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Harmonizing RDM

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Towards FAIR Research Data in Metrology

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Abstract. Good data management is necessary to maintain the trustworthiness and reliability of data. This is particularly important in metrology, the science of measurement, which ensures stable, comparable, coherent, and traceable measurement results. The digitalization of metrology has increased the demand for structured and harmonised research data management (RDM).

To meet this demand, the project TC-IM 1449 "Research data management in European metrology" was established in 2018. The project aims to promote good RDM practices underpinned by the FAIR principles, supporting traceability and reproducibility of measurement results. For that purpose, the project is providing researchers with the knowledge, competency, awareness, and tools to implement good RDM practices.

The project has formulated a vision for RDM in metrology for the support of scientists by developing and disseminating recommendations and in the organisation of training. As part of this vision, the project has produced several deliverables, including a template research data management policy, guidelines for data documentation, creation of metadata, and quality assurance for data publication. The project is also creating a comprehensive guide to RDM, a checklist for project coordinators, and providing training modules.

The project's activities reflect the needs of metrologists that are collated and communicated by the technical experts from the relevant Technical Committees and European Metrology Networks. Furthermore, the project's deliverables will be an invaluable resource for researchers seeking to effectively manage and share their research data.

Keywords: FAIR principles, Research data management, Metrology, Data management plans, Semantic technologies, Ontologies, Measurement units

1. Motivation

Metrology is the science of measurement, embracing both experimental and theoretical determinations of measurement uncertainty in science and technology [1]. Metrology

establishes a common understanding of measurement quantities and units, ensuring stable, comparable, coherent, and traceable measurement results. Moreover, it provides confidence in measurement at a stated level (usually described by a measurement uncertainty) and a structure based on scientific and technological concepts, thus underpinning all activities relying on accurate measurements.

For that purpose, it is essential to properly manage all data to make them trustable, reliable and protected against loss or corruption. Research data management (RDM) contributes to the digitalisation of metrological services, in line with both open science principles and the metrological principles of traceability and reproducibility. Indeed, both metrology and data management are prerequisites for efficient scientific research, which ensure that accurate and reliable information can be obtained from the produced data, leading to better understanding and reusability throughout science.

2. Project aims and background

To support this transition, the TC-IM 1449 project “Research data management in European metrology” was established in 2018. The project goal is fostering the development of harmonised practices for RDM of metrological data and services to improve the management of research data in metrology.

To this end, the project has formulated a vision for RDM in metrology and taken over the tasks to provide scientists with awareness, expertise and tools to implement it. This is achieved through the development and dissemination of recommendations in the form of guidelines, checklists, templates, and training.

The project’s activities reflect the needs of metrologists that are collated and communicated by the technical experts from the European metrology consortium EURAMET. The engagement with scientific communities and other stakeholders is achieved through the EURAMET Working Group on Metrology for Digital Transformation (WG M4D) and ensures that guidance, training, and templates are relevant to metrologists, meet data management requirements by the relevant funders and communities, and create lasting data assets for the research community. All deliverables comply with the current “European Partnership on Metrology (EPM)” funding programme, which is based on Horizon Europe.

3. Project outputs

The project deliverables are designed to provide researchers with the tools and guidance they need to ensure their data are properly managed, stored, and shared. The co-dependencies between the project workstreams, inputs and outputs are illustrated in Figure 1.

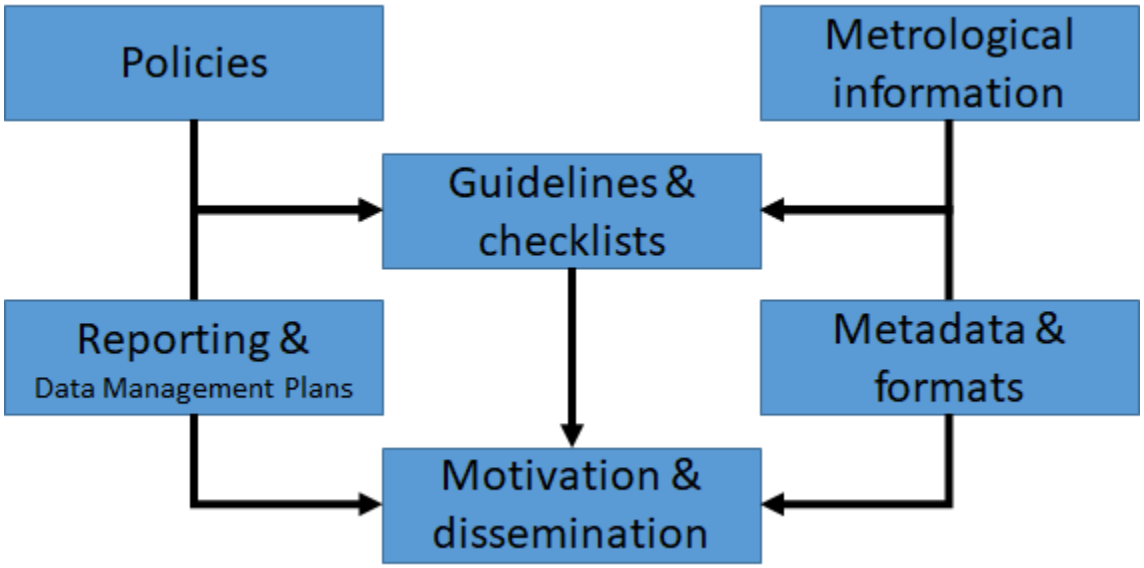

Figure 1. TC 1449 project workstreams, outputs and inputs.

In the first instance, we produced a template research data management policy. A wide adoption by metrology institutes, while catering to national specificities, would help harmonising the RDM practice and also offer a good example to other research institutions.

Moreover, we have produced a number of recommendations aiming to support researchers in doing good research data management during all different phases of a research activity. For the funding application phase, we provide text snippets to fill in the sections of EPM project proposals about “Gender dimension”, “Open science” and “Research data management and management of other research outputs”. For the project start, we provide a commented data management plan template, including controlled answer options and some help text for the most difficult parts.

To help researchers sharing and reusing data in machine-interpretable formats, guidelines for data documentation, creation of metadata and quality assurance for data publication are being prepared. Initial guidance on the adequate semantic representation of metrological information in a machine-actionable form has been published in an article [2] illustrating the benefits and limitations of open semantic technologies for metrology based on two real-world case studies. The key finding was the need for a flexible ontology of metrological concepts, agnostic to ontologies for quantities and units of measurement, thus facilitating community-driven good practices for FAIR and metrologically accurate representation of scientific data.

Further outputs include a comprehensive guide to RDM that will provide researchers with an overview of best practices and guidelines for managing their data throughout the research lifecycle, as well as a checklist for project coordinators to help align the project work with the best practices in RDM. The documents will be available by the end of 2023, providing a go-to resource for researchers who seek to improve their RDM.

To increase competences and awareness among our target group, a set of training modules on research data management for project coordinators was organised in 2021. Further training is planned in 2023 to support the preparation for the 2024 EPM funding call.

4. Partial conclusions and direct impact

This work presents the TC-IM 1449 project that aims to design and disseminate good RDM practices based on the FAIR principles as well as the core metrology concepts of traceability and reproducibility.

The project activities are integrated into the European metrology community framework for cooperation and knowledge sharing between all involved stakeholders. The project outputs relate to various stages of RDM and include definition of organisational policies, specification of metadata, elaboration of guidelines on data sharing and training of researchers. These outputs are aimed to support good RDM and accompany researchers and project coordinators in all phases of a research activity. The outputs are disseminated within the metrology community and beyond.

It is expected that TC-IM 1449 activities will lead to higher quality of research results and their documentation; reduction of costs for RDM; harmonised procedures for documentation of research projects; an easier dissemination of published data via repositories or databases; machine-interoperability of metrological information; improved compliance with the FAIR principles and funder's requests; and, as a result, higher chances of funding success.

5. Outlook

Future activities contemplate the definition of machine-interoperable editions of relevant terminology, such as the International Vocabulary on Metrology (VIM); recommendations for machine-interoperable data and metadata formats for metrological information (starting from the use case of key comparison data); recommendations for the design of repositories; checklists and guidelines for FAIRness maturity and FAIRification of datasets; recommendations for data quality evaluation and assurance (e.g., ISO 8000) [5]; procedures for semantic data validation in machine-to-machine data transfer. It is possible that the project outputs will contribute to the establishment of international standards (ISO, IEC, IEEE).

Data availability statement

Being a project about networking and capacity building, this project does not produce its own research data.

Underlying and related material

All project outputs (recommendations, training materials) are available online on the project's GitLab platform https://gitlab1.ptb.de/GLanza/tc-im-1449 .

Author contributions

All authors contributed equally to the conceptualization of the work described and on the review and editing of the abstract. FGT wrote the first draft together with ASP, MIG, JLH, MK, OP, GL.

Competing interests

The authors declare that they have no competing interests.

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