
Product Life Cycle Oriented Data Management Planning with RDMO at the Example of Research Field Data

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A research data management plan (DMP) is an integral part of the organization of working with research data according to the FAIR-Data-Principles. The task area Base Services of the National Research Data Infrastructure for Engineering Sciences (NFDI4Ing) support the open source software Research Data Management Organiser (RDMO) as an important and well established tool for data management planning. The purpose of this contribution is to demonstrate the application of RDMO for the organization of field data throughout a product life cycle at the example of the pilot use case of the archetype Golo. The possibilities of creating DMPs for the outlined use case using RDMO are presented.

1 Introduction

Research data management (RDM) is gradually becoming an integral part of the activities of modern scientific and educational organizations. In engineering disciplines, whose spectrum is itself quite broad and closely related to related scientific fields such as the natural sciences, research data from simulations or experiments with a wide variety of processes and methods are heterogeneous [1]. The heterogeneity of research data ranges from measurement data, observational data, simulation data, surveys and interviews to video and imagery.

Historically, different models, concepts, techniques, methods and data sets used in engineering disciplines have been developed for specific needs within specific areas of research and educational organizations. This can partially explain the fact that at present there is no unified concept of engineering data handling, standardized metadata schemas, generic and domain-specific ontologies and repositories of engineering research data. Typical problems are the exchange of big data, versioning of data, models and the corresponding program code, semantic linking of data, data reusability, reproducibility of results, etc. Cultural and historical aspects of working with research data, the variety of standards and approaches adopted by different research and educational organizations, and, therefore,

taking into account different goals and the need for changes in the culture and processes of organizations, also play an important role [2]. The overall goal of implementing RDM and workflow standards is to systematically make data findable, accessible, interchangeable, and reusable [3]. Germany's National Research Data Infrastructure (NFDI) aims to bring together existing infrastructure components, services and research communities to create a comprehensive, interdisciplinary RDM [4].

1.1 NFDI4Ing - National Research Data Infrastructure for Engineering Sciences

Initiated in 2017 by RWTH Aachen University and the Technical University of Darmstadt, the consortium NFDI4Ing aims to create a research data management system that ensures the preservation of new scientific findings, global aggregation and transparent promotion through standardized data management [5]. For modular and sustainable development, the research profiles of engineers are structured into so-called archetypes, which represent sub-areas of heterogeneous engineering activities and thus enable the systematic and oriented development of research data management solutions. The concept of archetypes has been developed as a result of a systematic analysis of various typical research and engineering activities and has been validated in the engineering community [6]. The archetypes are named for easier distinction and reference. In order to bring together the common aspects of the archetype-specific requirements as well as to promote cross-consortium communication, the standardized, modular and central services are implemented via the Base Services.

Archetype Golo deals with typical activities that belong to the research of technical systems, include planning, recording and subsequent analysis of field data for examination of the operating conditions of a technical system and/or subsequent adaptation of a system to the environment and real operating conditions.

1.2 Life cycle of research field data

One example of such a technical system are high-resolution vehicle headlamps (see section 2). Vehicle headlamps can be either considered as a separate independent system, a system within the system of the car, or to study the data obtained in the context of the use and interaction of several technical systems.

The product development process follows a V-model according to VDI guideline 2206 [7]. In the V-model, the process of technical system development starts with the definition of the requirements, followed by a system design considering various influencing factors, a domain-specific design, and the prototype. The prototype goes through one to several development and validation cycles, which in turn can result in the adaptation of the prototype or even its new development. The result of a completed cycle of the V-model is the product, which features a certain degree of maturity of the planned final product. For

the RDM it means the occurrence of different types of collected data like test data and field data. The test data is generated at the beginning of the research process by means of laboratory experiments and various simulation settings (Fig. 1). The field data collected by testing the developed prototype under real environments with new, additional factors is associated to it.

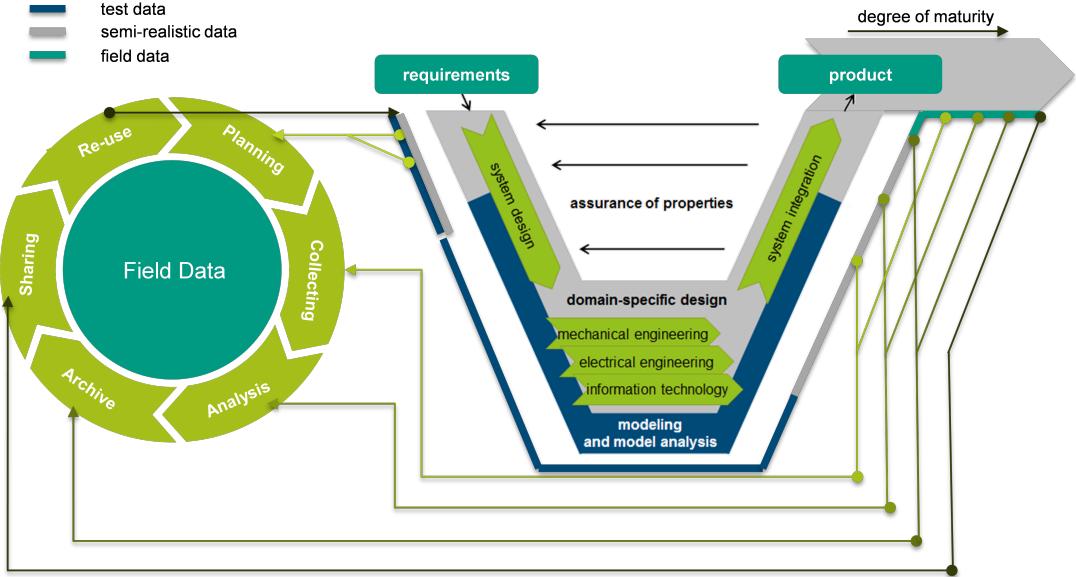


Figure 1: V-model and research data lifecycle.

In the planning phase, both qualitative and quantitative test results must be thoroughly documented. Often this documentation is scattered over several files, is partly done manually, and is rarely standardized. Therefore, it is desirable to use metadata standards and to choose ontologies that allow researchers to select appropriate attributes for the relevant data type and describe them in as standardized a way as possible. In addition, a specification of provenance metadata is required.

Because engineering research projects work with different types of data with different access rights, a data management platform that allows role assignment and rights management is needed to fully collect and store data. This is often accomplished through the services of the research organization and providing access to external project partners. Here, usage of a data management platform that provides functionalities such as standardized data and metadata storage and a possibility for standardized storage of test protocols would be favourable.

During the data analysis phase, depending on the data type, different data volumes in the range of MB to TB are generated; these include raw data as well as extensive simulation data of partly proprietary software components and in-house developments.

Within archiving and providing access to the data the interests of all research participants, e.g., educational and research organizations as well as industrial partners, and the possible mixed project funding should be taken into account. There is a continuous data exchange

between the partners throughout the research data life cycle. This mixed financing of research projects requires graded rights of subsequent use of the resulting research data. The choice of a data management platform for data exchange and storage should be made with the guarantee of long-term archiving of data and metadata and thus ensure their potential reuse.

2 Use Case: Validation of high-resolution vehicle headlamp

The purpose of this example is to demonstrate how the archetype Golo can use DMP for an organization of the RDM process for the development of a high-resolution vehicle headlamp. The fundamental aim of vehicle lighting technology is to optimize visibility for the driver and the visibility of the vehicle for other road users. Two main functions are to be taken into account in the design: lighting the road section and providing information signals to road users, including pedestrians. To realize the functions of lighting, traffic analysis and displaying warning signals a separate block for information processing can be used. An increasing networking, as with the vehicle camera and other sensors, requires an early definition of data and interfaces and requires a frequent exchange of domain-specific field data [8]. Within modeling, implementing and testing all blocks of the system, test sets of quantitative and qualitative data are used.

2.1 Organization of the validation process and data types

The distraction potential for other road users is investigated in a study, when road projections are directed at the driver of the projecting car. For this, a blind study with different test persons driving a constant motorway section are overtaken by a vehicle projecting an image onto the street surface. The distraction potential is examined with an eye-tracking system, which detects the direction of the subjects gaze. Another camera behind the windshield of the test subject's vehicle records the traffic area in front of the vehicle. In addition, the subjects' physiological perception of the headlight projection is recorded with a questionnaire afterwards. Deviations from the intended test procedure are also noted. The sheets with the answered questionnaires and notes are scanned after each trip.

2.2 Project Data Management Plan

For the research data life cycle of this use case, a DMP should be created at the beginning of the product development process, which is adapted to the process steps described in the V-model. The developed DMP template is a Word-document, a checklist in the form of tables with questions. The DMP takes into account the different project phases: initiation, execution, controlling and closing. In the DMP template the project execution set includes subsections: general information, general questions about the experiment, questions about

the raw data of the experiment, questions of the evaluation of the experiments and the subsection other. A cut-out of the section with questions from initiation phase is shown in Fig. 3. The process of filling out the DMP involves quality control of the answers by the project management and the management of the responsible departments, as well as feedback from the project developers who filled out the document, in order to improve the informativeness and quality of the DMP. The first scenario described in the following paragraph explains how to transform the developed DMP template, including the different phases of the project and the corresponding quality control workflows, into a catalog in RDMO.

3 Data Management Planning with RDMO

3.1 What is RDMO?

The Research Data Management Organiser (RDMO) is a software that enables institutions as well as researchers to plan and carry out their management of research data. RDMO can assemble all relevant planning information and data management tasks across the whole life cycle of the research data. RDMO is ready for application all kind of research projects. It is run by several universities and research institutions all over Germany [18]. The current main feature of RDMO is the provisioning of templates for DMPs (so called catalogs), allowing the collaborative creation and maintenance of neatly standardized DMPs. The templates can be customized individually while in same time still being interoperable.

In two project phases funded by DFG, the tool was continuously developed by the project partners Leibniz Institute for Astrophysics (AIP), Fachhochschule/University of Applied Sciences Potsdam (FHP), and the library of Karlsruhe Institute of technology (KIT) in close cooperation with users. The tool was extended by enhancing its implementation of roles and interfaces to institutional infrastructure, e.g. repositories, ticketing systems, and the infrastructure for authentication and authorization. The development of RDMO and the organisation of DMP templates is continued by the RDMO Working Group[17].

3.2 How we want to make use of RDMO in NFDI4Ing?

In the NFDI4Ing consortium there are two tasks concerned with RDMO that are included in the Base Service measure "Quality assurance in RDM processes and metrics for FAIR data", that is carried out jointly by IPeG Leibniz University Hannover, WZL RWTH Aachen University, University Library RWTH Aachen and University and State Library Darmstadt (ULB Darmstadt). In the one task NFDI4Ing will offer a DMP service to all researchers of engineering through a central multitenant RDMO instance maintained by ULB Darmstadt.

It provides a highly adaptable user interface, authorisation procedures and customizable DMP templates per client, but runs on a single database, thus allowing easy collaborative data management planning in multi-institutional research projects. Local RDMO editors can take care of the content of one client. We will implement new features in RDMO regarding 1) the validation of entries in DMPs in order to connect RDMO with RDM maturity models, 2) Usability improvements, e.g. a recommender for suitable DMP templates, 3) connection to other RDM systems via the RDMO API (e.g., repositories, metadata services, ORCID, CRISs). Furthermore, we will be engaged in the RDMO Working Group regarding the maintenance of the code.

In the second task we will foster the use of specific DMP templates in engineering. We will develop, test and evaluate archetype and sub-discipline specific DMP templates, for different stages of research projects, as well as in close collaboration with all archetypes and community clusters. We will also investigate how to support researchers and local RDM offices by designing a DMP review service based on maturity levels. The establishment of an RDM certification scheme introducing an “NFDI4Ing seal for FAIR data” is our goal in the long run.

3.3 From a local check list to RDMO - a researcher’s perspective

3.3.1 An introduction to RDMO’s data model

There are two starting situations for researchers who would like to develop their own data management plan questionnaires or *catalogs* in RDMO: Either a data management checklist already exists, e.g. in the form of a text file, which is to be transferred to RDMO, or there is no such preliminary work. In both cases it is highly recommended to build upon existing RDMO catalogs already developed by the RDMO community. On the one hand this approach makes work easier, on the other hand – and even more important – it increases the interoperability and therefore reusability of the new catalogs.

To achieve this, it is essential to have a basic understanding of RDMO’s underlying data model, of which Fig. 2 shows an important part.

Catalogs in RDMO consist of *elements*, including *questions*, *attributes*, *options* and *conditions* (the latter not shown in Fig. 2). Within a catalog, questions can be organized in question sets and sections as parent structural elements, options in option sets. These elements are predefined by the creator of the catalog.

To create a data management plan for a specific research project based on a catalog, the researchers first have to create a new project in RDMO. During the following structured interview, RDMO presents them the predefined question texts which are internally stored in the question elements. The answer or *value* given to a specific question by the researchers is stored in RDMO by linking it to an attribute which is also linked to that same question, as shown in Fig. 2. To make the filling of the questionnaire easier, it is possible to present predefined answer *options* to the researchers, from which they can

select the appropriate ones. Options in RDMO are organized in option sets. An example of an option set could be the faculties of a university, with each faculty being one option. Generally, this concept of decoupling the predefined question elements (blue in Fig. 2) from the user specific content (green) through attribute (red) and option elements (orange) makes it possible for researchers to switch the project’s catalog while their answers are taken over to the new catalog automatically, provided that the latter elements were chosen in a standardized way.

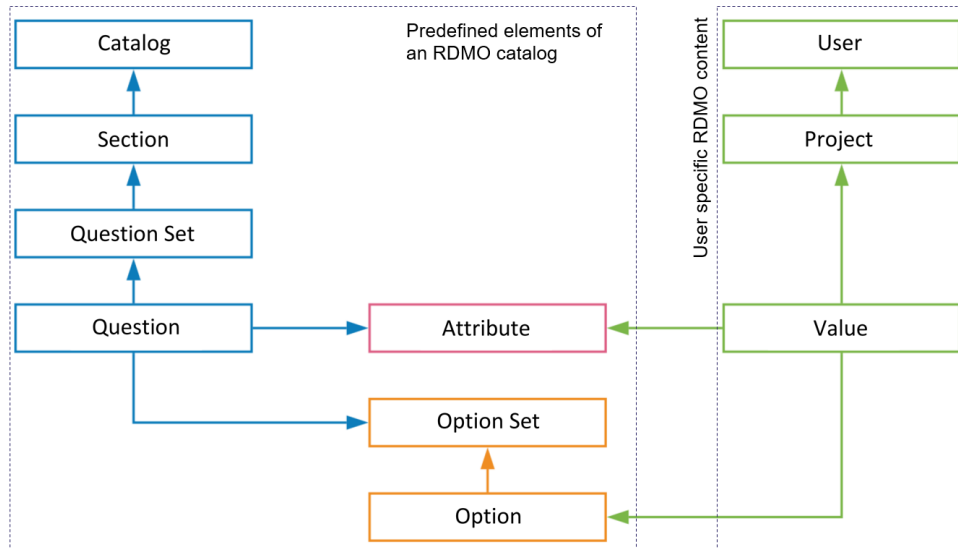


Figure 2: Part of RDMO’s data model. Illustration slightly modified taken from [9].

Every element in RDMO is identified by a URI, i.e. a string of characters with the structure of an internet address, but without an actual page behind it. Although, technically, all URIs may be defined completely freely by the developer of a new catalog, for interoperability purposes it is highly desirable to reuse existing attributes with the official RDMO prefix¹ <https://rdmorganiser.github.io>. An RDMO XML file containing all existing attributes with that prefix can be found in the folder *rdmorganiser/domain* of the RDMO-Catalog GitHub repository [19].

By importing this file into an RDMO instance, the attributes become available for catalogs within this instance. It is therefore recommended to import the RDMO Domain XML file immediately after the installation of RDMO.

¹In RDMO, the URI prefix is defined as the first part of the URI and is important for data exchange between different RDMO instances. [15] Typically, the prefix should indicate the RDMO instance to which the respective element belongs, although in principle it can be freely chosen as long as it adheres to a basic URL scheme (see [15]). In contrast to other elements, such as questions, where the prefix might be changed if they have been imported from an external source to a local RDMO instance, the prefixes of attributes with the <https://rdmorganiser.github.io> prefix should not be changed because of the interoperability reasons that are described in the text. In this context, an RDMO prefix can be compared to an XML namespace which is also a unique identifier for a collection of (XML element and XML attribute) names.

Each attribute in this file should uniquely represent one concept, e.g. "file size", and the RDMO Content Group, which is part of the RDMO Working Group [17], ensures that only unique attributes are newly added to the file.² Suppose, there are two catalogs A and B, each containing its own question about file size, but linked to this same attribute. If researchers decide to create a project based on catalog A, they can switch to catalog B at a later point without losing their given answer since the connection between the question element and the answer value is established via the same attribute. Since each question in RDMO is connected to exactly one attribute and each attribute can represent a concept, conversely, each question should ask for one concept to improve the interoperability of the catalog. If, on the other hand, one question asks for several concepts at the same time, the answer value has to be linked to a more generic attribute and cannot be split up again (at least not in an automatic way) when changing to a catalog with specific questions.

3.3.2 First Scenario: A data management checklist exists

Fig. 3 shows an extract of an existing data management checklist in .docx format used for the use case validation of high-resolution vehicle headlamps (Chapter 2). In order to transfer this checklist to RDMO, at first a new catalog must be created within the RDMO instance. This includes the assignment of a title, a URI prefix and a key. While the URI prefix can be freely chosen in principle, it is a good idea to choose it as your own RDMO's domain name, e.g. <https://tudmo.ulb.tu-darmstadt.de> for the RDMO instance of TU Darmstadt. Next, sections, question sets and questions can be created. Since the technical aspects of creating a catalog are very well described on *forschungsdaten.org*, we refer to this documentation [20] and will focus on the content process of finding and reusing existing attributes to make the new catalog interoperable. In general, if one is working on a new RDMO catalog, one can add information about it to the "Catalogs in Development" table on *forschungsdaten.org* [16] so that other groups who might be interested in collaborating can get into contact.

Using question 1.5 about the size of the expected research data as an example, the first step in transferring this checklist to the newly created RDMO catalog would be to check whether an appropriate attribute for this question already exists with the official RDMO prefix <https://rdmorganiser.github.io>. Provided that the above mentioned RDMO Domain XML file has been imported to the local RDMO instance, one option would be to go through the attributes in the window of the management interface (see Fig. 4) manually, looking for an appropriate attribute. Although the attributes can also be searched

²During the RDMO DFG project phase, Heger (2016) [10] explored the possibility of mappings between RDMO attributes and existing metadata schemas, the most promising being CERIF or SEMCERIF [11] as well as Friend of a Friend (FOAF) [12] and DDCMI [13]. However, since these metadata schemas allowed only the mapping of a limited number of attributes, at the moment the RDMO Content Group does not conduct a mapping to existing schemas for new attributes. If, however, persons who have developed new attributes, send them to the Content Group for the review process and decide to provide a mapping to existing metadata standards, this would always be highly appreciated (although it is not mandatory). At the moment, the mapping could be provided in the *dc:comment* elements of the RDMO XML Domain file [14]

for by their URI, it might be difficult to find the right one, in this case *https://rdmorganiser.github.io/terms/domain/project/dataset/size/volume*, since one has to search for the exact term that is used within the URI.

Checklist		
Nr.	Questions / Activities	Answers / Releases
1	Project Initiation	
1.1	If required: introduction to the research data management by the RDM team.	
1.2	Selection of a person responsible for the research data management of the project.	
1.3	What research activities are involved in the project?	
1.4	What research data is to be expected?	
1.5	What is the expected size of the research data?	
1.6	Who needs to access the data during the project?	

Figure 3: An excerpt from a data management checklist of the IPeG at Leibniz University Hannover. The highlighted question is used in the text as an example of how existing checklist questions can be transferred to RDMO.

The screenshot displays the RDMO Domain menu. On the left, there is a list of attributes, each with a red highlight and a set of icons for editing, deleting, and other actions. The attributes listed are:

- Attribute <https://rdmorganiser.github.io/terms/domain/project/dataset/size>
- Attribute https://rdmorganiser.github.io/terms/domain/project/dataset/size/number_files
- Attribute <https://rdmorganiser.github.io/terms/domain/project/dataset/size/volume>
- Attribute https://rdmorganiser.github.io/terms/domain/project/dataset/software_documentation
- Attribute <https://rdmorganiser.github.io/terms/domain/project/dataset/storage>
- Attribute https://rdmorganiser.github.io/terms/domain/project/dataset/storage/naming_policy
- Attribute https://rdmorganiser.github.io/terms/domain/project/dataset/storage/naming_policy_mb
- Attribute https://rdmorganiser.github.io/terms/domain/project/dataset/storage/organisation_policy

On the right side, there is a sidebar with the following sections:

- Filter attributes**: Includes a search input field and a dropdown menu for "All URI prefixes".
- Options**: Includes a "Create new attribute" button.
- Export**: Lists various export formats: PDF, Rich Text Format, Open Office, Microsoft Office, HTML, Markdown, mediawiki, LaTeX, CSV comma separated, and CSV semicolon separated.
- XML**: A section for XML export.
- Import**: A section for importing data.

Figure 4: RDMO Domain menu.

A more powerful way to search for attributes is the web tool RDMO-Terms [22] which allows to search all elements of all catalogs available at the central RDMO content repository. By searching for questions regarding file size there is a greater chance of finding the appropriate attribute than by searching for the attribute directly. The reason is that question elements do not only consist of a URI string³ but also of the question texts,

³In fact, attributes can also contain a description of their meaning in form of a comment. However, in practice most attributes do not have such a comment.

mostly at least in English and German, which are also searched. As an example, Fig. 5 shows one of the questions found by a search for the term "size" from which the appropriate attribute can be identified. It is recommended to check several of the found questions in order to be sure that the most suitable⁴ attribute has been identified.

In case an appropriate attribute does not already exist, it should be created, initially using your own organisation's RDMO prefix. When you decide to publish your catalog, it will be checked by the RDMO Content Group, that all newly created attributes are indeed unique, i.e. that they do not have an existing equivalent attribute with the `https://rdmorganiser.github.io` prefix. To facilitate this work, it is beneficial to copy the text of the associated question into the comment field of the attribute. A brief outline of the editorial workflow is given in section 3.3.

While it is possible now to create the question about the file size manually in the new catalog and link it to the found attribute, it can save some time to copy the whole question from the original catalog⁵ via RDMO's question copy function (see Fig. 6) into the new catalog. The links to the attribute as well as to a possible option set are taken over at the same time. The prerequisite for this is that the respective catalog's questions and, if applicable, options XML files were previously imported from the RDMO catalog GitHub repository.

The screenshot shows the RDMO-Terms web interface. At the top, there is a navigation bar with 'rdmo-terms' and links for 'Questions', 'Domain', 'Options', 'Conditions', 'Tasks', and 'Views'. Below this is a search bar containing the text '*size*' with a callout box pointing to it that says 'Search term with truncation operators'. To the right of the search bar, it says '21 of 1985 elements displayed.' Below the search bar, there is a note: 'We use lunr syntax, please use wildcards (*) to search inside a URI, e.g. *dataset*.' The main content is a table of search results. The first result is highlighted. It has a 'Search result' callout box pointing to the first column. The table columns are: 'Question', 'uri_prefix', 'key', 'attribute', 'text_en', and 'text_de'. The first row shows: 'Question' with the URL 'https://rdmorganiser.github.io/terms/questions/dcc/collection/dataset-format_size/volume', 'uri_prefix' with 'https://rdmorganiser.github.io/terms', 'key' with 'volume', 'attribute' with 'https://rdmorganiser.github.io/terms/domain/project/dataset/size/volume', 'text_en' with 'What is the actual or expected size of the dataset?', and 'text_de' with 'Was ist die tatsächliche oder erwartete Größe des Datensatzes?'. A callout box 'Number of questions and question sets found' points to the top right of the table. Another callout box 'Complete URI of the question' points to the 'uri_prefix' column. Below the table, there is a 'Next search result' callout box pointing to a 'Questionset' with the URL 'https://fdm-bayern.org/eHumanities/questions/Horizon2020/data_summary/datasets-size_and_use'.

Search result	Question	uri_prefix	key	attribute	text_en	text_de
	https://rdmorganiser.github.io/terms/questions/dcc/collection/dataset-format_size/volume	https://rdmorganiser.github.io/terms	volume	https://rdmorganiser.github.io/terms/domain/project/dataset/size/volume	What is the actual or expected size of the dataset?	Was ist die tatsächliche oder erwartete Größe des Datensatzes?
Next search result	Questionset	https://fdm-bayern.org/eHumanities/questions/Horizon2020/data_summary/datasets-size_and_use				

Figure 5: Search for questions containing the term "size" within the web tool RDMO-Terms.

3.3.3 Second scenario: No data management check list exists

When there is no pre-existing checklist, a good strategy is to first look at the existing RDMO catalogs that have already been developed by the RDMO community and

⁴In the end it is up to the creators of the catalog to decide if the found attribute is appropriate for their question.

⁵In this case the RDMO dcc catalog which can be found under <https://github.com/rdmorganiser/rdmo-catalog/tree/master/rdmorganiser/questions>

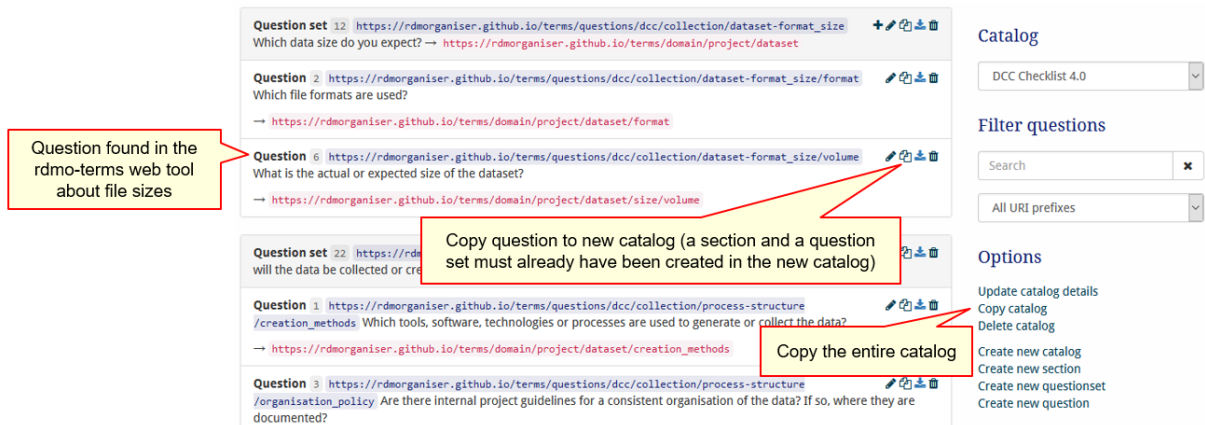


Figure 6: Copy question and copy catalog functions of RDMO.

published in the RDMO-Catalog GitHub repository. There are two folders, one of them ("rdmorganiser") with catalogs developed by the RDMO project and the other ("shared") containing catalogs from different institutions and initiatives. Most of these catalogs come with a documentation, describing the content of the respective catalog, which makes it easy to identify catalogs that might be of interest to ones use case. In addition, the catalogs of the official RDMO project can also be tried out live in the RDMO project's demo instance⁶.

Ideally, one of the official or shared catalogs already fulfils the project's requirements. The only task that has to be done then would be to import all the necessary content files of the catalog in the local RDMO instance, which for shared catalogs often also includes files from the official RDMO catalog (especially the domain file with the attributes) since these are often referenced.

Even if none of the catalogs fully meets the requirements, a new catalog can be created reusing content from different existing catalogs. As described in section 3.3, one could first create an empty catalog and fill it with self created questions as well as questions copied from other catalogs. If, on the other hand, one catalog already meets the requirements well and only minor changes are needed, it makes sense to implement these changes either in the imported catalog directly or in a copy, generated via RDMO's copy catalog feature (see Fig. 6). This latter option has the advantage, that one can define a URI prefix which is then automatically applied to all question elements of the copy, making it clear that it is a new catalog of its own.

3.3.4 What happens after this?

When a new catalog has been developed, it helps other RDMO users if it is published in the RDMO-Catalog GitHub repository so that it can be reused. A good way to do this is

⁶<https://rdmo.aip.de/>

to create two pull requests to the dev branch of the repository, one for the domain XML file and the second for the remaining files (including questions, options and conditions).

In preparation for publication, all attributes that have been newly defined for the catalog should be added to the RDMO Domain XML file which is located in the rdmo-catalog repository in the folder `rdmorganiser/domain`. The new attributes should be inserted into the existing hierarchy of attributes at the positions that seem most appropriate. As prefix, <https://rdmorganiser.github.io> should be used and in the comment section of each attribute the text of the associated question should be inserted. The RDMO Content Group will then review the changes with the discussion taking place in the form of public comments within the pull request. Since the editorial workflow for the inclusion of newly defined options and conditions is still under development, these files can be provided as separate files for the "shared" folder along with the question XML file in the second pull request.

Finally the entire catalog is checked to see if it works technically. If this is the case, both pull requests are merged into the dev and later into the master branch of the repository.

3.4 Where are we now?

Currently, a generic NFDI4Ing client usable for all researchers with DFN-AAI access credentials is being created. NFDI4Ing started a coordination process within the NFDI on DMPs and tools by hosting a workshop on these topics in march 2021 jointly with the RDMO Working Group [23]. A respective working group on the NFDI level will be formed soon. For now, ULB Darmstadt runs RDMO for a network of Hessian universities [21] and for RWTH Aachen.

In 2021 it is planned to conduct a needs assessment for the further RDMO clients within NFDI4Ing and Germany-wide in order to establish further clients. The international perspective (RDA, EOSC) is monitored.

4 Conclusions

The creation of a DMP for a research project using RDMO software has been analyzed. Two scenarios of working with RDMO are considered: the case of an existing DMP and its transformation into a catalog of RDMO questions and the case of creating a catalog of RDMO questions from scratch. The transformation of the existing DMP is illustrated by the example of the Use Case within the archetype Golo of the Consortium NFDI4Ing.

In general, it can be noted that the application of RDMO simplifies the creation of a DMP if one is faced with the necessity to build a plan for the first time. In the case of transforming an existing DMP into an RDMO question catalog template, the advantage of such a transformation is the availability of ready-made plans and the ability to borrow existing ready-made questions. The disadvantages of the transformation process

includes the need for a long search for existing attributes. When searching for appropriate attributes, the general recommendation should be to use the attributes with the official RDMO prefix whenever possible. Since only one attribute can be assigned to a single question during the transformation, complex questions should be avoided and formulated in such a way that they contain, if possible, one key word that can be used as the basis for finding the attribute. Among the strengths of using RDMO is the ability to save catalog of questions in universal formats, which make it possible to link documents semantically and automatically transform catalog of questions and plans into, for example, a wiki-based software such as Semantic MediaWiki.

Further advantages of RDMO sharing in NFDI4Ing, and the perspective in NFDI, are that every researcher can work on a DMP together with every other researcher via the common database. DMP templates can be easily reused, can be adapted by each client for his institution or cooperative project, are jointly developed and can be standardized with regard to completeness, scope, validity, etc. Last but not least, the approach results in very lean IT operations.

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