**Enhancing Trust, Integrity, and Efficiency in Research through Next-Level Reproducibility Impact Pathways**

# Deliverable 2.6 – Second TIER2 policy brief: Recommendations for Reproducible Research from TIER2

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POLICY BRIEF

# Recommendations for Reproducible Research from TIER2


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# 1. INTRODUCTION

From 2023 to 2025, the EC-funded Horizon Europe project TIER2 [1] has aimed to address growing concerns about reproducibility in scholarly research by systematically investigating reproducibility in context. These contexts included three broad research areas (social, life and computer sciences) as well as two cross-disciplinary stakeholder groups (research publishers and funders). Our overall aims were to (1) strengthen the evidence base and conceptual understanding, (2) build capacity through awareness raising, targeted investment, training and networking, (3) pilot and systematically evaluate innovative reproducibility tools and practices, and (4) provide policy advice for key stakeholders.

This policy brief fulfils the last of these objectives, presenting final recommendations co-created with stakeholders through a range of engagement methods during 2025. Our recommendations primarily address researchers and research communities, governments, funders, publishers, and institutions. We emphasise that our recommendations are aimed at all types of funders – including public, governmental, not-for profit, philanthropic and commercial. Likewise, there is substantial diversity in publishers (from large commercial to small community-owned publishers), and our recommendations aim to be applicable to all.

Two conceptual approaches to understanding reproducibility were central to TIER2 and directly informed the creation of the recommendations: the importance of epistemic diversity, and the distinction between *redoing* and *enabling redoing*:

- Respecting epistemic diversity is crucial, because relevance and feasibility of reproducibility differ substantially between different modes of producing knowledge. We therefore strove to develop recommendations that respect different ways of generating knowledge and leave room for implementing the recommendations in ways appropriate to diverse communities.
- The distinction between redoing research and enabling others to redo it (Ulpts & Schneider 2025a) clarifies what reproducibility practices are trying to achieve. Being mindful of this distinction enables us to be more alert to when and how individual reproducibility practices are relevant and/or feasible. Practices that enable redoing – such as transparent workflows and FAIR outputs – also create conditions for scrutiny and reuse, whether or not reproduction is actually undertaken. Our recommendations therefore address both redoing and enabling redoing of research.

In what follows, we present recommendations, alongside explanations and concrete advice for implementation, in four categories: Infrastructure, standards and community (Section 2); Incentives and policy (Section 3); Training and skills (Section 4); and Strengthening the evidence-base (Section 5). An overview of the recommendations is presented below in Table 1. In addition, we finally include (as Appendix A) a summary overview of the evidence and lessons learned within TIER2 that inform these recommendations, as well as a summary of our methods in co-creating the recommendations.

[1] https://tier2-project.eu

## TABLE 1. OVERVIEW OF TIER2 RECOMMENDATIONS

| Theme | No. | Recommendation |
|---|---|---|
| **Infrastructure, standards and community** | R1.1 | Governments, institutions, and all types of funders should provide sustainable support for open infrastructures |
| | R1.2 | Research communities should improve and expand standards and guidelines for data re-use |
| | R1.3 | Funders, publishers and institutions should require Globally Unique, Persistent and Resolvable Identifiers (GUPRIs) and open metadata for research objects and entities |
| **Incentives and policy** | R2.1 | Funders, publishers and meta-researchers should develop and implement responsible metrics to enable monitoring of reproducibility practices |
| | R2.2 | Funders should actively support and incentivise replication studies across all funding streams |
| **Training and skills** | R3.1 | Institutions, funders, and publishers should build sustainable support networks and training ecosystems for reproducibility |
| | R3.2 | Institutions should strengthen leadership engagement and provide training to research leaders to foster reproducibility practices |
| | R3.3 | Publishers should enhance journal capacity and infrastructure for checking and managing digital research objects |
| **Strengthening the evidence-base** | R4.1 | Meta-researchers, supported by funders, publishers and institutions, should investigate the efficacy of reproducibility interventions |
| | R4.2 | Meta-researchers, supported by funders and publishers, should investigate the costs and benefits of reproducibility interventions |
| | R4.3 | Funders and publishers should enable meta-research regarding funding and publishing workflows through streamlined processes for collaboration and data-access |

# 2. INFRASTRUCTURE, STANDARDS AND COMMUNITY

Robust, sustainable infrastructure and well-aligned community practices are essential foundations for reproducible research. Standards for identifying, describing, interlink and sharing digital objects are essential, but are almost 2,000 in number and often domain specific. [2] Achieving reproducibility at scale requires more than individual effort. It depends on shared standards, interoperable systems, and strong coordination across the research ecosystem. By investing in open, trustworthy infrastructures and fostering an active community committed to transparency and collaboration, stakeholders can create an environment in which research outputs are consistently findable, accessible, reusable, interoperable, and verifiable. TIER2 hence recommends that:

### R1.1. GOVERNMENTS, INSTITUTIONS, AND ALL TYPES OF FUNDERS SHOULD PROVIDE SUSTAINABLE SUPPORT FOR OPEN INFRASTRUCTURES

Per the UNESCO Recommendation on Open Science (UNESCO, 2021), open infrastructures are an essential pillar of Open Science, and all stakeholders – including governments, funders and institutions – should ensure sustainable long-term support for the repositories, tools, standards, and identifier services that underpin reproducibility. Many critical components of the research ecosystem operate on fragile or short-term funding models, creating systemic risks for the preservation, accessibility, and interoperability of research outputs. As highlighted by the OECD Global Science Forum (OECD, 2025) and the Global Sustainability Coalition for Open Science Services (SCOSS [3]), if open infrastructures are to function as public goods, they require coordinated, reliable investment to remain trustworthy and community governed. Sustainable funding mechanisms and transparent governance structures are therefore crucial to guarantee continuity of services, enable community participation, and ensure that these infrastructures can evolve alongside research needs, ultimately strengthening the global capacity to verify, reproduce, and re-use scientific work.

### R1.2. RESEARCH COMMUNITIES SHOULD IMPROVE AND EXPAND STANDARDS AND GUIDELINES FOR DATA RE-USE

While many existing frameworks focus on how researchers should produce reusable data, comparable guidance for those who re-use data remains less developed and is often fragmented across disciplines. Research communities, such as Academies, Councils, Associations and Societies, alongside communities focused around disciplinary infrastructures such as data and software repositories, should collaborate to develop and strengthen principles, standards and guidelines that support the responsible and effective re-use of data, with an emphasis on helping secondary users understand how to assess data quality, fitness-for-purpose, provenance, consent conditions, and methodological limitations. Although detailed standards should be domain specific, some overarching principles (e.g. ethical use, attribution, careful assessment of uncertainty, and concerns around data security and governance) may apply more broadly.

[2] Source: FAIRsharing https://fairsharing.org/search?fairsharingRegistry=Standard
[3] https://scoss.org

### R1.3. FUNDERS, PUBLISHERS AND INSTITUTIONS SHOULD REQUIRE GLOBALLY UNIQUE, PERSISTENT AND RESOLVABLE IDENTIFIERS (GUPRIS) AND OPEN METADATA FOR RESEARCH OBJECTS AND ENTITIES.

Global and openly resolvable persistent identifiers, alongside high quality and open metadata, are essential for reliably tracking research outputs – such as publications (including preprints), datasets, software, samples, pre-registrations, protocols and patents – and for connecting them to the people, organisations, projects, grants and other activities that produced them. Such connections form the backbone of a transparent, discoverable and interoperable research ecosystem, enabling others to find, retrieve, verify, re-use, and reproduce research results. To achieve this, funders and publishers of all types, as well as research institutions, should require, and implement where relevant, the use of Globally Unique, Persistent and Resolvable Identifiers (GUPRIs) [4] across the research lifecycle, including (but not limited to) ORCID [5] for researchers, DOIs for datasets, publications and software, ROR IDs [6] for institutions, RAiD [7] for projects, and other community-endorsed identifiers. These identifiers must be accompanied by, and resolvable to, open, high-quality metadata that supports machine-readability, provenance tracking, and automated linking across systems. Mandating GUPRIs and open metadata strengthens research integrity, reduces ambiguity, supports FAIR data principles (Wilkinson et al., 2016), and enables consistent attribution and accountability across diverse research domains.

## 3. INCENTIVES AND POLICY

While many researchers recognise the value of transparent and rigorous practices, systemic pressures including publication expectations, career advancement criteria, and limited support and recognition for replication often act as disincentives. Effective policy must therefore align incentives with reproducible and trustworthy research, encourage communities to lead the development of appropriate norms, and ensure that assessment and monitoring systems reflect the diversity of research approaches across disciplines. Hence, to foster a culture in which practices that enable and deliver research reproducibility is not an additional burden but an integral and rewarded part of the research process, TIER2 recommends that:

### R2.1. FUNDERS, PUBLISHERS AND META-RESEARCHERS SHOULD DEVELOP AND IMPLEMENT RESPONSIBLE METRICS TO ENABLE MONITORING OF REPRODUCIBILITY PRACTICES IN WAYS WHICH ACCOUNT FOR THE DIVERSITY OF RESEARCH APPROACHES

Funders and other relevant stakeholders should strengthen monitoring of and communication about reproducibility to raise awareness among funded researchers, while recognising that any metrics used for this purpose must be carefully designed, responsibly implemented, and sensitive to the considerable epistemic diversity that exists across and within disciplines (Hicks et al., 2015).

[4] https://faircookbook.elixir-europe.org/content/recipes/infrastructure/gupri.html
[5] https://orcid.org
[6] https://ror.org
[7] https://www.raid.org

Reproducibility metrics can support automated oversight, for example by tracking availability of open outputs, but poorly designed indicators risk oversimplifying complex research practices, encouraging box ticking, disadvantaging fields with different norms, or becoming targets in their own right. Metrics might address both enabling (e.g. how transparent are research outputs) and actual redoing (e.g., the extent to which results from replication studies agree with initial findings). Metrics should complement, not replace, expert judgement; be transparent about their limitations; and be co-developed with and sensitive to the research communities they affect. By adopting reproducibility metrics that are field appropriate, proportionate, and used for learning rather than punitive evaluation, funders and other bodies can encourage continuous improvement in reproducibility practices without undermining the richness and diversity of research cultures.

### R2.2. FUNDERS SHOULD ACTIVELY SUPPORT AND INCENTIVISE REPLICATION STUDIES ACROSS ALL FUNDING STREAMS

Replication work remains undervalued in many fields, in part because standard grant mechanisms privilege novelty over verification. Yet replication is a core scientific activity that strengthens confidence in research findings and can guide improvements in methods, reporting, and research design across disciplines. To address this gap, funders should mainstream replication by embedding explicit support across their portfolios of funding instruments. One approach is to embed replication in larger grants: proposals could begin by replicating the key prior studies their work builds upon. This grounds innovative research in verified findings while providing a principled basis for deciding which studies, among the many that could be replicated, most warrant the investment. Given that replication studies are still systematically undervalued, funders could also consider dedicated funding streams or top-up funding for well-justified replication studies [8]. Such funding may stimulate early uptake, build community capacity, and signal the importance of verification as first-class research outputs. Over time, these efforts will support mainstreaming replication, so it becomes a routine and expected part of funded research.

## 4. TRAINING AND SKILLS

Improving reproducibility depends not only on strong policies and infrastructure but also on ensuring that researchers, supervisors, and editorial staff have the skills and support needed to implement good practices in their daily work. Building these capabilities requires coordinated investment in training, peer-support systems, and leadership development across the research ecosystem. By empowering individuals and communities, stakeholders can create a knowledgeable, confident workforce able to embed reproducibility as a routine and sustainable element of research practice. TIER2 hence recommends that:

[8] A leading example of such a funding scheme is that of the NWO Open Science NL Replication Studies Programme which will enter its third round in 2027. See: https://doi.org/10.5281/zenodo.17579089

### R3.1. INSTITUTIONS, FUNDERS, AND PUBLISHERS SHOULD BUILD SUSTAINABLE SUPPORT NETWORKS AND TRAINING ECOSYSTEMS FOR REPRODUCIBILITY

Sustainable support networks and training ecosystems for reproducibility should be embedded within existing research and education structures, such as PhD programmes, postdoctoral training, and institutional professional development. Integrating coaching, peer-support mechanisms, and train-the-trainer models equips researchers at all career stages with practical, context-specific guidance and helps normalise reproducible methods early in their careers. Stakeholders should also invest in, and provide sustainable career pathways for, specialist roles (e.g., data stewards, statisticians) that support research teams with specific competences. In the long term, coordinated training ecosystems strengthen both individual and collective competences, as well as institutional capacity, ensuring that reproducibility becomes a routine and sustainable part of research practice.

### R3.2. INSTITUTIONS SHOULD STRENGTHEN LEADERSHIP ENGAGEMENT AND PROVIDE TRAINING TO RESEARCH LEADERS TO FOSTER REPRODUCIBILITY PRACTICES

Strengthening reproducibility requires active engagement from research leaders, supervisors, and principal investigators, who shape local research culture and set expectations for rigour, transparency, and documentation. Developing targeted training and incentive structures for these leaders can enhance their awareness of reproducibility challenges, equip them with practical strategies for supporting good practice within their teams, and reinforce their accountability as role models for responsible research behaviour. Embedding such training within institutional frameworks – through leadership development programmes, supervisory training, promotion criteria, and departmental expectations – ensures that responsibility for reproducibility extends beyond early-career researchers and becomes a shared organisational priority. To avoid resistance from leadership, training programmes should be paired with awareness raising on why reproducibility practices matter when case training is obligatory, and with encouragement and incentives to take part, in particular when it is voluntary.

### R3.3. PUBLISHERS SHOULD ENHANCE JOURNAL CAPACITY AND INFRASTRUCTURE FOR CHECKING AND MANAGING DIGITAL RESEARCH OBJECTS

Publishers are facing growing challenges in ensuring research quality and provenance, including a documented surge in paper mill submissions (Richardson et al., 2025) and the widespread adoption of generative AI in scientific writing (Liang et al., 2024). To safeguard the integrity of published work, including its reproducibility, journals and publishers should strengthen their capacity to manage digital research objects by upskilling editorial and other relevant staff and dedicating resources to apply reproducibility and data-sharing checks consistently and effectively. These efforts must be supported by clear, regularly updated policies that reflect community standards and are openly registered in resources such as FAIRsharing [9]. As the volume and complexity of datasets, code, protocols, and other digital objects grows, editorial and other relevant teams (including research integrity, screening and some production teams) need budget, training, and technical support to assess compliance with data availability requirements, metadata standards, persistent identifier use, and repository best practices.

[9] https://fairsharing.org

To make these processes scalable and consistent, journals should collaborate with internal and external service providers to integrate automated and AI-enabled tools, such as automated data-availability checkers, code-execution verifiers, and metadata validators, directly into manuscript workflows. Given that the reliability of such tools is itself an active area of research, their viability should be regularly assessed. Where possible, cross-publisher collaboration on such services is to be encouraged. Ongoing initiatives, such as the STM Integrity Hub, [10] a shared, dynamic set of tools to screen manuscripts, as well as United2Act [11], a coalition of publishers to address the growing challenge of paper mills, offer very promising examples of such collaboration.

# 5. STRENGTHENING THE EVIDENCE-BASE

Effective policy for improving reproducibility must be grounded in robust empirical evidence. Yet despite growing recognition of reproducibility challenges, the evidence base for which interventions work, under what conditions, and with what trade-offs remains limited. A rapidly expanding meta-research community has begun to fill these gaps, but requires stronger support from funders, publishers, and institutions to generate actionable insights. TIER2 hence recommends that:

### R4.1. META-RESEARCHERS, SUPPORTED BY FUNDERS, PUBLISHERS AND INSTITUTIONS, SHOULD INVESTIGATE THE EFFICACY OF REPRODUCIBILITY INTERVENTIONS

There remains a substantial lack of evidence on the outcomes of reproducibility interventions and on how interventions intersect, interact, or amplify each other. Most existing studies rely on proxy indicators aimed at enabling redoing, such as data-sharing rates or adherence to reporting guidelines, which offer only partial insight, as they rarely assess the success of redoing as direct outcomes (Dudda et al., 2025). Evidence on the effectiveness of training programmes is particularly limited, especially regarding which formats benefit which audiences and how long such effects persist. In addition, reproducibility is shaped by contextual factors that remain understudied, including epistemic and disciplinary norms, study populations, methodological traditions, and research team composition. To inform effective, evidence-based policy, meta-research is urgently needed to evaluate interventions rigorously, clarify how reproducibility manifests across diverse research communities, and identify the conditions that enable interventions to succeed. Funders should therefore provide targeted, sustained support for this work, recognising it as essential for improving research quality. In addition, publishers and funders should publicly share results of their internal investigations of reproducibility interventions.

### R4.2. META-RESEARCHERS, SUPPORTED BY FUNDERS AND PUBLISHERS, SHOULD INVESTIGATE THE COSTS AND BENEFITS OF REPRODUCIBILITY INTERVENTIONS

Evidence on the actual costs and benefits of reproducibility interventions remains limited, making it difficult for policymakers to prioritise actions or allocate resources effectively. Future research should include systematic cost-benefit analyses that assess not only financial and time burdens for researchers, funders, and editorial/operational staff, but also impacts on research workflow, equity, and researcher wellbeing.

[10] https://stm-assoc.org/what-we-do/strategic-areas/research-integrity/integrity-hub
[11] https://stm-assoc.org/what-we-do/strategic-areas/research-integrity/united2act

It is equally important to examine the potential negative consequences of interventions, such as the risks of sharing low-quality or biased data, the possibility that standardisation may constrain methodological innovation, or the creation of new administrative burdens that disproportionately affect certain disciplines or career stages. By building a clearer evidence-base (using both qualitative and quantitative methods) on both the advantages and the trade-offs of reproducibility measures, meta-research can help funders, publishers, and institutions design effective policies and to implement workflows that are proportionate, targeted, and sensitive to disciplinary and contextual variation.

### R4.3. FUNDERS AND PUBLISHERS SHOULD ENABLE META-RESEARCH REGARDING FUNDING AND PUBLISHING WORKFLOWS THROUGH STREAMLINED PROCESSES FOR COLLABORATION AND DATA-ACCESS

Meta-research on reproducibility frequently depends on access to funder and publisher data such as grant information, peer-review records, editorial decision timelines, and other publisher or funder workflows (e.g. screening checks), and often requires direct collaboration to run controlled trials of policy or workflow interventions. However, such research is currently hindered by fragmented processes, inconsistent data-sharing arrangements, privacy considerations, and unclear pathways or standards for establishing collaborations. Funders and publishers can therefore make a real difference by streamlining their internal workflows to support meta-research, as well as developing transparent policies on collaboration, standardised data-sharing agreement templates, and establishing secure mechanisms for researcher access to sensitive operational data. By making these processes more transparent and consistent, organisations can enable rigorous empirical investigation into how funding and publishing practices influence reproducibility and help generate evidence needed to inform effective policy-making.

# 6. ÁPPENDIX A: OVERVIEW OF TIER2 FINDINGS AND LESSONS LEARNED

Over its three-year duration, TIER2 undertook a range of research, innovation and capacity building activities. In this section, in order to contextualise and provide evidence in support of the recommendations, we present an overview of the key findings and lessons learned throughout the project. Please note that as a Policy Brief, our main aim here is to succinctly communicate key messages. We include direct references to our publications and outputs where relevant, but readers who wish to gain a fuller scholarly understanding of this evidence may wish to consult our final project synthesis report which gives a much fuller presentation of this material (Ross-Hellauer et al. 2026).

## 6.1 UNDERSTANDING REPRODUCIBILITY

TIER2's approach to improving reproducibility was deeply contextual, informed by previous theoretical work regarding the role of "epistemic diversity" [12] in shaping the meanings and implications of reproducibility across research methods, disciplines and cultures (Guttinger, 2020; Leonelli, 2018, 2022; Penders et al., 2019). The core of TIER2's contribution to this understanding is the Knowledge Production Modes (KPM) framework, which interprets reproducibility as a function of both epistemic relevance and practical feasibility (Ulpts & Schneider, 2025). Relevance depends on research goals, epistemic functions, and systems of justification that govern quality criteria and evaluative standards. Especially in qualitative, exploratory, or interpretivist traditions, reproducibility may hence be less relevant as an indicator of quality than concepts like credibility, reflexivity, or plausibility. Treating reproducibility as universal risks epistemic injustice, marginalising valid forms of inquiry simply because they do not conform to norms imported from experimental, positivist or quantitative traditions (Fricker, 2007). Even where relevant, though, we must also be alert to how feasible reproducibility is in given contexts, i.e., whether reproducibility can realistically be achieved or expected due to practical, methodological, technical, and epistemic constraints of the research setting.[13]

Understanding these sources of diversity, we also sought to better define reproducibility. Our review of more than 400 definitions of reproducibility revealed profound variety across and within research fields (Ulpts & Schneider, 2025a). Our response was pragmatic: distinguishing between redoing (attempting to repeat part or all of a study) and practices aimed at enabling redoing (providing transparency so others can understand or reuse the work). This distinction clarifies what is to be done (the practice) and for what purpose (the function), facilitating researchers or stakeholders in navigating this conceptually confused territory.

## 6.2 EVIDENCE SYNTHESIS

We complemented this conceptual work by synthesising the evidence on the efficacy of reproducibility interventions, as well as with in-depth investigations of the meanings and implications of reproducibility in two broad groups of knowledge production methods, chosen for their novelty (Machine Learning-driven research)

[12] Epistemic diversity refers, according to Leonelli (2022), to "the condition or fact of being different or varied, which affects the development and/or understanding of knowledge".
[13] Examples include theoretical or methodological uncertainty of subject matter or study goals, the required levels of tacit expertise to conduct the research, and availability of resources, materials or infrastructure.

and controversy over relevance and feasibility (qualitative research). Our general synthesis of efficacy of interventions (Dudda et al., 2025) [14] found that evidence is surprisingly scarce, with 105 studies identified after screening over 36,000 articles, and clustered largely in distinct fields, especially health and behavioural sciences. Most assess proxy measures associated with enabling practices like data availability or methods transparency, rather than outcomes associated with improvements in levels of reproducibility. Some interventions, including availability of software and mandatory data-sharing policies, show demonstrable benefits for computational reproducibility. But the effectiveness of mandates also depends on various factors, such as how strongly they are enforced or norms regarding use of standards within research fields.

Studying the case of Machine Learning-driven research, we found that while some reproducibility issues mirror those in other fields (e.g., incomplete documentation, unavailability of code or data, questionable research practices), there are also novel challenges for relevance and feasibility such as nondeterminism, data leakage, and environmental variability (Semmelrock et al., 2025). In our investigation of qualitative research, we confirmed that conventional quantitative definitions of reproducibility and replicability are often considered inappropriate. However, well-adapted, epistemically aligned interpretations can be meaningful (Cole et al., 2024). Together, these cases support TIER2's approach to understanding reproducibility within epistemic context, suggesting that effective reforms must be tailored to the specific aims, norms, and constraints of different research traditions.

## 6.3 INNOVATIVE TOOLS AND PRACTICES

At the heart of TIER2 were a series of eight pilots of innovative tools and practices, co-designed and implemented in collaboration with stakeholders. [15] The pilots sought to translate insights from other areas of the project into novel applications, and then to assess their efficacy. Descriptions of each pilot and their main outcomes are given below in Table 2.

## TABLE 2. OVERVIEW OF TIER2 PILOTS' OBJECTIVES AND OUTCOMES

| Pilot name | Lead | Objectives | Key findings |
|---|---|---|---|
| **Pilot 1 - Decision Aid (Relevance and Feasibility of Reproducibility)** | Aarhus University | Aimed to operationalise the Knowledge Production Modes framework into a tool to help users assess whether reproducibility is relevant and feasible for a given study. | The prototype proved conceptually valuable but was hindered by its complexity, especially for non-expert stakeholders, and was eventually discontinued as resources expired. The authors hope to continue development in future work. |

[14] This work was undertaken in collaboration with our sister project OSIRIS, see: https://osiris4r.eu
[15] Full descriptions of the tools and their implementation and assessment are given in the relevant deliverable reports (Adamidi, Vergoulis, Momeni, et al., 2025; Adamidi, Vergoulis, Tijdink, et al., 2025; Klebel & Lister, 2025; Leitner et al., 2025).

| Pilot name | Lead | Objectives | Key findings |
|---|---|---|---|
| **Pilot 2 - Reproducibility Management Plans (RMPs)** | OpenAIRE | Sought to integrate reproducibility planning into research workflows through structured, machine-actionable templates on the ARGOS Data Management Plan platform. [16] | The pilot showed that RMPs support systematic planning and funder monitoring but require substantial time and strong institutional support to implement effectively |
| **Pilot 3: Reproducible Workflows (SCHEMA api and SCHEMA lab)** | Athena Research Center | Aimedto enable reproducible computational research, especially in Life Sciences, by packaging code, data, environment and provenance into containerised workflows. | We found that structured workflows increase transparency and reuse, although adoption depends on awareness of standards and technical capacity. |
| **Pilot 4: Reproducibility Checklists for Computational Social Science** | GESIS | Aimed to improve reproducibility for Computational Social Sciences through simple, actionable checklists embedded in the GESIS Methods Hub platform [17] | The pilot increased reproducibility success and demonstrated that usability and platform integration are critical for uptake. |
| **Pilot 5 - Reproducibility Promotion Plans for Funders (RPPs)** | Amsterdam UMC | Developed a policy template to help funders embed reproducibility into their funding policies and workflows. | RPPs were welcomed by funders and viewed as usable and adaptable across contexts to help foster improved reproducibility of their funded research. Barriers included bureaucratic constraints and resource shortages. |
| **Pilot 6 - Reproducibility Monitoring Dashboard** | Athena Research Center | Created a prototype dashboard for tracking datasets, software and other research artefacts in order to assess reusability and provide proxies for reproducibility. | The pilot showed that shared monitoring infrastructure can support policy evaluation and cross-stakeholder alignment. |

[16] https://argos.openaire.eu/home
[17] https://methodshub.gesis.org

| Pilot name | Lead | Objectives | Key findings |
|---|---|---|---|
| **Pilot 7 - Editorial Workflows to Increase Data Sharing** | Know Center | A randomised controlled trial testing a "nudge" intervention on editorial workflows to prompt authors to share data. | Results indicated little effect, suggesting that meaningful change requires stronger mandates and enforcement rather than gentle prompts. |
| **Pilot 8 - Editorial Reference Handbook for Reproducibility and FAIRness** | University of Oxford | Developed practical checks and workflows to help journals embed reproducibility and FAIR principles into editorial practice. | The pilot confirmed that the Handbook is feasible, adaptable across diverse journals and effective in raising the quality and clarity of research outputs. |

## 6.4 CAPACITY BUILDING

A core principle of TIER2 was that action to increase reproducibility must be targeted holistically to boost capacity at all levels. Hence, we conducted a series of capacity-building activities, including extensive co-creation and stakeholder engagement via workshops, ReproHacks, tutorials, and cross-network meetings, [18] development of online training modules [19], creation of new Reproducibility Networks in "Widening Participation" countries [20], curation of our knowledge resources at the Embassy of Good Science [21], and the creation of a new grassroots network of meta-researchers, the MERRI collaboration. [22] These activities underlined for us the importance of participatory, iterative design to ensure relevance and community, as well as the demonstrated enthusiasm amongst stakeholders at all levels for reproducibility initiatives.

## 6.5 THE WAY AHEAD

What is the future of reproducibility in research and policy? To answer this question, we used an innovative "future studies" methodology to engage participants in forecasting and projection (Horbach et al., 2025; Tijdink et al., 2023). The future of reproducibility that participants imagine:

- Has a particular research culture that prioritises quality over quantity and centres reproducibility in research practice and in training;
- Has standardised reproducibility requirements that account for methodological and epistemic diversity and standardised and shareable methods, tools and workflows;
- Incentivises reproducible, open and collaborative practices by providing recognition for them, funding them, and making them visible (these include alternative research outputs);

[18] See (Kohrs & Bannach-Brown, 2025) for a summary.
[19] https://openplato.eu/enrol/index.php?id=543
[20] https://tier2-project.eu/rn-award, for a definition of "Widening Participation" countries, see: https://rea.ec.europa.eu/horizon-europe-widening-who-should-apply_en
[21] https://embassy.science/wiki/Initiative:286109fc-03cb-4a08-bd45-c0276eae3079
[22] https://merricollaboration.github.io

- Has infrastructure that is designed for ease of use with clear guidance, policies and training, hosts FAIR and open tools and workflows, and sufficient resources are available to develop and maintain such infrastructure.

Our participants identified the factors they believe will be key in enabling or hindering this future. Most important were research culture, including norms, values and shared definitions, and the infrastructures required to engage in reproducibility practices, including repositories, support staff, and digital infrastructure for sharing research materials. Other key factors included policy efforts to incentivise reproducibility practices, training and education to empower researchers and support staff to engage in reproducibility practices, and the financial resources required to facilitate this transition empower funding for reproducibility.

These and the other findings above lead us to conclude that improving reproducibility is a question of the alignment of epistemic, cultural, technical, and institutional factors. In particular, we identify the following key lessons. Firstly, reproducibility is inherently contextual, and its relevance and feasibility must not be assumed. Secondly, improving reproducibility requires cultural change, shared norms, and capacity building, not just infrastructures or policies. Third, we emphasise the essential role of research communities, who are best placed to lead development of reproducibility standards suited to their own epistemic contexts. Fourth, early-stage planning to embed reproducibility into research design is advisable, and can heavily reduce downstream work. Fifth, intuitive infrastructures and institutional support play key roles in enabling reproducibility. Sixth, mandates and structured checks may be necessary at reporting stage, given the evidence on the lack of efficacy of weaker measures. Seventh, our work underlines the need for meta-research to test efficacy of interventions and inform policy measures. Finally, eighth, we need greater understanding on the gains and savings associated with different approaches, especially whether and how gains in term of system-level efficiencies are balanced by upstream costs to individual researchers, and how funding and incentives structures may evolve to best balance these factors.

## 6.6 RECOMMENDATIONS SCOPE, METHODS AND PROCESS

In response to these findings, TIER2 has prepared the above evidence-informed, collaboratively designed recommendations for actions to foster reproducibility of research. These recommendations were iteratively prepared through an inter-consortium workshop (with members of TIER2, OSIRIS and iRISE [23]), ongoing discussions amongst TIER2 members, and external stakeholder feedback and validation (through in-person presentation and discussion, and in-document collaboration). They build on the empirical evidence gathered within TIER2 described above, as well as inputs from a wide range of stakeholders, including funders, publishers, researchers.

Selection of the final set of recommendations was conducted via a multi-step process. We first collected a long list of potential recommendations (v1) via workshops and requests within TIER2 and the TIER2 advisory board. Next, we collected structured feedback from colleagues within TIER2, as well as the TIER2 advisory board members, on the relevance and feasibility of each suggested recommendation, along with further conceptual feedback.

[23] See: : https://osiris4r.eu/research, https://irise-project.eu

From this feedback, we collated the revised list (v2), aiming to capture recommendations that are relevant, actionable, and fill gaps in existing efforts to improve reproducibility across the research ecosystem. We received feedback on the revised version (v2) from colleagues across the TIER2 consortium, seven TIER2 advisory board members, as well as from representatives across our stakeholder communities among publishers and funders. The feedback was carefully integrated into the final version of the TIER2 recommendations. Throughout this process, our priorities were to identify gaps in existing policy and provide concrete advice, and to avoid making general recommendations that were vague or restated points already well established.

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# ABOUT TIER2

**PROJECT NAME:**
TIER2 (Enhancing Trust, Integrity and Efficiency in Research through next-level Reproducibility)

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- Athena Research & Innovation Center In Information Communication & Knowledge Technologies - ARC - Athens, Greece
- Biomedical Sciences Research Center Alexander Fleming - FLEMING - Athens, Greece
- The Chancellor Masters & Scholars of The University of Oxford (Associated Partner) - UOXF - Oxford, United Kingdom
- Charité, Charté Universitätsmedizin Berlin - Charite - Berlin, Germany
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- Stichting VUmc - VUmc - Amsterdam, Netherlands
- Pensoft Publishing - PENSOFT - Sofia, Bulgaria
- OpenAIRE AMKE - OpenAIRE - Athens, Greece
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**FURTHER READING:**
https://tier2-project.eu/library