model, one that is open, fair, inclusive, and built to serve the evolving needs of science and society.

The Conceptual Architecture: Tiers and their Interplay

In this section, we present a clear and structured model for organizing OI into four connected tiers that support RRA. These tiers form the backbone of an open, inclusive, and scalable assessment system—one that responds to the emerging needs of RPOs and RFOs as they implement the principles of CoARA, i.e., recognizing the full diversity of research contributions, reducing reliance on journal-based metrics, and enabling qualitative, narrative-based, and context-sensitive evaluation practices.

This architecture emphasizes OIs as community-driven, non-proprietary systems designed to:

- **Move beyond closed, proprietary systems** that limit access, obscure evaluation processes, and reinforce systemic inequalities.
- Ensure an open, interoperable, and globally connected research assessment landscape, preventing fragmentation and siloed evaluation practices.
- **Provide a roadmap for integrating** institutional, national, and international infrastructures, fostering a cohesive,data-driven, and trusted RRA ecosystem.

The Four-Tier Model

This model maps the **key stages of the research lifecycle**, detailing the functions of each tier and its role in advancing fair and transparent research assessment:

- **Foundation Tier (Tier 0):** Establishes data integrity and interoperability through PIDs, metadata, and standards. It forms the reliable base for all subsequent processes.
- **Publishing Venues Tier (Tier 1):** Hosts research outputs in repositories and OA journals, ensuring visibility, discoverability, and linkage. It guarantees research outputs are widely accessible and permanently archived.
- **Scholarly Metadata Aggregators Tier (Tier 2):** Collects, enriches, and connects metadata across diverse sources, creating a unified and contextualized research information network.
- **Research Assessment Support Services Tier (Tier 3):** Translates data into actionable insights via indicators, analytics and monitoring tools, including services that enable narrative CVs and researcher-centric reporting frameworks.

Beyond its structural clarity, this model highlights the ecosystem's many actors—libraries, research institutions, funders, infrastructure providers, and policymakers. However, a major challenge remains: fragmentation across institutional, national, and disciplinary boundaries. Diverse domains have differing evaluation methodologies, metadata standards, and infrastructure needs, making interoperability difficult and leaving gaps between otherwise complementary systems.

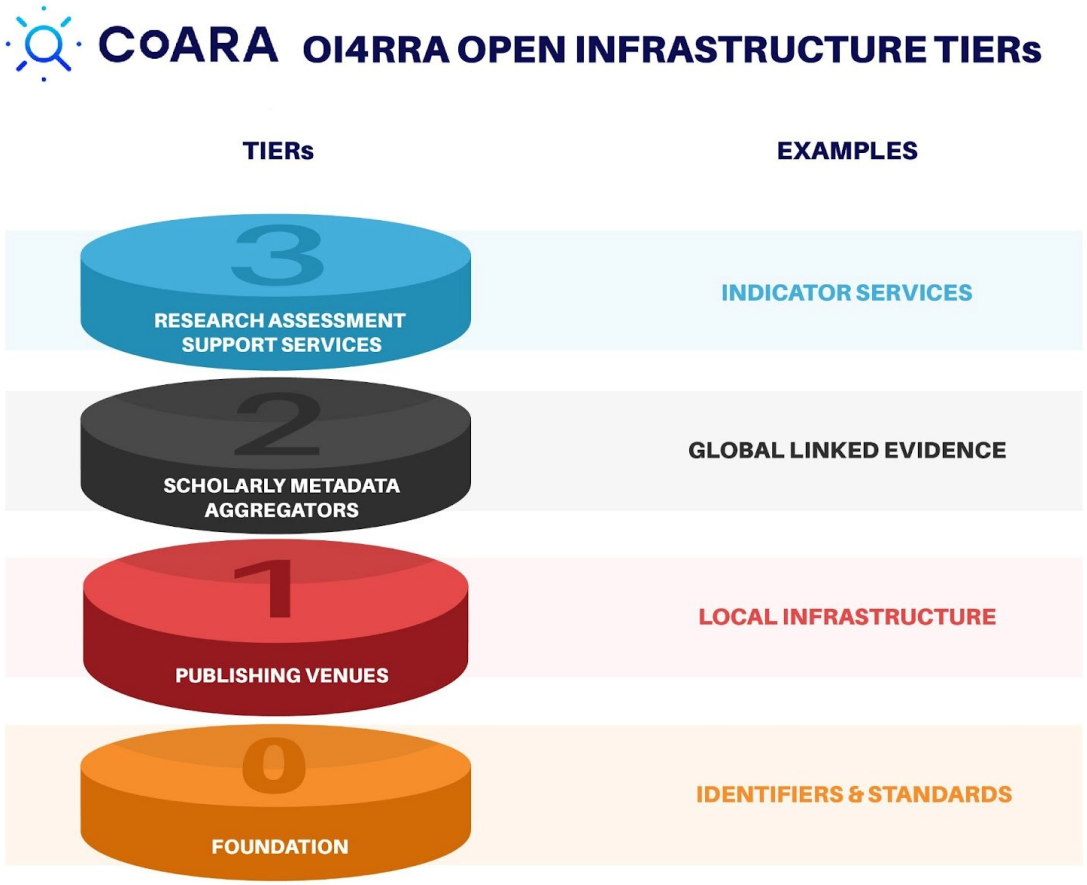

Figure 1. Open Infrastructure for Responsible Research Assessment Conceptual Architecture

To address this, the framework clarifies how the tiers interact and why coordination matters. By identifying key roles and enabling collaboration across policy and technical levels, it supports the alignment of investments and governance strategies. This helps ensure that OIs for RRA are not only sustainable and interoperable but also globally connected and fit for purpose in a new era of research evaluation.

TIER 0 - Foundation Tier: The Backbone of OIs for RRA

The Foundation Tier serves as the structural backbone of OIs, ensuring that research outputs, contributors, institutions, and funding sources are consistently identified, accurately described, and interconnected. It comprises three essential resource types that support research assessment by ensuring data integrity, discoverability, and interoperability:

- Basic Metadata Providers – Supplying structured information on research activities, outputs, and entities.
- Persistent Identifier (PID) Providers – Guaranteeing stable and unambiguous identification of research objects.
- Standards and Specifications Providers – Establishing interoperability and classification frameworks to harmonize data exchange.

Key Functions

Ensures consistent, structured, and persistent research information that underpins RRA by:

- Providing accurate metadata to describe research outputs activities, researchers, and institutions;
- Ensuring research entities remain uniquely identifiable over time through PIDs, enabling reliable tracking and linking;
- Facilitating data interoperability by adopting standardized vocabularies and taxonomies, allowing seamless integration across systems;
- Supporting open and transparent research assessment by ensuring that data sources are verifiable and accessible to all stakeholders.

How it Supports RRA Processes

For research assessment to be comprehensive and reliable, it requires structured, persistent, and standardized data flows. The Foundation Tier:

- Including a broad range of research contributions – Covers the breadth of research outputs, including publications, datasets, software, methodologies, training, and events;
- Supports transparency and reproducibility – Provides clear metadata and persistent identifiers for proper attribution and verification;
- Facilitates global interoperability – Aligns with global Open Science infrastructures to avoid silos and ensure seamless data sharing;
- Enhances institutional decision-making – Helps institutions track research contributions beyond publications and integrate alternative indicators.

TIER 1 - Publishing Venues Tier

Tier 1 plays a central role in the research assessment ecosystem by facilitating the **dissemination, accessibility, and long-term preservation** of research outputs. It includes research product repositories and OA scholarly journals and publishers, ensuring that scholarly contributions are visible, accessible, and reusable within and beyond institutional boundaries.

By supporting various research outputs and activities, including publications, datasets, software, methodologies, and multimedia, this tier provides the foundation for responsible, transparent, and **equitable research assessment**. The integration of persistent identifiers (PIDs), open metadata standards, and compliance frameworks ensures that research is discoverable, interoperable, and linked across infrastructures.

Key Functions

It serves multiple functions that support the research community, including:

- **Ensuring Open Accessibility** – Enabling open availability of research outputs, ensuring accessibility beyond paywalls.
- **Providing Structured Archiving** – Ensuring that research outputs are stored in repositories with persistent access.
- **Facilitating Compliance with Open Science Principles** – Encouraging transparency through open licensing, machine-readable metadata, and adherence to FAIR principles.
- **Enhancing Research Visibility & Citability** – Offering DOI registration, metadata curation, and indexing to improve research tracking and impact assessment.

- **Maintaining Versioning & Reproducibility** – Supporting multiple versions of research outputs (e.g., preprints, postprints, datasets) to enable dynamic and transparent research evaluation.

How it Supports RRA Processes

For research assessment to be inclusive, transparent, and comprehensive, it should consider diverse research outputs. In relation to RRA, this tier:

- **Captures Research Beyond Publications** by supporting datasets, software, preprints, open peer review, and other scholarly outputs;
- **Promotes Fair & Responsible Use of Indicators** by reducing the reliance on journal impact factor by recognizing contributions from multiple formats;
- **Enables Contextual & Local Assessment** by enabling institutions to analyze research contributions within institutional and disciplinary contexts rather than global ranking systems alone;
- **Facilitates Narrative-Based Evaluations** by that can be used in qualitative research assessment approaches, such as narrative CVs.

TIER 2 - Scholarly Metadata Aggregators: Strengthening Interoperability for Responsible Research Assessment

Tier 2 plays a critical role in enhancing metadata discoverability, integration, and interoperability across research assessment platforms. Scholarly metadata aggregators serve as a bridge between local research information systems and global knowledge infrastructures, ensuring that research outputs and contributions are accurately collected, connected, and contextualized.

Key Functions

It ensures that research information is:

- **Collected from diverse sources**, i.e., it aggregates data from institutional repositories, CRIS systems, PID registries, and publishing venues;
- **Standardized and harmonized**, i.e., it uses common metadata schemas to align data across different infrastructures;
- **Enriched, Linked and contextualized**, i.e., it offers valuable enrichments on the basic scholarly metadata, connects research outputs, projects, institutions, funding, and impact indicators for a holistic view;
- **Integrated into research assessment workflows,** i.e., it supplies curated, interoperable data to support fair, responsible, and transparent research evaluation.

How it Supports RRA Processes

For research assessment to be meaningful and evidence-based, it requires a continuous flow of structured and verified research information. This tier ensures:

- **Comprehensive research coverage** by bringing together publications, datasets, software, funding, and Open Science contributions and activities in one place;
- **Transparency and verification** by supporting traceability of data sources, ensuring that assessment relies on verifiable information;
- **Interoperability across platforms** by allowing research institutions, funders, and policymakers to access harmonized, globally recognized research data;
- **Support for diverse indicators** by facilitating the use of both qualitative and quantitative assessment methods, including collaboration networks, Open Science practices, and narrative CV elements.

TIER3 - Research Assessment Support Services Tier

Tier 3 builds on data from the preceding tiers to provide insights, indicators, analytics, and monitoring capabilities that support RRA. These services translate raw data into meaningful analyses, helping institutions, policymakers, and funders assess research performance beyond traditional metrics.

Key Functions

It enables evidence-based research assessment by offering:

- **Indicator Provision** by supplying diverse indicators, such as usage metrics, citation-based impact measures, collaboration networks, and Open Science adoption levels;
- **Analytics & Monitoring Services** by enabling RPOs, RFOs, and policymakers to track trends, benchmark performance, and assess policy impact;
- **Academic Profiling, Narrative CVs & Researcher Evaluation** by supporting researchers in showcasing their full range of contributions, beyond publications, including mentorship, societal impact, training, and interdisciplinary work, with structured formats like narrative CVs;
- **Event & Assessment Management** by facilitating transparent and standardized hiring, tenure, career progression, and faculty evaluation processes.

How it Supports RRA Processes

By leveraging OIs, this tier:

- **Promotes Responsible Use of Indicators** by encouraging context-aware application of research indicators, and avoiding over-reliance on citation metrics;

- **Expands Assessment Beyond Publications** by supporting FAIRness, Open Science practices, interdisciplinarity,and research impact evaluations, including qualitative and narrative-based assessments;
- **Enhances Transparency & Accountability** by ensuring that assessment decisions are informed by openly documented methodologies and verifiable data sources;
- **Facilitates Global & Local Comparisons** by enabling institutions to assess research performance using structured data at institutional, national, and global levels.

Interplay, Interoperability and Streamlined Data Flow

The four tiers of OIs for RRA are designed to function as a connected system. Each layer contributes a specific function while reinforcing the others, ensuring that research outputs, contributors, and institutions are accurately identified, openly accessible, and evaluated in a transparent and scalable way. The following illustrates how data moves through the tiers, with each one adding value to create a reliable and interoperable research assessment ecosystem.

- **Tier 0: The Foundation Layer** – ***Persistent Identifiers, Metadata, and Standards***

Tier 0 establishes the essential building blocks for the system by providing PIDs (e.g., DOIs, ORCID, ROR) and metadata standards (e.g., shared vocabularies, ontologies) that ensure consistent identification and classification of research outputs, activities, researchers, institutions, and funding sources. This foundational layer guarantees that all subsequent tiers can interconnect and interoperate with reliable, structured data.

- **Tier 1: Publishing and Repository Layer** – ***Research Output Dissemination***

Using the standards and identifiers from Tier 0, repositories, Open Access journals, and publishing platforms in Tier 1 store and share research outputs, including publications, datasets, software, and other research products. These systems ensure that research is properly archived, linked to contributors and funders, and openly accessible to the research community. This layer includes API endpoints for seamless data exchange between local systems and global aggregators.

- **Tier 2: Metadata Aggregation and Enrichment Layer** – ***Connecting and Enhancing Research Data***

Tier 2 aggregates, integrates, and enriches research metadata from Tier 1, ensuring that research outputs are discoverable, searchable, and reusable. This tier acts as a bridge between scattered institutional repositories and the broader research ecosystem by linking related data, standardizing records, and enabling global interoperability. It leverages APIs for flexible querying.

- **Tier 3: Research Assessment and Analytical Tools – *Providing Insights and Evaluation Metrics***
  Tier 3 builds on the structured, enriched data from Tier 2 to provide assessment tools, indicators, and analytics that help RPOs, RFOs, and policymakers evaluate research contributions beyond citation metrics. These tools facilitate responsible research assessment by offering insights into Open Science adoption, societal impact, and research integrity.

Bringing It All Together: From Data to Decision Making

To fully understand the value of OIs in RRA, it is important to see how the system operates in practice. The following walk-through illustrates how a single research contribution progresses through each tier. It demonstrates how unique identifiers, metadata, aggregation, enrichment, and analysis come together to create a complete, transparent, and reusable record of research activity. This journey shows how RPOs and RFOs can derive greater value from the research they support and how their investment in OIs translates into better-informed assessment practices.

The workflow follows a logical progression:

- Research contributions are deposited, uniquely identified, versioned, and properly attributed using PIDs (Tier 0 → Tier 1);
- Metadata is aggregated, linked across platforms, enriched with classification schemes, and prepared for broader reuse (Tier 2);
- The enriched data is analyzed and benchmarked, generating indicators and insights to support responsible, contextual research assessment (Tier 3).

Step 1: Deposition and Identifying Research Contributions (Tier 0 → Tier 1)

A researcher, working on a project funded by a national grant, uploads their latest dataset and a related preprint to an OA repository. As they submit the files, the system automatically assigns a PID , ensuring the research output remains permanently citable and discoverable. To accurately associate the contribution with its creator, the repository links the submission to the researcher's ORCID iD, verifying authorship and helping disambiguate their identity from others with similar names. This process ensures that every research contribution is clearly identified and traceable.

Since the project is backed by external funding, the researcher includes the Grant ID, allowing for clear attribution of the funding source, including disclaimers or acknowledgement that the funder indicates. The affiliated institution is recorded using a Research Organization Registry (ROR) ID, ensuring proper institutional credit. If the researcher has previously shared preliminary versions of this work—such as a preprint before peer-review or a dataset update—these versions are interconnected, giving a complete view of the research lifecycle.

This structured metadata ensures that research contributions are well-documented and persistently identifiable, laying the groundwork for transparent and RRA.

Step 2: Aggregation, Enrichment, and Disambiguation (Tier 2)

Once deposited, research outputs do not remain confined to a single repository. Metadata aggregators play a crucial role in collecting, linking, and enriching research records, ensuring they become part of the broader global knowledge ecosystem.

At this stage, the aggregator connects research outputs across repositories—not only linking different versions of publications but also associating related datasets, software, and supplementary material stored in different platforms. This process ensures that research contributions are seen as a complete body of work rather than isolated pieces. This step turns raw data into a unified, enhanced information resource.

Since repositories and research management systems often vary in levels of interoperability, metadata aggregators step in to disambiguate and reconcile records. For example, a researcher's contribution might appear under slightly different name variations or institutional affiliations in different systems. Using PIDs (e.g., ORCID, ROR, Grant IDs, DOIs) and machine learning techniques, the aggregator harmonizes these discrepancies, ensuring accurate attribution and relationships between entities.

Beyond just linking outputs, the aggregator **enriches metadata** by applying **different classification systems**, such as:

- **Research Domains and Fields** (e.g., OECD classifications, national taxonomies);
- **Sustainable Development Goals (SDGs)** to assess societal relevance;
- **Funding Programmes and Policy Priorities**, ensuring alignment with strategic objectives.

Additionally, citations and usage data (such as downloads, views, and alternative engagement metrics) are linked from multiple sources where possible. By integrating diverse signals of media/public attention and societal/academic impact, the aggregator provides a fuller picture of research influence, beyond sheer citation counts.

Where discipline-specific metadata extraction is possible, text-mining and natural language processing techniques analyze the publication content to infer links to other related research outcomes. This enables the automatic identification of connections between publications, datasets, patents, and policy documents—further embedding research into the global knowledge graph.

In short, this step transforms raw metadata records into enriched, structured, and interconnected, actionable knowledge, ensuring that research is discoverable, contextualized, and prepared for advanced analytics in the next assessment phase.

Step 3: Research Assessment, Benchmarking, and External Linkages (Tier 3)

With a well-structured and enriched metadata record, research assessment tools step in to analyze the broader impact of the contribution. Advanced analytics process citation data, usage metrics (such as views and downloads), and collaboration patterns. The system compares the work's citation and engagement levels against similar research in the same

scientific domain, either within a specific geographical region or at an international level. By benchmarking research against disciplinary and regional trends, institutions and funders can contextualize impact, rather than relying on raw citation counts. This analysis turns data into clear, actionable insights for evaluation.

In addition to academic citations, **usage data** shows how often a dataset is accessed, software is reused, or outputs are viewed, highlighting attention from both academic and non-academic audiences. These metrics provide a more complete picture of how research contributes to knowledge, innovation, and public discourse.

The analysis also explores connections beyond academia. Outputs may be linked to **patent databases**, showing commercial relevance, or to policy documents and standards, reflecting societal and regulatory uptake. These connections help assess real-world influence and broader impact.

To support a more **inclusive and qualitative evaluation**, Tier 3 services also enable narrative-style researcher profiles and CVs. These tools allow individuals to describe contributions, such as such as mentoring, open peer review, data curation, public engagement, and interdisciplinary work, that are often overlooked by traditional indicators,. Integrating these narrative elements, with structured metadata and assessment indicators, narrative CVs promote a richer, fairer view of a researcher's contributions, aligning with RRA principles.

Drive Change: Evolve and Invest in Open Infrastructure

Driving meaningful change in research assessment requires more than replacing proprietary tools. It involves strengthening a globally connected ecosystem of OIs that supports transparent, inclusive, and context-sensitive evaluation practices. This ecosystem should capture the full range of research contributions, from datasets and software to societal impact narratives, while ensuring interoperability, openness, and long-term sustainability.

RPOs and RFOs are key enablers of this transition. Their role must extend beyond managing internal systems and instead align with the broader OI landscape. To move forward, they should:

Reassess Their Position in the OI Ecosystem

Institutions and funders should evaluate their current infrastructures (repositories, CRIS systems, funding databases, monitoring tools) in terms of how they connect with and contribute to the global research environment. The goal is not only local efficiency but systemic interoperability.

Invest in Foundational and Strategic Layers

Support must be directed toward key infrastructure components across all tiers of the system.

- At Tier 0, this includes sustaining PID providers and actively contributing to the development of metadata standards that capture the evolving nature of research, such as software, training materials, and protocols.
- At Tier 1, institutions and funders should invest in making repository and publishing services fully interoperable, ensuring that they are embedded in the broader OI ecosystem and connected with global aggregators and identifier systems.
- At Tier 2, organizations should improve metadata quality and ensure that structured, reusable, and standardized data is consistently contributed to aggregators and scholarly indexes to strengthen integration and discoverability.
- At Tier 3, investment should focus on both RRA tools and the emerging infrastructure needed to support narrative-based researcher profiles. This includes developing indicators and services that reflect diverse contributions, facilitate qualitative evaluation, and support new models of researcher assessment aligned with fair and context-aware practices.

Support with Resources and Expertise

Open does not mean free. Financial support is essential, but equally important is the contribution of domain expertise and policy alignment. Institutions and funders should participate in the governance, design, and maintenance of infrastructures to ensure they remain relevant, resilient, and inclusive.

Adopt a Mindset Beyond the Local

Strategic alignment with global OIs is key. RPOs and RFOs must shift from siloed investments to coordinated actions that bridge domains, disciplines, and regions. This means embedding OIs into institutional policies, supporting shared standards, and enabling cross-border collaboration.

5.1 RPO Action Plan: Leading the Change

To make RRA a reality, RPOs must take the lead in transforming their systems, policies, and investments. This means embracing OIs not as optional upgrades but as essential enablers of fair, transparent, and future-ready evaluation practices. The steps below outline where to act now.

- **Align Institutional Systems with Global Open Infrastructures** – Ensure repositories, CRIS systems, and research information management platforms are fully integrated into the broader scholarly communication ecosystem by linking to global aggregators and implementing PIDs and open metadata standards. Register and connect all research contributions, including not only publications, datasets, software, and training materials but also information on courses taught, leadership roles, mentoring, and public engagement, often held within internal institutional systems. These data are essential for comprehensive and fair assessment. Leverage API connectivity to support seamless data exchange across systems, enabling real-time updates, interoperability, and the dismantling of silos that limit visibility. Conduct periodic audits to evaluate integration performance and identify gaps that hinder discoverability and reuse.
- **Invest in Metadata Quality and Interoperability** – Improve metadata curation, institutional naming conventions, and compliance with open standards, ensuring research outputs are accurately recorded, discoverable, and reusable. Adopt frameworks like the Scientific Knowledge Graphs – Interoperability Framework (SKG-IF), which facilitates a unified metadata model that enhances the interoperability and integration of research information across diverse platforms.
- **Invest in the deposition of diverse contributions** – Invest in and develop novel, robust mechanisms and platforms supporting the deposition and long-term preservation of evidence about a broad range of contributions beyond primary research products, such as teaching, training, public engagement, and organisation and coordination efforts. This step is necessary to enable OI to tap into such machine-actionable knowledge and enable its processing, exchange and composition into digital CVs and portfolios.
- **Support Open Research Indicators and Assessment Tools** – Move beyond citation-based metrics by adopting assessment frameworks that recognize diverse contributions (e.g., datasets, software, Open Science practices) and contextualized indicators that reflect institutional, national, and global impact.

- **Extend Open Infrastructures to Support Narrative CVs** – Treat narrative CVs as a natural extension of OIs by building technical and policy capacity to represent diverse contributions in structured, machine-readable ways. Invest in platforms and workflows that allow researchers to assemble portfolios drawing on data from repositories, CRIS systems, training records, and engagement activities. This ensures that narrative CVs are not standalone documents but integrated outputs of the OI ecosystem, aligned with RRA and CoARA principles.
- **Embed Open Infrastructure Adoption in Institutional Policies** – Ensure that hiring, tenure, and funding policies explicitly support the use of OIs and RRA. This includes recognizing research contributions beyond publications and requiring transparent, open indicators for evaluation.
- **Build Capacity for Open Infrastructure Adoption** – Develop training programmes for research administrators, technical staff, and researchers to ensure effective adoption and governance of OIs. Training should cover metadata management, PID implementation, responsible research indicators, and Open Science compliance. Institutions should also provide guidance for researchers on narrative CVs and alternative assessment frameworks.
- **Ensure Financial and Technical Sustainability** – Secure long-term investment in institutional and national OIs, ensuring their sustainability, scalability, and resilience. This includes actively supporting OI aggregators to guarantee continued access to high-quality, openly available research data.

RFO Action Plan: Funding the Future

RFOs shape the research assessment landscape through funding strategies and monitoring frameworks. By aligning funding policies with Open Science principles, they can foster transparency, accountability, and long-term impact. To ensure OIs effectively support RRA, RFOs should:

- **Ensure Funding Information is Open and Interoperable** – Implement PIDs for grants and funding data (e.g., Grant DOIs, ORCID, ROR) to enable accurate tracking of funded projects and their outputs. Standardize metadata formats to facilitate transparent reporting and integration across research infrastructures.
- **Integrate Funding Data into the Broader Scholarly Ecosystem** – Ensure that funding databases, monitoring platforms, and evaluation systems are fully interoperable with OIs. This requires not only adopting open metadata standards and data-sharing frameworks, but also providing well-documented, openly accessible APIs to enable seamless and reliable data exchange. Such integration connects funding allocation with research outputs and impact metrics, ensuring traceability, transparency, and usability across platforms.
- **Apply Research Indicators Responsibly** – Move beyond citation-based metrics by incorporating alternative indicators that reflect Open Science practices, societal

impact, and research integrity. Support qualitative and contextualized evaluation models that emphasize open collaboration, knowledge sharing, and real-world contributions.

- **Recognize Diverse Research Contributions** – Encourage the use of narrative CVs and qualitative assessment models in funding evaluations to ensure that diverse research outputs (e.g., datasets, software, policy contributions, Open Science practices) are properly valued.
- **Embed Open Infrastructure Adoption into Funding Policies** – Mandate that funded institutions and researchers deposit research outputs in Open Access repositories, assign PIDs, and adhere to open metadata standards. Ensure that funding requirements align with Open Science principles to enhance research visibility and accessibility.
- **Build Capacity for Open Infrastructure Adoption** – Provide training for research officers, policymakers, and grantees on how to engage with OIs, use PIDs, and apply RRA principles in funding applications and reporting.
- **Support Local Infrastructure Development -** RFOs should offer targeted small grant calls to support the setup of local research information infrastructures (Tier 2). These grants should encourage the use of open-source software for building local OIs, while acknowledging that even open-source solutions incur significant costs (e.g., hardware, customization, staffing, training, and policy development). It is also essential for RFOs to allocate funds for the ongoing maintenance and operational expenses of these infrastructures. This targeted support is critical for small institutions in less developed countries and ensures that local infrastructures capture a comprehensive snapshot of an institution's activities, including those outputs not present on global aggregated platforms.
- **Support the Sustainability of Open Infrastructure Aggregators** – Invest in the long-term development, maintenance, and governance of OIs, including metadata providers, open scholarly indexes, and open assessment tools, ensuring their stability as critical components of the research ecosystem.

Full-Stack Investment: Building a Sustainable, Interconnected Responsible Research Assessment Ecosystem

Despite growing awareness of the need for change, many institutions still invest in fragmented ways across the research assessment ecosystem. Too often, these investments focus on visible, local services in Tier 1, such as repositories or institutional dashboards—while neglecting foundational elements like persistent identifiers (Tier 0), metadata enrichment services (Tier 2), and the long-term sustainability of assessment tools (Tier 3). This piecemeal approach weakens the ecosystem's ability to function as a connected whole.

As Skinner (2024)[1] notes, the idea that "there isn't enough money" masks the real issue: the absence of coordinated, strategic investment. Relying solely on funding the "pretty" parts is like paying for an ornate roof while letting the foundation crumble. A **full-stack approach** is essential to ensure interoperability and sustainability.

RPOs and RFOs should look beyond their local infrastructures and invest in the global layers that make their systems interoperable. This means contributing not only financially but also through technical alignment and active engagement across the full stack. This includes:

- **Strengthening Tier 0** by supporting PID providers and standard-setting bodies that underpin scholarly interoperability;
- **Investing in Tier 2** services that enrich, harmonize, and connect data, enabling research contributions to be part of a global knowledge graph;
- **Supporting open, transparent Tier 3 services**, including global metadata aggregators, that provide contextualized insights and host emerging tools such as narrative CVs, rather than relying on proprietary assessment platforms that perpetuate opaque and inequitable evaluation models.
- **Ensuring Tier 1 systems are not isolated but fully interoperable** with other layers through well-documented, open APIs and shared metadata models.

This is not just about money. It is about shaping the direction of OIs through participation, requirement setting, and shared responsibility.

Sustainable Investment Mechanisms

To build a truly responsible, resilient, and globally connected research assessment ecosystem, OIs must be funded as **core public knowledge assets**, **not as short-lived**

[1] Skinner, 2024. "The Emperor's New Clothes: Common Myths Hindering Open Infrastructure." Invest in Open. Accessed April 7, 2025. https://investinopen.org/blog/the-emperors-new-clothes-common-myths-hindering-open-infrastructure/

project outputs. Project-based funding may spark innovation, but it cannot sustain the critical services that underpin interoperability, transparency, and trust across the full stack, in an operational capacity.

To be effective, investment in OIs must be coordinated across all tiers and shared across actors. No single institution, funder, or country can sustain the system alone. A globally connected, interoperable ecosystem requires joint responsibility and co-financing, underpinned by predictable, equitable, and long-term funding models. These must go beyond short-term project grants and align with actual infrastructure use, strategic priorities, and the collective benefits derived.

Examples of emerging and necessary funding mechanisms include:

- **Distributed Cost-Sharing Agreements -** Institutions and funders co-finance shared services (e.g. PID providers, aggregators) based on proportional use or negotiated agreements.
- **Tiered Membership Models -** Scalable contributions adapted to institutional size or capacity, ensuring inclusion while supporting sustainability.
- **Pooled Sovereign Investment -** Countries co-invest in international infrastructures through coordinated initiatives or supranational programs (e.g. EU-wide instruments, SCOSS, IOI).[2]
- **Multi-Year Infrastructure Funds -** Long-term financial instruments that go beyond grant cycles to cover development, operations, governance, and upgrades.
- **Service-Level Investment Frameworks -** Stakeholders co-design and co-fund services, especially at Tier 3, ensuring tools like narrative CVs and open indicators reflect real-world assessment needs.

These mechanisms must be expanded and institutionalized. Without them, OIs will remain dependent on fragile, piecemeal support. Sustainable funding is the only path toward a future-ready, fair, and open research assessment system.

[2] SCOSS. "How It Works: Current Funding Calls." Accessed April 7, 2025. https://scoss.org/how-it-works/current-funding-calls/#:~:text=Image%20%20113Maria%20Gould.; Invest in Open. Accessed April 7, 2025. https://investinopen.org/.

Conclusion and Next Steps

This document offers an initial blueprint for a conceptual architecture that organizes OIs into a coherent, tiered model to support RRA. It lays the foundation for aligning institutional and national investments with a global, interoperable, fair and equitable assessment ecosystem.

Yet this is only a starting point for a transformative shift. Advancing this vision requires focused action on several fronts:

- **Estimate the true cost of OIs**, including the development, operation, and long-term maintenance of services across all tiers.
- **Assess the investment needed for interoperability**, from standardizing metadata to enabling system integration through open APIs.
- **Identify the financial and operational needs for upskilling**, ensuring institutions and funders can adopt and govern OIs effectively.
- **Explore sustainable funding models**, including cost-sharing mechanisms, revenue strategies, and long-term investment planning.
- **Conduct coordinated studies and consultations**, to build evidence, refine priorities, and design scalable, realistic solutions.
- **Develop models for global co-investment**, ensuring that countries, funders, and institutions share responsibility for sustaining core infrastructures.

Moving beyond project-based thinking is essential. OIs require stable, long-term support, guided by shared governance and strategic coordination. Ensuring their sustainability at scale is not just a technical challenge but a collective responsibility, one that must be embedded in policy, funding, and institutional practice.

This framework is a first step. The work ahead lies in translating it into action.

ANNEX

Policy Brief

Transitioning from Closed Proprietary Systems to Open Infrastructures for Responsible Research Assessment

For Research-Performing & Research-Funding Organizations

Executive Summary

Traditional, closed research assessment systems rely on narrow citation metrics and opaque data flows that fail to capture the full spectrum of scholarly contributions. Transitioning to open infrastructures (OIs) fit for Responsible Research Assessment (RRA) offers a transparent, interoperable, and comprehensive practice that recognizes all outputs—from publications and datasets to software and public engagement.

***Call to Action**:* Decision makers in research-performing organizations (RPOs) and research funding organisations (RFOs) should modernize policies, invest in technology and training, and actively join existing OI communities to drive the transition from closed systems to open, integrated systems. With rapid technological advances and evolving funding priorities, a timely shift is essential.

What's at Stake?

Research assessment is the foundation of funding decisions, career advancement, and strategic planning. Relying on closed, proprietary systems that focus narrowly on citation metrics leaves critical research contributions, like datasets, software, training and community engagement, undervalued. The stakes are high:

- **Innovation and Research Quality:**
  Closed systems stifle innovation by overlooking non-traditional research outputs, diminishing overall scholarly excellence.
- **Transparency and Accountability:**
  Opaque evaluation practices obscure methodologies and hinder data verification, reducing trust in research outcomes.
- **Global Competitiveness and Equity:**
  Data silos in proprietary systems impede international collaboration and equitable access, perpetuating global disparities in research evaluation and funding.
- **Long-Term Institutional Viability:**
  In the digital age, institutions that fail to transition risk decreased funding, reduced collaboration, and diminished influence in shaping future research practices.

Research Overview

The Four-Tier Open Infrastructure Conceptual Architecture

The proposed Conceptual Architecture for Responsible Research Assessment is built on a **four-tier model** that modernizes evaluation systems by breaking down data silos and fostering interconnected workflows:

1. **Tier 0 – Foundation: Building the Backbone**

- **Function:** Every research output gets a unique "name tag" (using identifiers like DOI, ORCID, or ROR) along with standardized metadata.
- **Significance:** This creates a universal ID system that ensures every piece of research is reliably recognized and traceable across all platforms.

2. **Tier 1 – Publishing Venues: Sharing and Archiving**

- **Function:** With their unique ID cards from Tier 0, research outputs are deposited into open-access repositories and journals—much like placing books in a public library.
- **Significance:** This guarantees that research is widely accessible and permanently stored, enabling anyone to find and use these outputs.

3. **Tier 2 – Metadata Aggregation: Connecting the Dots**

- **Function:** This tier collects and organizes all the "name-tagged" research from various sources into one unified system, similar to merging different libraries into a global catalog.
- **Significance:** It bridges data silos and enriches the research information, providing additional context that helps in understanding the complete research story.

4. **Tier 3 – Assessment Support: Turning Data into Insights**

- **Function:** Advanced tools analyze the rich, interconnected data from Tier 2. This stage goes beyond counting citations—it provides deep insights into research impact, including societal influence and interdisciplinary contributions.
- **Significance:** It transforms raw data into meaningful evaluations, enabling a nuanced and comprehensive understanding of research performance.

How They Work Together:

Each tier builds on the previous one—starting with unique IDs (Tier 0), ensuring research is available (Tier 1), linking and enriching data (Tier 2), and finally analyzing impact (Tier 3). The innovation lies in standardizing data, breaking down silos, and using smart analytics to offer a complete, transparent picture of research performance.

Discussion/Analysis

Challenges with Closed Systems:

Proprietary systems operate in isolation, leading to fragmented data and evaluations that overlook key research contributions. Their narrow focus on citation metrics limits a full understanding of a researcher's work, hindering both innovation and accountability.

Advantages of Open Infrastructures:

- **Integrated Data Flow:** Standardized metadata and persistent identifiers facilitate seamless, real-time data exchange between local systems and global networks.
- **Comprehensive Recognition:** Every research output is documented and interlinked, ensuring a complete picture of the research lifecycle.
- **Nuanced Impact Evaluation:** Advanced analytics support a shift from raw citation counts to multidimensional indicators that capture societal and interdisciplinary contributions.
- **Policy Transformation:** Transitioning to open infrastructures requires updating internal policies, investing in training, and committing to long-term support. Decision makers can join established open infrastructure communities to share resources and expertise, enhancing institutional competitiveness and promoting global equity.

Recommendations for Research-Performing Organizations

1. Integrate Your Core Systems with Global Open Infrastructures

- **Connect Your Platforms:** Link your repositories, CRIS systems, and research management tools with global databases using API connectivity for seamless data exchange.
- **Use Unique IDs:** Require that every research output gets a unique identifier (like a DOI, ORCID, or ROR) along with standardized metadata—this unique "ID card" makes it easy to track and link all research contributions.
- **Monitor Integration:** Regularly audit your systems to check how well they work together and identify any gaps.
- **Join Open Infrastructure Communities:** Engage with established networks and consortia to share tools, protocols, and best practices.

2. Improve Metadata Quality and Data Sharing

- **Adopt Common Standards:** Use widely accepted frameworks, such as the Scientific Knowledge Graphs – Interoperability Framework (SKG-IF), to ensure all metadata is consistent across systems.
- **Train Your Staff:** Offer regular training sessions on best practices for managing metadata and using open data standards.

- **Upgrade Your Tools:** Invest in software that automates metadata enrichment and ensures smooth data exchange between your systems and global networks.

3. Broaden the Range of Research Outputs You Collect

- **Expand Your Platforms:** Connect with open systems that support various research contributions—such as publications, datasets, software, training activities, and records of public engagement.
- **Build Digital Portfolios:** Enable researchers to create narrative CVs that compile all their contributions into one easily accessible profile.
- **Link Related Outputs:** Use unique identifiers to connect different parts of a project, ensuring a complete and traceable research record.

4. Adopt Open Research Indicators

- **Use a Variety of Metrics:** Move beyond just counting citations. Connect with open systems that Include indicators that show how research is used, its societal impact, and how it supports collaboration across fields.
- **Update Evaluation Policies:** Revise the criteria for tenure, promotion, and funding to include these broader measures.
- **Collaborate on Standardization:** Join national and international efforts to refine and standardize these new research indicators.

5. Embed Open Infrastructure Practices in Your Policies

- **Revise Your Policies:** Update hiring, tenure, and promotion guidelines to require the use of open infrastructures and transparent research metrics.
- **Mandate Open Deposits:** Ensure that all research outputs are stored in approved, open-access repositories with proper unique identifiers.
- **Set Clear Guidelines:** Develop straightforward rules for using open and verifiable research indicators in decision-making.

6. Build Capacity and Ensure Long-Term Support

- **Continuous Training:** Establish ongoing training programs for administrators, IT staff, and researchers on how to use and manage open infrastructure tools.
- **Develop Best Practice Guides:** Create easy-to-follow guides and toolkits that document successful processes and case studies of open infrastructure adoption.
- **Secure Funding:** Allocate dedicated budgets for system maintenance, technological upgrades, and training. Partner with national agencies and international groups to share costs and expertise.

Recommendations for Research-Funding Organisations (RFOs)

1. **Promote Open Funding Data**

- **Assign IDs:** Require unique identifiers for every grant and standardize metadata in funding applications and reports.
- **Standardize Internal Data:** Ensure all grant data meets global protocols for consistency and accuracy. Adopt standard data protocols within your internal systems to ensure consistency, accuracy, and verifiability of grant records. This step focuses solely on the quality and uniformity of your internal data management.

2. **Integrate and Monitor Funding Outcomes**
   - **Link Systems:** Connect funding databases with OIs for real-time tracking of research outputs. using robust APIs and standard protocols. Facilitate automated, real-time exchange with international research repositories by establishing clear technical connections.
   - **Monitor Impact:** Develop transparent monitoring systems that leverage open data to assess research outcomes.
3. **Adopt Responsible Research Indicators**
   - **Diversify Metrics:** Incorporate alternative metrics that capture Open Science practices, societal impact, and interdisciplinary contributions.
   - **Revise Criteria:** Update funding evaluation frameworks to reward a broader range of research outputs and impacts.
4. **Embed OI Requirements in Funding Policies**
   - **Mandate Deposits:** Require that all outputs from funded projects are deposited in approved open-access repositories with proper identifiers.
   - **Align Policies:** Ensure funding calls and evaluation guidelines adhere to Open Science principles.
5. **Support Local Infrastructure Development**
   - **Target Grants:** Provide dedicated grants for developing and maintaining local OIs, particularly for metadata aggregation.
   - **Sustain Systems:** Invest in long-term maintenance and robust governance for OI aggregators.
6. **Foster Capacity Building and Collaboration**
   - **Offer Training:** Deliver ongoing training programs for funding officers, grantees, and policymakers on effective use of OIs.
   - **Engage Collaboratively:** Engage with national/international advisory boards, implement incentive structures, and set up feedback mechanisms to drive continuous improvement.

Organisations affiliated to this WG

- OpenAIRE AMKE
- Leiden University (CWTS)
- Consiglio Nazionale delle Ricerche (CNR)
- Federation of Finnish Learned Societies (TSV)
- Ss Cyril and Methodius University in Skopje
- University of Minho
- Masaryk University
- OpenCitations
- University of Debrecen
- Trinity College Dublin
- University of Bologna
- Universities Norway
- NIFU (Nordic institute for studies of innovation, research and education)
- EIFL
- Netherlands Research Council (NWO)
- COKI (Australia) *
- National Institute of Informatics (NII, Japan) *
- Michael J. Fox Foundation (United States) *
- Technische Universiteit Delft
- West and Central African Research and Education Network (WACREN, Ghana) *
- Vrije Universiteit Amsterdam (Netherlands)
- UEFISCDI (Romania)
- University of Ljubljana (Slovenia)
- Netherlands eScience Center (RSD)
- UKRN
- NASA TOPS*
- University of South-Eastern Norway
- University of Hamburg
- INRIA
- Athena Research Center
- LMU Munich
- Université Côte d'Azur
- University of Novi Sad
- University of Padua
- Lusófona University
- Petre Shotadze Tbilisi Medical Academy
- CSC – IT Center for Science
- Netherlands eScience Center (RSD)
- Library and Information Centre of the Hungarian Academy of Sciences

- Training Centre in Communication (TCC Africa)
- University of Groningen
- SPARC EUROPE
- JISC

CoARA

The Coalition for Advancing Research Assessment (CoARA) is a collective of organisations committed to reforming the methods and processes by which research, researchers, and research organisations are evaluated. Current research assessment methods rely heavily on publication-based metrics such as citation counts and often fail to recognise the wide array of contributions made by researchers.

Over 700 research organisations, funders, assessment authorities, professional societies, and their associations have agreed on a common direction and guiding principles to implement reform in the assessment of research, researchers, and research organisations, outlined in the Agreement on Reforming Research Assessment published in July 2022 which provides an outline for reform and implementation.

Find out more about CoARA at www.coara.eu.

Working Group Overview

Working Groups are key communities of practice that work to implement research assessment reform in specific thematic areas. Participating members exchange knowledge, learn from each other's experience, discuss and develop outputs to advance research assessment and support the implementation of members' commitments.

The Working Group "Towards Open Infrastructures for Responsible Research Assessment" is committed to advancing the transition from closed, proprietary research infrastructures toward open, community-governed, and interoperable systems. This shift is essential for enabling ethical, transparent, and RRA practices. The group emphasizes the importance of making research information universally accessible, transparent, and inclusive of a wide diversity of disciplines, geographic contexts, languages, and research output types. It prioritizes the development of open infrastructures that are sustainable, interoperable, community-driven, and aligned with the principles of Open Science. Central to this work is the aim to support infrastructures that foster trustworthiness, equity, and inclusivity in research assessment processes, ensuring that the infrastructures themselves are fit for responsible research evaluation across varied global contexts.