OPEN SCIENCE SERVICES BY RESEARCH LIBRARIES: ORGANISATIONAL PERSPECTIVES

DEVELOPMENTAL STAGES AND COMPETENCES FOR OPEN ACCESS AND RESEARCH DATA MANAGEMENT SUPPORT SERVICES

A LIBER/ADBU study

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CONTENT

AIM OF THE STUDY

Many research libraries in Europe deliver Open Science services in the field of **FAIR Research Data Management** (RDM) and **Open Access** (OA). However, it is estimated that up to half of the European research libraries deliver only limited services in these domains. This LIBER/ADBU study focuses on understanding the organisational structures and competences needed for these services. The aim is to support an acceleration of the adoption process of these two Open Science services by research libraries throughout Europe by a toolkit based on this study.

STUDY METHODS

Interviews have been held with libraries with developed and/or advanced support services in these areas. Based on these interviews, this report describes four development stages in RDM services with related organisational structures and competences needed. In addition, three development stages of OA services are similarly described.

RDM SUPPORT SERVICES

The overall purpose is to provide RDM support services and infrastructures to researchers that cover the entire data life-cycle: The data life cycle consists of three stages: preparation of the research project with among others a data management plan (DMP), the execution of the research with so-called 'active data' and the final stage of publishing and/or archiving the resulting datasets. In order to create the service portfolio that supports researchers across the entire data life-cycle, collaboration between the library and other internal stakeholders such as the IT department, Research Office, Data Protection Officers, Ethics Board, and Technology Transfer Office – in short, an ecosystem of RDM support professionals – is necessary. An important part of the role of the library is to connect and coordinate the activities of these stakeholders and bundle their RDM support services for the researchers.

Four development stages can be observed:

- **Initial stage:** Research funding organisations increasingly demand data management plans (DMP) for the research projects they finance. This has triggered many research libraries to start developing DMP support services. This service often is complemented with a referral service for existing data repositories and data archives – in line with other traditional referral services. Thus, most library RDM services start with services at the beginning and at the end of the data life-cycle.
- **Developing stage:** At this stage, the services are covering the entire data life-cycle. RDM support infrastructures for the storage and sharing of active data as well as training & advisory services are often provided by the IT department in collaboration with the library. Archiving and publishing support services often encompass an institutional data repository (or an institutional space in a national repository) for publishing & archiving datasets. The library services in this stage are generally generic and discipline-agnostic.
- **Developed stage:** At this stage, the advisory services become more discipline-oriented. This requires data stewards that are embedded in faculties and or research departments. In the larger research institutions, this leads to a first line/second line organisational service structure for the RDM services. Also in the larger institutions, at this stage there many RDM support professionals

and therefore the library often employs a community manager to stimulate collaboration and knowledge exchange.

- **Advanced stage:** The services in this advanced stage can encompass the provision of data managers 'on loan' for research project teams who carry out operational tasks. An additional service is the monitoring of archived/published datasets by the institutional researchers. Finally, services around research software are being developed.

Six job categories can be distinguished: Generic data steward or data librarian, embedded data steward, data manager, educator/trainer (mostly part of the task of the data librarians/data stewards, sometimes a separate position), data curator (for curating datasets to be deposited in the data repository) and community manager.

In the development of RDM support services **two fault lines** can be observed:

- **Organisational structures:** The transition of the developing stage to the developed stage of RDM support services is generally characterised by a transition of service organisation that is centrally located in the library to a distributed model with a first line/second line organisational structure. The data stewards in the first line of service – embedded in research departments or faculties – are sometimes employed by the library, sometimes by the faculties.
- **Competences:** The competences that are needed for the RDM support services in the initial and developing stage can generally be fulfilled by traditional librarians who can learn additional, discipline-agnostic competences 'on the job'. However, for the discipline-oriented RDM support services in the developed stage a different set of competences is mostly seen as necessary: therefore, for the position of embedded data stewards, people with the research background in the specific discipline(s) are generally hired. This is also true for the data managers in the advanced stage, who need to have operational competences in research data management.

OA SERVICES

The overall purpose is to provide a multi-road to Open Access in order to avoid the dominance of a single Open Access route: At this moment, the main drivers for Open Access are Green OA with author accepted manuscripts in repositories, APC-paid articles in Gold OA journals and the OA articles in hybrid journals as a result of Read & Publish agreements between libraries and publishers. A widespread concern about the increase in costs of Gold and Hybrid OA has led to recent a push to stimulate Diamond Open Access journals. In all routes, libraries play a crucial role.

Three development stages can be observed:

- **Initial stage:** The initial stage of OA services encompasses the services related to a repository and in addition education and training about OA in general. Most European research libraries operate a repository and have workflows in place to support and stimulate depositing of research output, such as Green OA articles in the repository. The repository can be institutional but also a national repository, such as HAL in France.
- **Developed stage:** At this stage, the main additional services are supporting researchers with selecting an OA journal and with publishing their articles on Open Access in Gold journals (by compensating the APCs with an OA fund), or in hybrid journals (by Read & Publish contracts).
- **Advanced stage:** At this stage, libraries offer institutional Diamond OA publishing services, either by offering an OA journal platform with technical support or by developing a full-service

University press for journals and/or monographs. Some of these Diamond OA presses are also starting to publish Open Textbooks (as part of Open Educational Resources).

Five job categories can be distinguished: Digital Scholarship librarian/other librarians in front-office functions, CRIS and/or repository manager, Open Access fund manager, Read & Publish licence manager, Diamond OA publisher.

With regard to the organisational structures and the competences needed for the services, two observations are important:

- **Organisational structures:** In contrast to the developed RDM support services, the central organisational model seems most appropriate for most OA services, also in their advanced stages.
- **Competences:** There appears to be a fault line with regard to competences for Diamond OA publishers. While the other job categories are fulfilled by librarians, for Diamond OA publishing services many libraries hire people with a background in publishing.

ADDED VALUE OF THE LIBRARY IN THE EYES OF OTHER STAKEHOLDERS

Interviewees from stakeholders within the institutions as well as (inter-)national stakeholders see two aspects to the added value of the research libraries in OA and RDM support services:

(1) **Intermediary function**: The library coordinating and connecting intermediary between the researchers on the one hand and other internal stakeholders on the other hand, based on its understanding of the context of research and the environment in which the researchers operate

(2) **Specific competences** that are relevant to Open Science services such as (a) having a comprehensive overview of the regulation and policy environment of institutions and research funders with regard to Open Science, Open Access, FAIR research data, research integrity, ethics et cetera; (b) technical expertise regarding digital publishing regarding metadata standards, ontologies, licenses, copyright, and identifiers and long-term preservation; (c) the fact that libraries do already support the research output in the form of publications, which makes them a suitable party to support the research output in the form of research datasets.

OTHER ASPECTS OF OPEN SCIENCE

This study has been focused on OA and RDM support services. However, other aspects of Open Science are related to research integrity, research evaluation, and participative research/citizen science. A number of libraries with advanced OA and RDM services have set-up organisational structures to play a coordinating and connecting role with the aim to foster Open Science in its broadest sense within the entire institution.

TRANSFORMATION OF RESEARCH LIBRARIES AND THEIR SERVICES

Research libraries are in a period of transformation in response to the advance of Open Science. Library services change from 'outside in' services to 'inside out' services (Dempsey & Malpas, 2018). These 'inside out' services support academics in opening-up the making, sharing and reuse of new knowledge. Researchers generally trust their libraries and for this reason, the support by these 'inside out' library services is broadly accepted and welcomed by the research communities. Therefore, the Open Science services by research libraries will probably become more essential and important to researchers than the traditional 'outside-in' services were.

LIBRARIES FINDING A ROLE IN OPEN SCIENCE

The above-mentioned Open Science services and the transformation of research libraries mean that library organisations need to develop new competencies in order to support researchers who are adapting to the requirements of Open Science. However, research libraries are not the only players in the new Open Science environment: other stakeholders within the University such as ICT departments and research offices also provide Open Science services to researchers in a networked environment. The Open Science services by these various players should of course be complementary and developed in collaboration with each other. However, in practice this is where the shoe pinches: research libraries often have difficulties in explaining their roles and their added value in the networked environment they work in, and this is especially true for some new terrains in the Open Science domain where research libraries need to acquire new competencies themselves.

ADOPTION OF OPEN ACCESS SERVICES BY LIBRARIES

Offering Open Access services for scholarly publications is generally seen as a logical role for libraries. Research libraries use repositories for Green Open Access, start new university presses for Diamond Open Access, negotiate Read and Publish agreements with publishers of hybrid journals and support researchers in publishing in APC-Gold journals by providing APC funds.
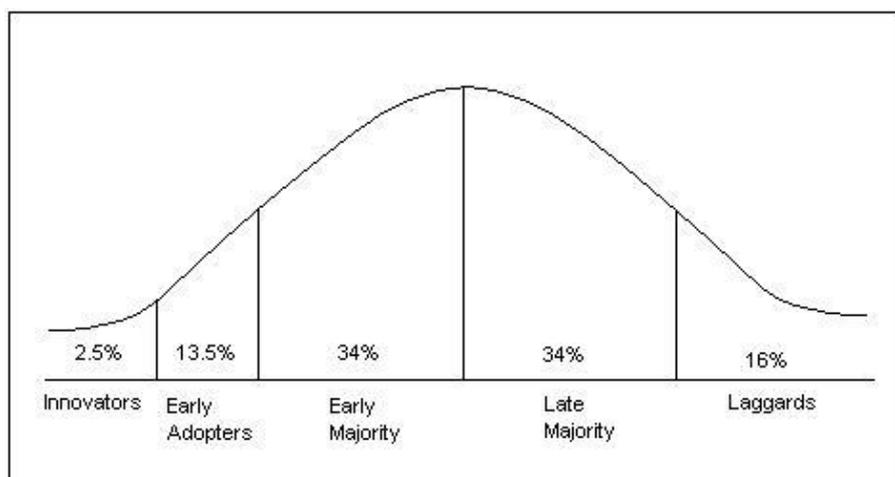
Figure 1 The adoption curve of innovations

This multi-road approach to Open Access is now generally accepted as the way forward: for example, the European University Association states in its Open Science agenda 2025 the need for 'avoiding the dominance of a single Open Access route'. Research libraries in the forefront are transforming the library

acquisition budget to an information budget in order to support OA publishing by the researchers of their institution. This can be seen as a paradigm shift for these libraries: from working on a collection to working on open research communication by creating and managing multiple routes to Open Access. However, we estimate that about half of research libraries in Europe do not offer Open Access services beyond a repository for Green OA (thus the late majority and the laggards in the adoption curve – see figure 1)[1].

ADOPTION OF RESEARCH DATA MANAGEMENT SUPPORT SERVICES BY LIBRARIES

Research libraries have an important role to play in the planning, production, sharing and archiving of FAIR and Open Research data. The increasing importance of research data as a result of the datafication of scholarship and the benefits of sharing research datasets early on (think of the role of data sharing during COVID pandemic) make well-developed infrastructures and practices particularly urgent. We estimate that these roles in research data have been taken up by innovators, early adopters, and some of the early majority of research libraries, but for a large part of the European research libraries this is still mainly uncharted territory. This estimate is corroborated by a survey among European universities that show that 55% to 70% of the 272 universities acknowledge the strategic importance of RDM and FAIR practices, but the data indicate a substantial gap with the implementation (only 15-25% reported a high level of implementation) (Morais et al., 2021). An earlier survey (carried out in 2016) among European research libraries sketches a somewhat more positive situation: 46% of the respondents indicated to have 'consultative research data services' regarding data management plans and 35% has created web guides regarding research data (Tenopir et al., 2017). These 'consultative research data services' frequently involve a personal client-librarian relationship and align with the traditional reference and educational services and as such can be seen as a precursor to more explicit and mature RDM services.

FOCUS AND AIM OF THIS STUDY

Based on the above-mentioned considerations, the aim of this study is to support an acceleration of the adoption process of Open Access services and Research Data Management support services by research libraries throughout Europe. In order to achieve this, the study focused on the organisational perspectives and competencies needed for these services. With this organisational focus, this study aims to build upon earlier studies on Open Science competencies that have focused on the identification of these competencies for research libraries and other service providers and researchers themselves with the eye on providing and/or developing education and training[2].

This leads to the following research questions:

1. What competences does a research library organisation need to possess in order to deliver Open Science services regarding Open Access of scholarly publications and FAIR/Open research data?

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[1] For illustration: of the 9 universities participating in the ENLIGHT university alliance, all have a repository, but only 4 have an OA publication fund, 6 a University press and 5 a publication platform (Schmidt, 2022/2022).

[2] The term 'competencies' is used throughout the report as an encompassing term for skills, knowledge, and abilities.

2. What are effective organisational setups for such Open Science services, including collaboration with other service providers inside and outside the institution? This will include job descriptions and descriptions of the range of services.
3. The study will also investigate how the answers to the questions above can be presented in such a way that it will facilitate research libraries presently without or with limited Open Science services in their portfolio to plan and develop these services further.

This report describes the results of the study itself. In addition, the study will result in a tool kit helping research libraries to develop their RDM support services. This tool kit will be published at the website of [LIBER](#) and [ADBU](#) in the summer of 2023.

EXECUTION OF THE STUDY

This study is commissioned by LIBER (the Association of European Research Libraries) and by ADBU (the Association of directors of University libraries in France).

The study is carried out by Maurits van der Graaf (Pleiade Management and Consultancy), accompanied by an expert group consisting of Christine Okret-Manville (Université Paris-Dauphine-PSL); Thomas Chaimbault (Enssib); Thorsten Meyer (ZBW); Minna Niemi-Grundstrom (Helsinki University); Göran Hamrin (KTH Royal Institute of Technology) and Astrid Verheusen (LIBER) during the entire study period as well as the participation of Sophie Valade (ADBU), Sophie Forcadell (SciencesPo), Veronique Stoll (Observatoire de Paris) for parts of the study period.

The photo on the cover is by Courtney Cook on Unsplash.

2. METHODS

The study was carried out from May 2022 to March 2023 and consisted of the following elements:

- Desk research
- 20 interviews with research libraries with well-developed OA or RDM support services.
- A workshop at the LIBER Winter event discussing preliminary results of the study.
- A group interview with 5 librarians from East and South Europe discussing preliminary results of the study.
- 11 interviews with internal, and (inter)-national stakeholders.

Library interviewees	Contact person
Technical University Delft	Alastair Dunning; Yann Wang
University of Amsterdam	Max Haring
University of Leiden	Michelle van den Berk
University of Leiden	Laurens Sesink
Ghent University	Myriam Mertens
University of Edinburgh	Dominic Tate
University College London	Paul Ayris
University College London	Kristy Wallis
Radboud University Press	Natalia Grygierczyk
European University Institute	Lotta Svantesson
European University Institute	Thomas Bourke
University of Turku	Ulla Nygrén
Library of Mannheim	Sabine Gehrlein
University of Groningen	Christina Elsenga
University of Lorrain	Jean-Francois Lutz
University of Lille	Marie-Madeleine Géroudet
Université Strasbourg	Adeline Rege
Technical University of Berlin	Jürgen Christof
ETH Zürich	Matthias Töwe
Saxion University of Applied Sciences	Sarah Zaunbrecher; Sarah Cooms
Librarians from East and South Europe	
University of Turin	Maria Cassella
Patras university	Giannis Tsakonas
Hungarian Academy of Sciences	Dora Gaalne Kalydy
Spanish National Research Council	Agnes Ponsati
National and University Library Zagreb	Alisa Martek
Internal stakeholders	
Leiden University	Mareike Boon
Leiden University	Krista Murchison
Radboud University Press	Joris Kregting
University of Turku	Kalle-Antti Suominen
Université de Lorraine	Nicolas Fressengeas
ETH Zürich	Henry Lütcke
(Inter-)national stakeholders	

Ministère de l'Enseignement supérieur et de la Recherche	Isabelle Blanc Catali
EOSC	Karel Luyben
cOAlition S	Johan Rooryck
Science Europe	Bregt Saenen
European University Association	Vinciane Gaillard

Table 1 List of interviewees

3. RDM SUPPORT SERVICES

### 3.1 OVERVIEW RDM SUPPORT SERVICES AND FOUR DEVELOPMENT STAGES
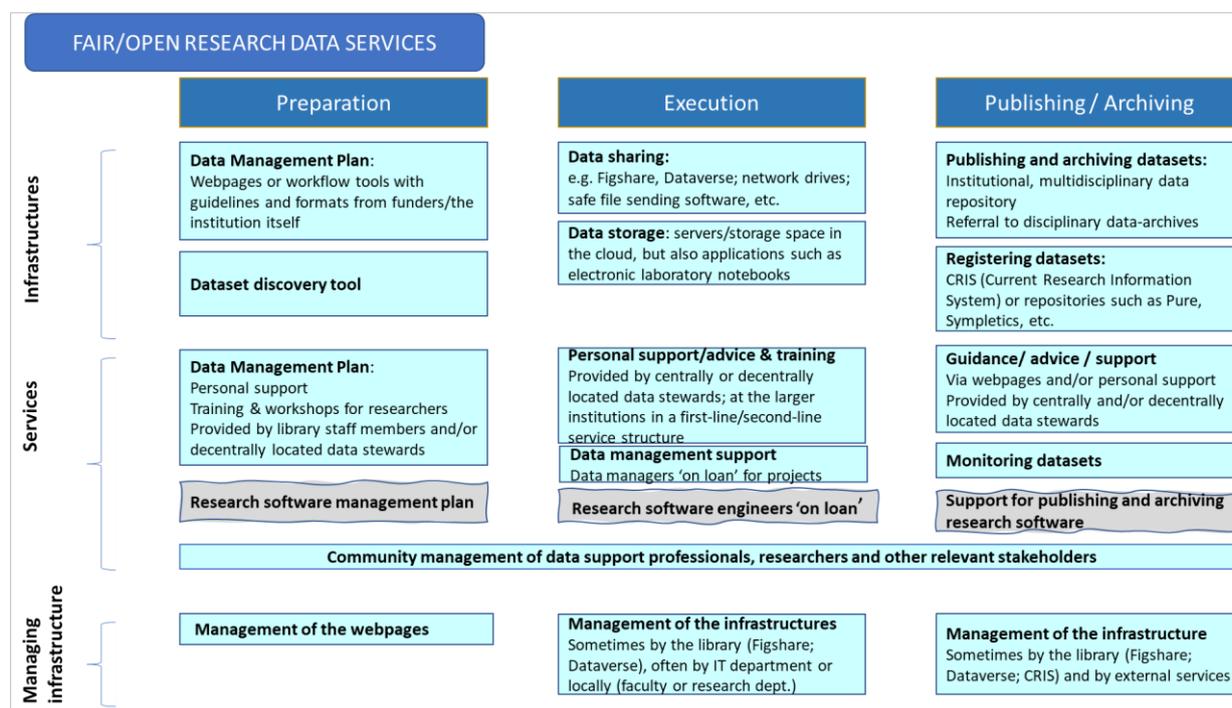
Figure 2 Overview RDM support services

In figure 1 an overview of the RDM support services by libraries is presented[3]. The services are presented along three axes: before, during and after the research project and divided into infrastructures, services, and the management of infrastructures. Below, the services are described in more detail.

BEFORE THE RESEARCH PROJECT

- **Supporting Data Management Plans**: Research libraries help researchers develop data management plans as these are increasingly mandatory by research funding organisations and sometimes by the institution itself. Guidelines and formats are presented at dedicated webpages, or a data management plan tool is provided. With such a tool, the researcher has to fill out questions and the tool provides the researcher with a relevant data management plan. In addition to this, there is personal advice, guidance, and consultancy on data management plans available, by library staff members ('generic' data stewards) and/or by 'embedded' data stewards (see below).

- **Dataset discovery tool or portal**: In some disciplines such as Economics, other Social Sciences and Humanities, libraries traditionally have acquired licences to datasets and therefore offered a discovery tool or portal to find these datasets. One respondent stated that they offer access to

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[3] Other library services supporting research, such as services with regard to persistent identifiers (DOI's; ORCID), bibliometrie, text and data mining and theses and dissertations are outside the scope of this study.

90 datasets, about 80% of them are licensed datasets and about 20% are public datasets. This respondent also notes that sometimes a dataset is important for researchers that is not directly available: in these cases, the library traditionally has negotiated access to this dataset, sometimes for access for one researcher only. In conclusion: for these disciplines, datasets for researchers were traditionally part of the library services and a portal or discovery tool for datasets already existed before the development of RDM support services. It has to be noted however that in other cases, offering a discovery tool for research datasets was part of later stages in the development of RDM services.

DURING THE RESEARCH PROJECT

- **Infrastructures and services for data sharing and data storage:** It is important to note that in an institution without RDM support services, infrastructures for data storage and data sharing are of course provided by the central IT department, by faculties or research departments themselves. However, with the start of RDM support services, a clear overview of the (central) infrastructure is given and in some cases improved with services such as Figshare, Dataverse or electronic laboratory notebooks). These infrastructures are combined with training and advisory services. In many cases, the infrastructures are provided by the IT department of the institution and therefore, the services around these infrastructures are generally delivered in narrow collaboration between the library and IT department: sometimes the library is in the lead, sometimes the IT department.

- **Data management support:**
    - One interviewed library has recently hired two data managers that can be 'on loan' to research projects. Similarly, the IT department has research software engineers 'on loan'. The data managers and research software engineers work directly with research teams and departments and deliver practical support to the researchers. The research software engineers focus on the coding of software, scripts used, et cetera, and are part of the IT department. The data managers focus on data management activities. The data managers and research software engineers have also a mentorship role for researchers and role in training the researchers. For both functions a joint governance of the library and the IT department is in place. There is a coordinator for these positions who is part of the IT department.
    - Another respondent states that since the library has services in the domain of research data management, you also get questions from researchers about the data themselves. This library has recently hired an employee for data support. This is still a try-out situation, focusing on support questions that refer researchers to existing tools or procedures.
    - How will the future of research support develop and what capacity is needed for it? One respondent stated that they have visualised this with the researcher in the middle and in circles the various support functions, such as ethics, software, research data management, policies et cetera. This respondent thinks that although researchers will have in the future more data skills and competences, research support in these various specialised domains will always be necessary. This research support is now often offered in various, rather separate silos and the aim is to integrate these.

AFTER THE RESEARCH PROJECT

- **Supporting publishing, archiving, and registering of dataset**:

- o **Publishing and/or archiving:** After the research project, the FAIR or Open research datasets can be published, archived, and registered. Increasingly, institutional data repositories are set-up and offered to researchers alongside existing, often disciplinary data-archives. There are also alternatives to an institutional repository, such as an institutional space in a national repository (for example recherche.data.gouv in France) or an institutional space in a generic repository such as Zenodo. Libraries without an institutional data repository or an institutional space in a generic repository offer generally a referral service, advising researchers to find their way in the landscape of data archives.

  - o **Registering**: The registering of datasets can be done (alongside publications) in the Current Research Information System (CRIS) or repository of the library. In most cases, this involves only the metadata of the datasets, while the dataset itself in some cases is then automatically deposited in the data repository.

- **Monitoring datasets**: One interviewed library has recently implemented the Data Monitor from Elsevier. By using this monitor, they could increase the number of datasets from researchers of the University that were documented in their CRIS system by a factor eight. This gave them the following insights:

  - o The data repositories that are most relevant for their researchers
  - o Insight in how the datasets have been deposited: this helps them to support researchers to develop a FAIR education strategy for the datasets.
  - o A good overview of datasets produced by research groups and a good accessibility of those datasets is seen as a plus in evaluations of research groups and researchers.
  - o The information gathered from this helps them to form their future institutional data policies.

DURING THE ENTIRE RESEARCH CYCLE

- **Community management**: A Dutch report on data stewardship (Verheul et al., 2019) emphasizes the importance of community forming within the institution among employees and researchers involved in data stewardship. Some University libraries have therefore created a position for community management in order to engage various groups that are involved within the institution.

- **Bottom-up approach**: In relation to the community management mentioned in the developed stage, several respondents have stressed the importance of bottom-up approaches: one library has created a network of researchers that function as ambassadors on research data management. They have now about 20 data champions who spread the word to their colleagues. This network came up with a proposal for an e-lab notebook: an electronic version of laboratory notebooks, which researchers can use to document everything in it from the start of the experiments. This will greatly improve the quality of datasets and facilitate the eventual depositing in a data repository.

SERVICES REGARDING RESEARCH SOFTWARE

- A number of libraries in the forefront are expanding their RDM services to research software. One respondent stated: 'research software is a new frontier for libraries to be crossed'. See for more details paragraph 3.6.

EVOLVING ECOSYSTEM FOR RDM SUPPORT

There is quite a body of literature about tasks and functions regarding research data management (RDM). The reason for this is that this consists of new tasks, parts of which are discipline- agnostic, while other parts are discipline-specific.

A landmark report by EOSC (Directorate-General for Research and Innovation (European Commission) et al., 2021) describes 10 actors/roles that are necessary for a FAIR and Open research data infrastructure. Five of these roles are deemed relevant for libraries. These roles are: policymaker, data steward/data librarian, data curator, educator/trainer, and data scientist/data analyst[4]. However, none of these roles are seen as exclusive to libraries. The message of this report is that it is key to develop an adequate RDM support ecosystem in collaboration with various stakeholders.

SIX JOB CATEGORIES RELEVANT TO LIBRARIES

In the interviews of this study, six job categories with regard to RDM support services within the library were mentioned. These job categories are described in more detail below.

DATA STEWARD/DATA LIBRARIAN:

A report (Verheul et al., 2019) has worked out in more detail the roles and tasks of data librarians/data stewards and makes a distinction in three task areas for this job category (see figure 1):

- policy, strategy, and coordination
- generic and advisory
- embedded and operational
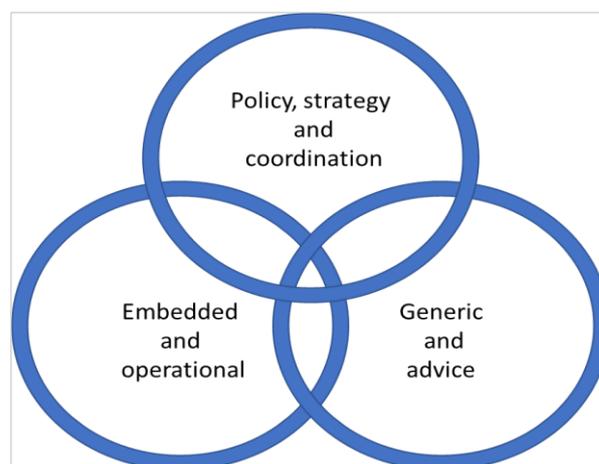
Figure 3 Three task areas for data stewards

The distinction between generic data stewards and 'embedded' data stewards is also mentioned by the interviewees:

- **The generic data steward or data librarian** is generally positioned within the library and helps researchers with all kinds of data related questions and refers them to others if necessary. He/she supplies information and training with regard to policy requirements and guidelines and helps to draw data management plans. In other words, the generic data steward is a centralised knowledge and communication hub for researchers. In practice, the coordinator of those

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[4] This last role ('consumes data and contributes with data analytic services') was however never mentioned in the interviews carried out for this study.

centrally located data stewards generally is more involved in policy-making, while the other data stewards are more involved in delivering consulting services.

o **The embedded data steward** is familiar with the specific needs of fellow researchers within the research unit/the relevant domain and translates generic data policy to practical implementation. The embedded data steward is often embedded within a faculty or research unit and has knowledge about the type of research data used within the disciplines of that faculty.

In practice, not all libraries have labelled the positions with these tasks as 'data steward' or 'data librarian': they use the more traditional label 'information specialist' or other labels.

DATA MANAGER

The above-mentioned embedded data steward have mainly advisory and educational tasks, but in some cases the library services are expanded in order to take on a more operational role: as an example of this, the library of the Technical University of Delft has recently employed two data managers who are available ('on loan') for data management tasks within a research project (van Gend & Zuiderwijk, 2022). The aim is to take research data management tasks out of researchers' hands.

EDUCATOR/TRAINER

Training, workshops, and other educational activities are often carried out by the above-mentioned data stewards. However, at some universities a specific position has been created for this: for example, the library of the University of Amsterdam has a coordinator Digital Skills who organises professional training on a broad area of digital skills, data management, data science and software development. These training programs are sometimes developed by the library themselves, but also from other parties such as The Carpentries.

DATA CURATOR

This position is related to a data repository or data archive and also depends on the level of quality assurance of the data repository. After a researcher has uploaded his dataset, the data curator will conduct a number of quality control checks before the database is accepted and available in the data repository. Checks are carried out on the file format, the completeness of the files, the data file contents and structure (such as the English language, tabular datasets with legible headers and labels et cetera), if the data contain sensitive information (personal information et cetera). In addition, the metadata will be reviewed, and additional metadata will be suggested. Finally, the data curator will check and advise on the licence of the dataset (Digital Science, 2021).

French institutions can create an institutional space in the French national data repository recherche.data.gouv.fr. They describe two groups of tasks for managing this institutional space: administrative tasks and data curator tasks. The workload between those two tasks is equally divided and related to the number of deposits per week: for example, for < 25 deposits per week, both tasks will take 0,2 FTE.

From the interviews with libraries with RDM services, it appears that the position of data curator is sometimes a separate position while in other cases these tasks are carried out by the data stewards.

COMMUNITY MANAGER

As stated earlier, some University Libraries with developed services on RDM have recently created a position for community management in order to engage various groups related to RDM within the institution. The community manager at 4TUResearchData, an international repository for science engineering and design research data of four Dutch universities might serve as an example. The focus of this community manager is to engage researchers and data support professionals about data management and to bring discipline-specific communities together to stimulate the creation of FAIR data through use of the 4TUResearchData repository (Digital Science, 2021).

COMPETENCES

Technical competence areas related to RDM library services (listed following the data life cycle)	
General	1. Knowledge about the structures of higher education and about how research and researchers work (a background in research might be required)
Planning and design	2. Composition of research datasets 3. Data policies (institutional, funder, national) 4. Fair data principles 5. Data life cycle 6. Data Management Plans 7. Research integrity, ethics and GDPR regulations 8. Pseudonymization and anonymization of data 9. Knowledge of the landscape of data repositories and data archives 10. Metadata of datasets
Data collection and management	11. Data creation and interoperability 12. Searching data sources
Data description	13. Metadata for digital collections and datasets
Data formatting and storage	14. Institutional infrastructures for storing and saving data
Data quality assurance	15. Knowledge about cleaning data 16. Data curator competences (related to (2) and (10)
Data processing and analysis	17. Data analysis and visualisation
Data archiving	18. Archiving and preserving data
Publishing and discoverability	19. Copyright and intellectual property 20. Licensing of research datasets 21. Reproducibility and reuse of data 22. Data discovery tools
Personal competences/ soft skills for RDM support professionals	
• Communication skills (including a certain robustness when encountering resistance/reluctance from researchers) • Advisory skills • Pedagogical competences • Service orientation • Ability to translate practical issues into protocols, services, and policies • Connecting role, ability to build and maintain/manage networks	

Table 2 Overview competences RDM support professionals

In table 2, the technical competence areas related to RDM services offered by libraries - resulting from this study – are listed together with the personal competences/soft skills for RDM support professionals as described by respondents. For the technical competence areas, one can distinguish three levels related to the role of the RDM support professional:

- **Generic, discipline-agnostic competencies**: These relate specifically to centrally located RDM support professionals, who are often part of the second-line support in case there is a first-line support. These professionals need to have a generic, discipline-agnostic knowledge about these areas. Function names often are data librarian, (generic) data steward or research data coordinator. Their tasks are mostly advisory and educational. An exception might be formed by data curators of a data repository, who need technical, operational skills in metadata production and technical insight in the composition of research datasets.
- **Discipline-oriented RDM competences**: These relate specifically to first-line RDM support professionals that are often embedded in faculties and/or research departments. These professionals need to have discipline-related knowledge about research data. Function names are often information specialists, data librarians or data stewards. Their tasks are mostly advisory and educational. If there are technical, operational skills needed, these relate mainly to metadata and depositing procedures.
- **Operational competences**: These relate specifically to RDM support professionals who are (temporarily) part of a research team and carry out operational tasks with regard to data management. The most-used function name is data manager, sometimes data scientist or data steward is used. These professionals need to have operational data skills in these competence areas.

In table 3, an overview is presented of the three levels of RDM competences and the five job categories.

Job title	Generic, discipline-agnostic RDM competences	Discipline-oriented RDM competences	Operational RDM competences
Data steward (generic)	V		
Data steward (embedded)	V	V	
Data manager	V	V	V
Educator	V	(V)	
Community manager	V		
Data curator			V

Table 3 Matrix RDM positions and competences

3.3 INITIAL STAGE RDM SUPPORT SERVICES

OVERVIEW SERVICES
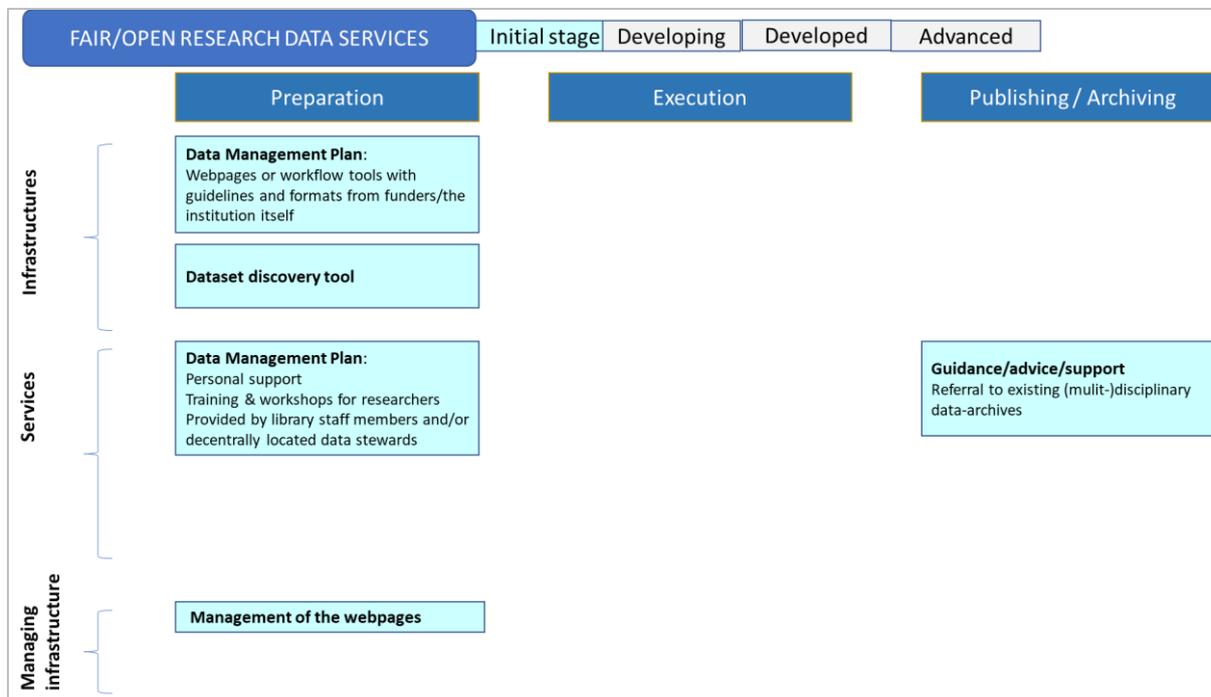
Figure 4 Initial stage RDM services

Research funding organisations increasingly demand data management plans (DMP) for the research projects they finance. This often has triggered research libraries to start developing services in the research data management area. A few aspects of this initial stage:

- **Somewhat hidden RDM services are already there**: Various respondents have described that information specialists and faculty liaison libraries often already supported researchers in individual cases with research data management. Therefore, part of developing the RDM services was to spread knowledge and competences among more colleagues in the library and make it a more official, visible service to the institutional researchers' community.
- **Senior management buy-in**: Library directors discussed the issues around research data management in the institution with the senior management in order to get support to start services in this area. Many respondents do see senior management buy-in as a prerequisite for developing RDM support services. One interviewee however mentioned that in the beginning, there was little resonance with regard to the importance of research data management among the senior management. However, over the years, they became convinced and now they fully support the encouragement of Open Science within the University.
- **Institutional data policy now or later?**: A number of RDM services have started based on the formulation of the institutional policy on research data management by the senior management. This policy statement is often initiated by the library and once an institutional FAIR data policy is in place, this gives the library RDM activities more leverage vis-à-vis researchers. However, another respondent states that they have developed the services first and then – with adequate

infrastructures and services in place – have implemented an institutional policy. Another respondent concurred: he stated that with adequate services in place, the implementation of a data policy by researchers is more professional and sustained.

- **Survey among researchers**: A survey among researchers about how they manage their research data now and what kind of obstacles they encounter can also help to get us senior management buy-in and simultaneously lie a basis for the development of RDM infrastructures and services. In another case, an official audit ordered by the senior management was the start of the development of the RDM support structure.
- **Data management plans**: Most research libraries have started their RDM services with support for data management plans: web pages describing the requirements by research funders, followed by introductory courses about data management plans and in some cases by providing a template or other tools for composing data management plans.
- **Referral to existing data repositories/data-archives:** Guidance (in the form of webpages and advice) to refer to existing data repositories and data-archives is often part of this initial stage and relatively easy to realise as this easily fits in other referral services from the library.
- **Dataset discovery tool**: As stated earlier, such a discovery tool or portal for datasets can be traditionally part of the services of libraries focusing on economics, other social sciences and/or humanities. In other cases, such a discovery tool often becomes part of the RDM support services in the developed/advanced stage.

ORGANISATIONAL STRUCTURE

Some respondents noted that at this initial stage, the RDM services were part of the portfolio of the information specialists dedicated to supporting researchers. Other respondents stated that they dedicated one colleague for RDM support and/or hired a data librarian.

COMPETENCES NEEDED

For the RDM services at this initial stage, generic, discipline-agnostic technical competences with regard to the entire data life-cycle are necessary. One respondent describes a gradual upskilling in line with the gradual development path of their services. This respondent stated that regarding metadata production, the competences are already available in the library, it only requires an adaption to other formats and standards for research datasets. With regard to the other RDM support services, the respondent states that 'you have to make steps', but 'it is not a different world'. They gradually developed their competences by attending professional conferences and liaisons with other libraries. A similar situation is described for another university (Mertens, 2020): they started with self-study, group discussions and meetings before starting outreach to the faculty. Similar comments have been made by other respondents: the above-prescribed competences are generally seen as related to the competences that are available within the library organisation and the part regarding research datasets can generally be 'learnt on the job' and in exchanges with other RDM support professionals from other libraries.

3.4 DEVELOPING STAGE RDM SUPPORT SERVICES
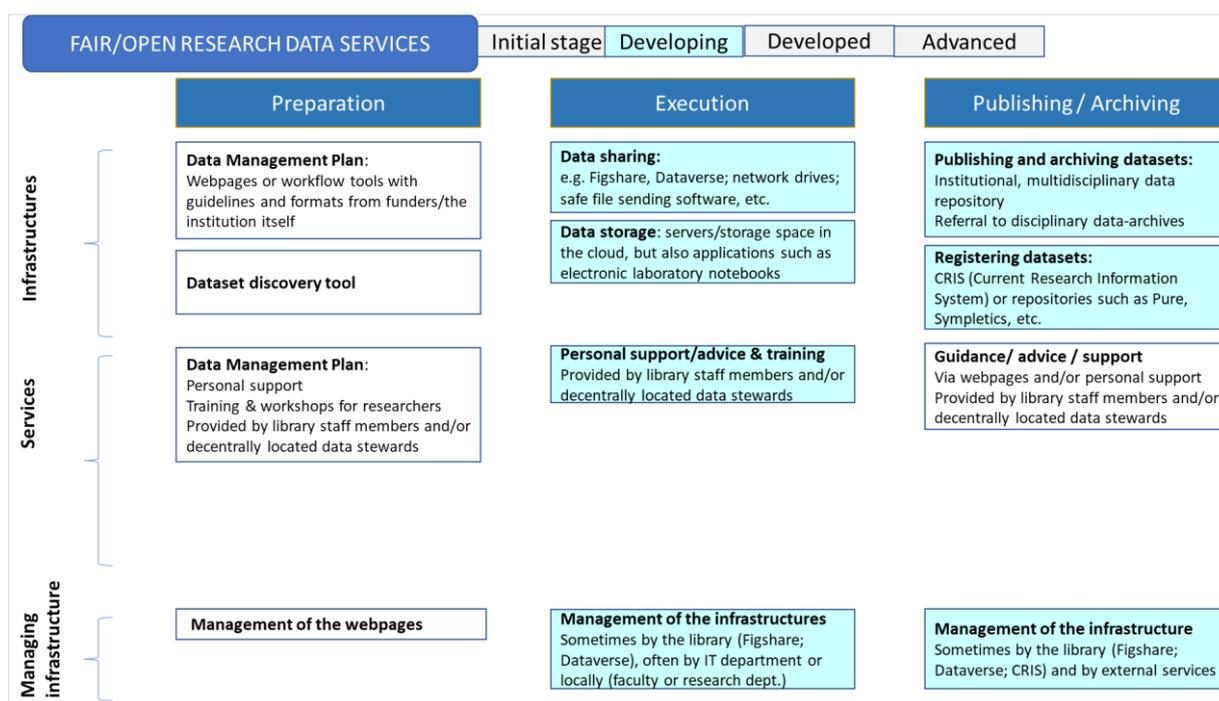
Figure 5 Developing stage RDM services

The developing stage of RDM services is characterised by:

- **Data management plan**: The DMP services often are further developed by offering an institutional template for a data management plan or a DMP tool that guides the researcher through the formats of the research funder(s) that are relevant for the research project.
- **Infrastructures and services for data sharing and data storage during the research project:** As stated earlier, without specific RDM services, universities, faculties, and research departments have of course infrastructures for data storage and data sharing for researchers. At this stage of the RDM services however, a clear overview of the (central) infrastructure is given (and in some cases improved) and combined with training and advisory services. As these infrastructures are often managed by the IT department of the institution, these services are generally delivered in narrow collaboration between the library and IT department: sometimes the library is in the lead, sometimes the IT department (see also Töwe & Barillari, 2020).
- **Institutional data repository:**
  - An institutional data repository (or an institutional space at a shared data repository) is seen as an important next step in the development of the RDM services. One respondent stated: 'With the data repository, we could offer a solution to the researchers, and this triggered the development of various services around the data repository'. Depending on the quality control procedures implemented for the data repository, this also might involve data curation and thus data curation competences (see below). At one university, the library was involved with the front-end of the data repository, the computing department for the back-end: the data curators were part of the back-end.
  - In addition, some universities developed special securitized data repositories to store very sensitive research data, sometimes called a data vault or a data safe haven (Rice, 2022).

- **Registering datasets:** Many European research libraries have a CRIS system in place: a Current Research Information Systems that is used to register and report the research output of the institution. These CRIS systems are adapted so that research datasets can be registered as well. When a publication is registered in a system, the full text is often simultaneously deposited in a repository. A similar workflow sometimes is developed for research datasets: registering in the CRIS, depositing in the data repository.

ORGANISATIONAL STRUCTURE

The organisational structure for the RDM services in this phase is characterised by centrally located in the library and an intensive collaboration with the IT department, the data protection officers, the ethics board, the research office, and the technology transfer office (TTO). The support professionals of the library often take a coordinating role here to connect all the stakeholders.
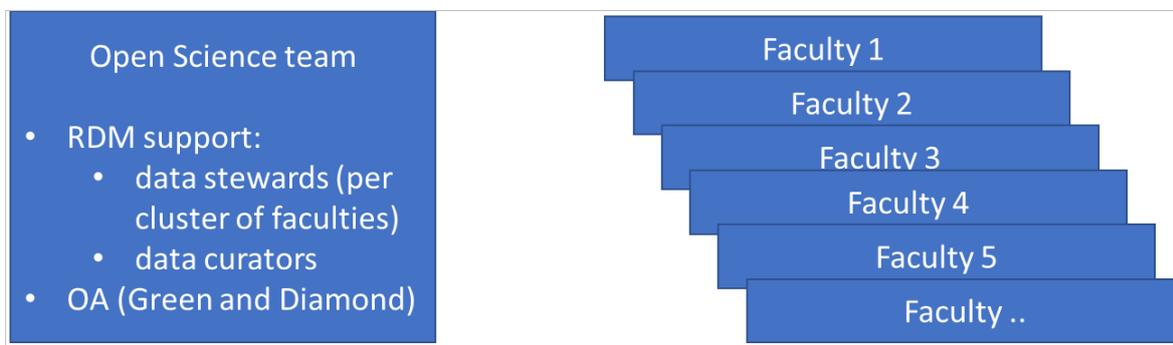
Figure 6 Sketch example of specialisation: an Open Science team at a library

Inside the library organisation, many libraries choose **specialisation**: the librarians delivering these services are in these cases grouped together in units with labels such as research data centre or research data service, digital competence centre, or combined with the Open Access services in one unit: Open Science team, Centre for Digital scholarship, Research Services or Academic Services unit or department (see figure 6).

Figure 7 Sketch example of integration

However, one interviewed library chose **integration** as the organisational route (see figure 7): they had a team of 4 to 5 FTE dedicated to Open Science support, but the other staff members of the

library were not involved and many of those did not really believe Open Science was a task for libraries. Review of the library organisation led to the recommendation to spread Open Science knowledge among the greater part of the library organisation. Now, they have formed four subject groups (Humanities, Social Sciences and Education, Law, and Business administration, and STM). Each unit has 4 to 6 information specialists who deliver the entire portfolio of library services to the faculties. In other words, Open Science is now integrated in the work of all information specialists, some have developed a deeper knowledge while others only have a basic knowledge.

It has to be noted that the management of the data repository is often carried out by another library department as is the metadata production for the data repository.

COMPETENCES NEEDED

From the interviews with many respondents, it becomes clear that the competences needed for developing RDM services at this stage (and at the next development stage) are becoming increasingly different from the competences of 'traditional' librarians. Several respondents noted that – when recruiting – they look for:

1) Research background, for example a PhD
2) Communication and relational skills
3) Data skills and experience/knowledge about research data.

This combination is difficult to find as there are no data librarian/data steward courses available. One respondent notes that the competences (1) and (2) are essential, because without (1) it is difficult to make a good start in this position and without (2) you cannot adequately communicate with the researchers. The competences mentioned under (3) can be learnt on the job if necessary.

In addition, some specialisation in (groups of) disciplines is seen in the RDM support professionals, meaning that although most competences are still generic and discipline-agnostic, increasingly discipline-oriented RDM competences and some operational RDM competences are needed.

3.5 DEVELOPED STAGE RDM SUPPORT SERVICES
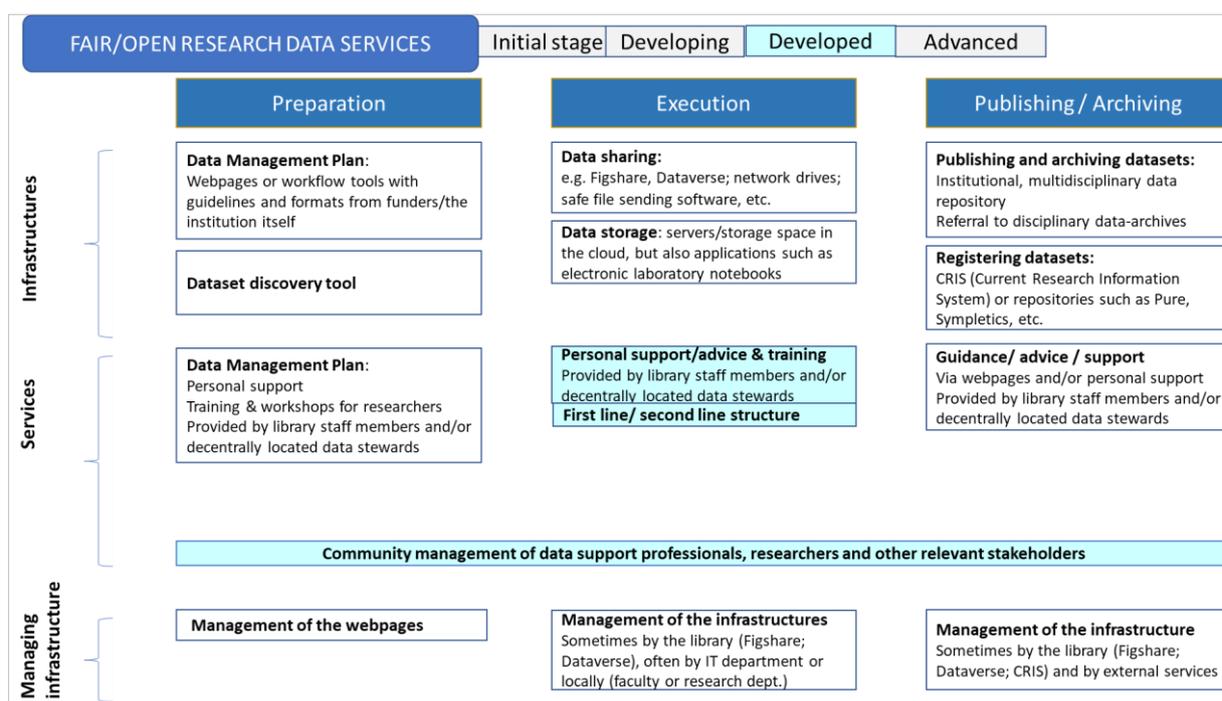
Figure 8 Developed stage RDM services

The developed stage of RDM support services is characterised by:

- **First-line/second-line service structure:** Research libraries with RDM support services at the developed and advanced stages have generally setup this with a first-line/second-line service structure:
  - A first-line support with decentrally located data stewards/data librarians, often embedded in/dedicated to a faculty or research department. Sometimes these embedded data stewards are employees of the central library, sometimes they are employed by the faculties themselves.
  - A second-line support team – centrally located – which has a coordinating role and takes care of complex questions that involve many stakeholders. In addition, the central team guarantees the continuity by training newly arrived data stewards, following the evolving data policies and requirements from research funding organisations and creating generic training modules to which faculty data stewards can add disciplinary information (see also the text box below).

Function of the second line service from the perspective of an embedded data steward

- Complex questions or questions about new methods that the embedded data steward cannot answer
- The central library has an overview of what happens at all the faculties and can refer to similar issues in other faculties
- Collaboration on training
- Replacement in case of absence
- RDM support information on the website of the central library (so no need for information provision at the level of the faculty)
- Help in translating the University-level data policies to faculty-level data policies.

- **Community management:** As the number of RDM support professionals and related individuals within an institution is in this stage growing, a number of research libraries have started to take on a community manager in order to connect and manage the community of these professionals within the institution.

ORGANISATIONAL STRUCTURE

Second line support

RDM support:
- Coordinator
- Generic data stewards
- [Data managers]

First line support

Embedded data steward(s) at Faculty 1
Embedded data steward(s) at Faculty 2
Embedded data steward(s) at Faculty 3
Embedded data steward(s) at Faculty 4
Embedded data steward(s) at Faculty 5
Embedded data steward(s) at Faculty 6
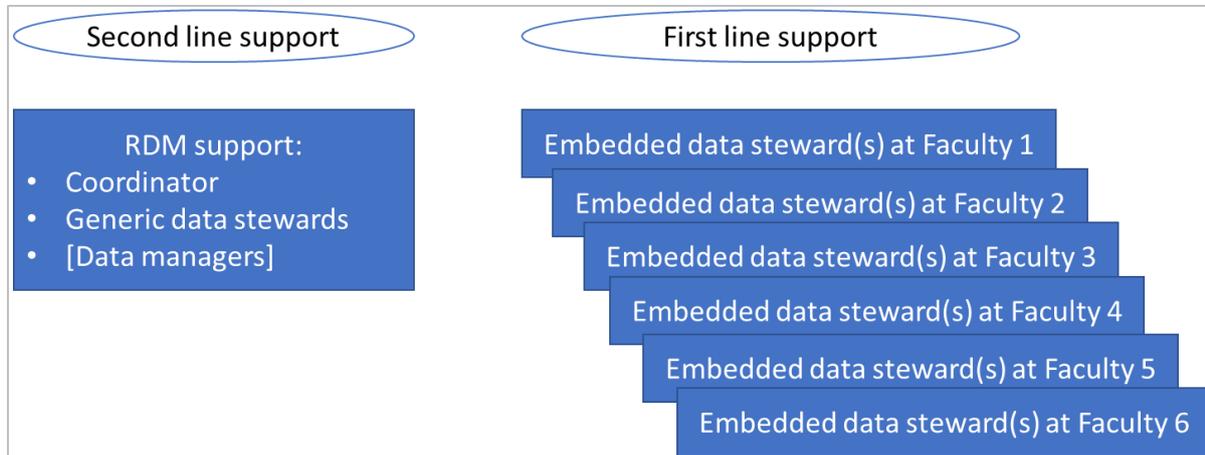
Figure 9 Sketch first-line/second-line service structure

The first-line/second-line service structure has been described above and is sketched in figure 9. It is noteworthy that many respondents stated that this distributed model seems the most appropriate for RDM support services at larger universities or research institutions. One University even mentioned to have a similar setup for services regarding data privacy and advice on research subsidies. This in contrast to the OA services in their advanced stage, for which a central service structure that delivers to the entire institution is generally seen as the most appropriate[5].

Several respondents remarked that the role of data steward at the faculty takes some time to be accepted and recognised. One respondent: 'In the beginning, there was not a good understanding of the role of data stewards, therefore a lot of outreach activities took place to heads of departments, researchers, and others. This was necessary to create a mutual understanding of the role. Gradually, the data steward established its role and now this role is generally recognised and accepted'.

Some respondents – aware of the first-line/second-line service structure at some universities, emphasise the importance of starting with a central team in which the staff members work together to build up expertise and experience in this domain.

COMPETENCES NEEDED

In this first-line/second-line service structure, the staff members in the first-line need discipline-oriented competences and (depending on the nature of the support function) some or many

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[5] Some Dutch universities do have CRIS-coordinators per faculty, who can give general support and can validate the data entered by the researchers of that faculty.

operational competences. One respondent stated that they recently hired a new colleague for RDM support services. They see three competences crucial for this function:

1) Knowledge about the structures of Higher Education and about how research works
2) Communication and relational skills in combination with a certain robustness vis-à-vis resistance or reluctance from researchers (in French 'savoir-être – 'ability to fulfil the required role')
3) Data skills and experience/knowledge about research data.

This respondent stated that the competences mentioned under (1) and (2) are crucial: without (1) it is difficult to make a good start in the position as data steward and without (2) it is difficult to adequately communicate with researchers. The more technical competences mentioned under (3) are preferable, however it is also possible to learn them on the job if you have enough curiosity. Another respondent made a similar statement. As there is no formal training for data stewardship , they looked for research experience in the relevant disciplines and interest in RDM in the first place.

3.6 ADVANCED STAGE RDM SUPPORT SERVICES
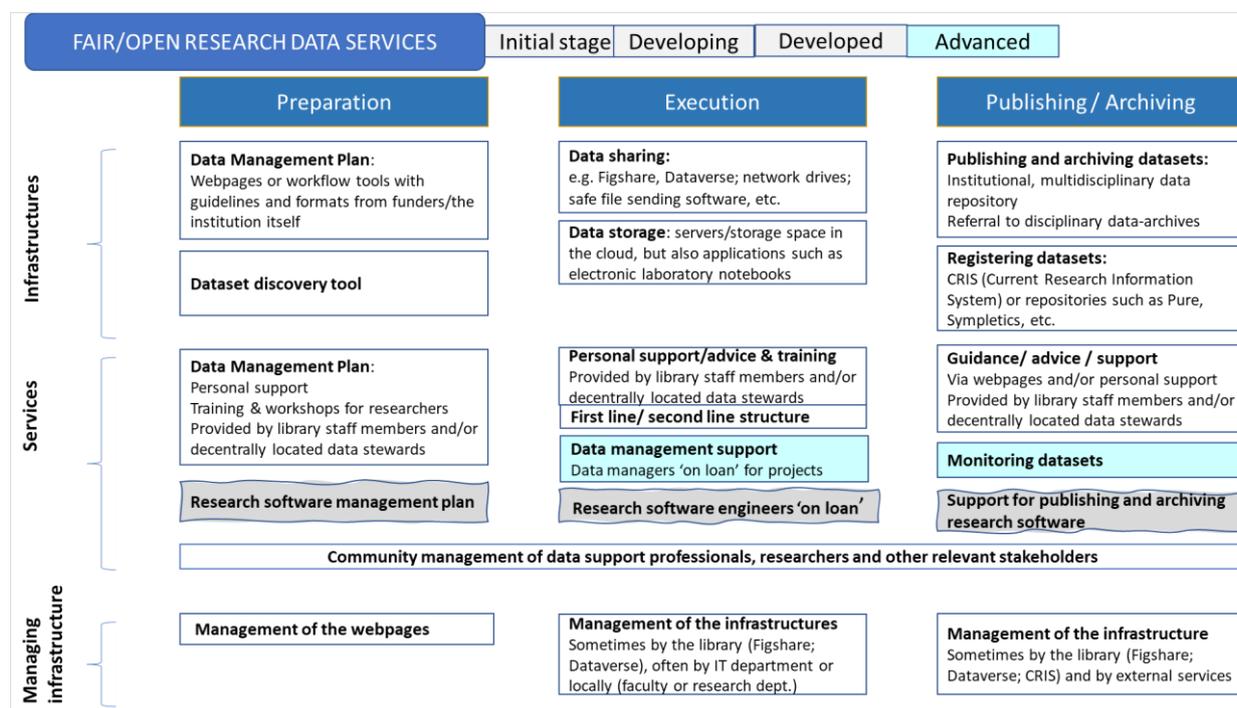
Figure 10 Advanced stage RDM services

The advanced stage of the RDM support services is characterised by:

- **Monitoring datasets**
- **Data management support**
- **Bottom-up approach**

These are already described in paragraph 1.1.

A number of libraries with RDM support services have also started to expand their services to **research software**:

- One respondent stated: 'What is research software? Scripts used in R or SPSS are generally deposited as part of the datasets. However, "real" research software, with a steady state version, needs a good description on how you can use it so that reuse becomes possible'.
- At Leiden University, the research software management expertise group is at this moment in an explorative stage. The purpose of data sharing is to enhance the reproducibility of the research. The research software that is developed for a specific research project (such as codes, scripts et cetera) are also an important part of the reproducibility of a study. As most attention goes to research data management, it was strongly felt that it is necessary to give specific attention to research software. As a start, they have recently developed a template for research software management plans (Martinez-Ortiz et al., 2022). One can see this as a new branch of the Open Science tree. It is actively stimulated by the Dutch funder NWO as a considerable percentage of the research grant submissions contains software development while NWO presently has no requirements for this.

- At the University of Lorraine, an operational committee for research software will start in 2023. It is certain that the library has a role here, as there are metadata and licences needed, but it is unclear if the library will take the lead in this domain. While publications are within the territory of libraries, and research datasets can be seen as an extension of publications, software is the much more unfamiliar terrain for librarians, which might mean a larger role for the IT department.
- At the Technical University of Delft, the position of research software engineers has been recently simultaneously created with the position for data managers. The proposal to create these functions in the framework of the Open Science program at the University was accepted. and is now implemented. The data managers are part of the library, the research software engineers are part of the IT department. They work together as part of the [Digital Competence Centre](). Both work directly with research teams and departments and deliver practical, operational support to the researchers. The research software engineers focus on the coding of software, scripts used, et cetera. The data managers focus on data management activities. The data managers and research software engineers have also a mentorship role for researchers and role in training the researchers. For both functions a joint governance of the library and the IT department is in place. There is a coordinator for both positions who is part of the IT department. This is seen as part of an ecosystem of support professionals with the library in the lead. The goals are to bring about a cultural change among researchers and to increase the competences of the researchers in this domain in order to enable them to do more themselves.

4. DEVELOPMENT STAGES FOR OA SUPPORT SERVICES

### 4.1 OVERVIEW OF THE OA SUPPORT SERVICES
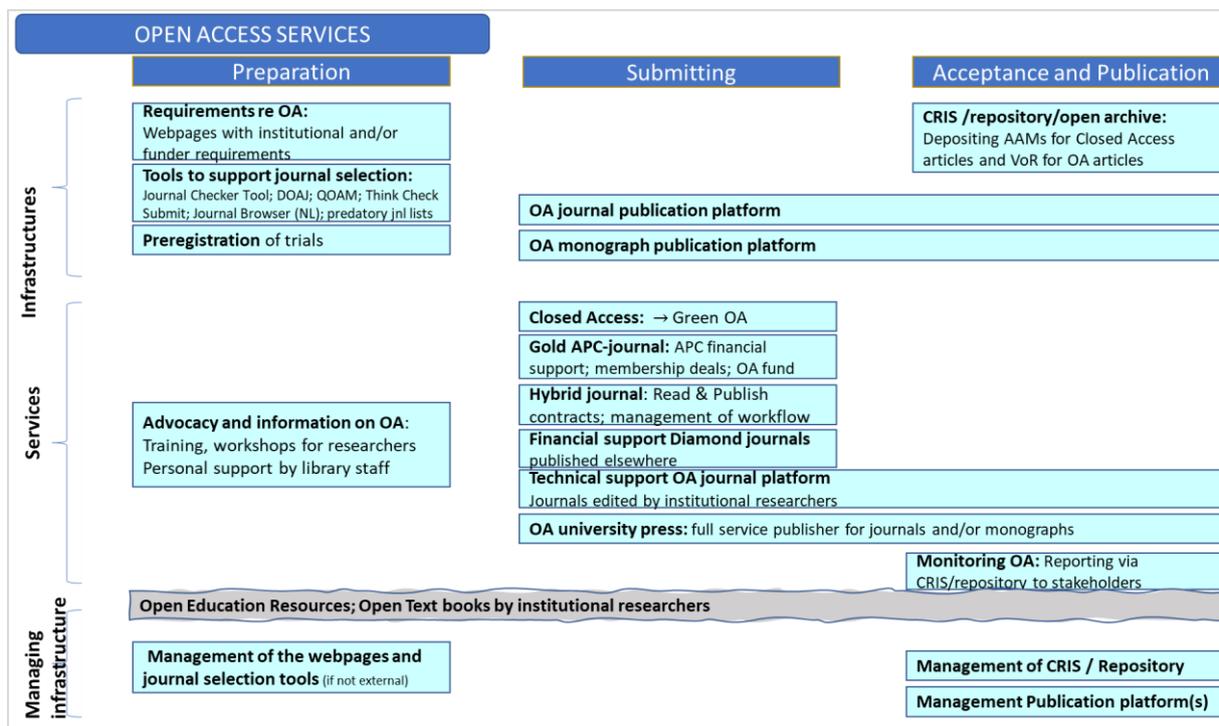
Figure 11 Overview Open Access support services

In figure 7 an overview of the OA support services by libraries is presented. The services are presented along three axes: preparation, submitting and acceptance & publication and divided into infrastructures, services, and the management of infrastructures. Below, the services are described in more detail.

PREPARATION PHASE

- With regard to infrastructures, there are web pages with requirements from the institution or funders with regard to Open Access publications. In addition, there are a number of tools to help researchers selecting relevant journals for submitting the paper. In addition, for (pre-)clinical trials information is presented on how to pre-register these studies. These webpages and – if managed by the library itself – the journal selection tools have to be managed and kept up to date.
- Training, workshops, and personal support on Open Access is given by library staff members.

SUBMITTING PHASE

- Libraries do provide support for the various types of Open Access. One of the earliest services by libraries is the repository service, where researchers can deposit the version of their published articles that is allowed by the journal publisher. This is for articles published as Closed Access in the journal often the Accepted Author Manuscript – AAM (the so-called Green Open Access option) – and for Open Access articles the Version of Record (VoR). The implementation of

institutional repositories by libraries started around the year 2000 and showed a rapid increase since then (van der Graaf, 2009). In addition, libraries provide financial support to authors of publications in Gold OA journals or of OA books via Open Access funds and increasingly leverage their budgets dedicated to journal subscriptions for so-called Read & Publish deals, whereby articles by (corresponding) authors of their institution will be published Open Access in subscribed Hybrid journals (the HybridOA option). Finally, there is the recent push for supporting Diamond OA journals by research libraries, either by financial support (for example the SCOAP journals) or by offering publishing services Diamond journals or books. All Open Access types (Green, Gold, HybridOA and Diamond) bring their own tasks and require specialists within the library:

- o Green OA: repository managers, metadata specialists
- o Gold OA: OA fund managers
- o Hybrid OA: Read & Publish license managers and librarians who manage the ensuing workflows (checking the authors affiliation and permitting the OA publication of the article under the contract)
- o Diamond OA: Diamond publishers.

ACCEPTANCE AND PUBLICATION:

- Most European research libraries operate a repository and have workflows in place to support and stimulate depositing of research output, such as Green OA articles in the repository. The repository can be institutional but also a national repository, such as HAL in France. Some institutions have the repository function included in a so-called CRIS system – a Current Research Information System. CRIS systems aim to register all research output of the researchers of the institution. Sometimes this means that the research output itself is deposited in the system, sometimes only the metadata are registered with a link to the research output archived elsewhere.

- The repository and/or CRIS system is used to monitor Open Access, which can be a task for the library in order to report to the senior management the progress with regard to Open Access. In addition, CRIS systems are increasingly used for other types of reporting, such as for research assessment purposes.

4.2 OVERVIEW JOB CATEGORIES AND COMPETENCES

INSTITUTIONAL REPOSITORIES FORM THE BASIS FOR MANY OA SERVICES

With regard to Open Access of publications, many research libraries have implemented an institutional repository for scholarly publications 10 to 20 years ago. This has led to widespread competencies within research libraries regarding repository management as well as knowledge about copyright and insight in scholarly publications of the authors of their institution. Therefore, newer Open Access services (such as an Open Access fund or Read & Publish agreements) could build on these existing competencies and expertise. In addition, many of the other Open Access services can be seen as an add-on on existing library services: licence management of subscriptions is extended to licence management of Read & Publish agreements. Workflows around these Read & Publish agreements focus on assessing the eligibility of authors, which is closely related to workflows related to repository management. This is also true for managing an Open Access fund for APC compensations.

However, research libraries that recently have started a library publishing programme focusing on Diamond publishing often hire staff with publishing background according to some interviewees. In these library publishing programs, the librarians bring insight and guidance on Open Access and Open Science, the professionals with the publishing background bring expertise in editorial and production workflows as well as a network of reviewers, typesetters et cetera to the table. One respondent: 'the marriage of those two skill sets is the basis for the success of our University press'.

FIVE JOB CATEGORIES

The positions involved in Open Access services by research libraries can be categorised in five categories:

1. **Digital Scholarship librarian/other librarians in front-office functions**: Providing training and workshop for researchers and personal advice, guidance, and consultancy on Open Access.
2. **CRIS and/or repository manager**: Managing the workflows around the CRIS and/or repository systems, including monitoring and reporting using the systems.
3. **Open Access fund manager**: Staff member dedicated to managing the Open Access funds that compensates APCs of articles by the authors of the institution according to the eligibility criteria of the fund.
4. **Read & Publish licence manager**: Licence management of Read & Publish agreements, including the workflows that determine the eligibility of articles under the agreements. Publishers increasingly provide dashboards in order to support these workflows.
5. **Publisher Diamond publications**: There are two forms of library publishing programs for Diamond publications:
   - The library offers a publishing platform for Diamond OA journals. The library offers technical support and support when setting up a journal. The requirement is often that one of the editors of the journal should be a researcher at the institution of the library.
   - A full-service OA publisher, which focuses on publishing Diamond journals and/or Diamond academic books (monographs, edited volumes and/or open textbooks).

In table 5, we combine competences found in this study and in the literature (see Appendix B) with the five functional categories as described above.

Technical competence areas related to OA services	
General	1. Knowledge about the structures of higher education and about how research and researchers work (a background in research might be required)
Related to OA services	2. Scholarly publishers' landscape (business models of publishers; journal types 3. Knowledge of open publication options (green, gold, hybrid, diamond OA) 4. Knowledge of Open Science, policies, funder requirements 5. Copyright and intellectual property in the digital environment 6. Digital scholarly communication landscape (aggregators, search engines, preprint servers, journal platforms, metadata, digital identifiers, metrics, et cetera)
Technical competence areas specific per position	
Digital Scholarship librarians/information specialists in the front-office	See soft skills
CRIS and/or repository manager	7. Development, management, and use of the CRIS/repository: technical and workflows
Open Access fund manager	8. Workflows related to the OA fund (e.g., determining the eligibility of authors)
Read & Publish licence manager	9. Negotiating skills 10. Workflows related to Publish & Read contracts (e.g., determining the eligibility of authors) 11. Licence management
Publisher Diamond publications	12. Editorial workflows including author workflows and reviewer workflows 13. Copyediting workflows 14. Production/publication workflows 15. Distribution channels for printed books 16. Catalogue management
Personal competences/ soft skills (relevant for most of these function categories, but especially for the front-office functions)	
• Communication skills (including a certain robustness when encountering resistance/reluctance from researchers) • Advisory skills • Pedagogical competences • Service orientation • Ability to translate practical issues into protocols, services, and policies • Connecting role, ability to build and maintain/manage networks	

Table 4 Competences related to OA services as proposed by this study

4.3 INITIAL STAGE OA SERVICES
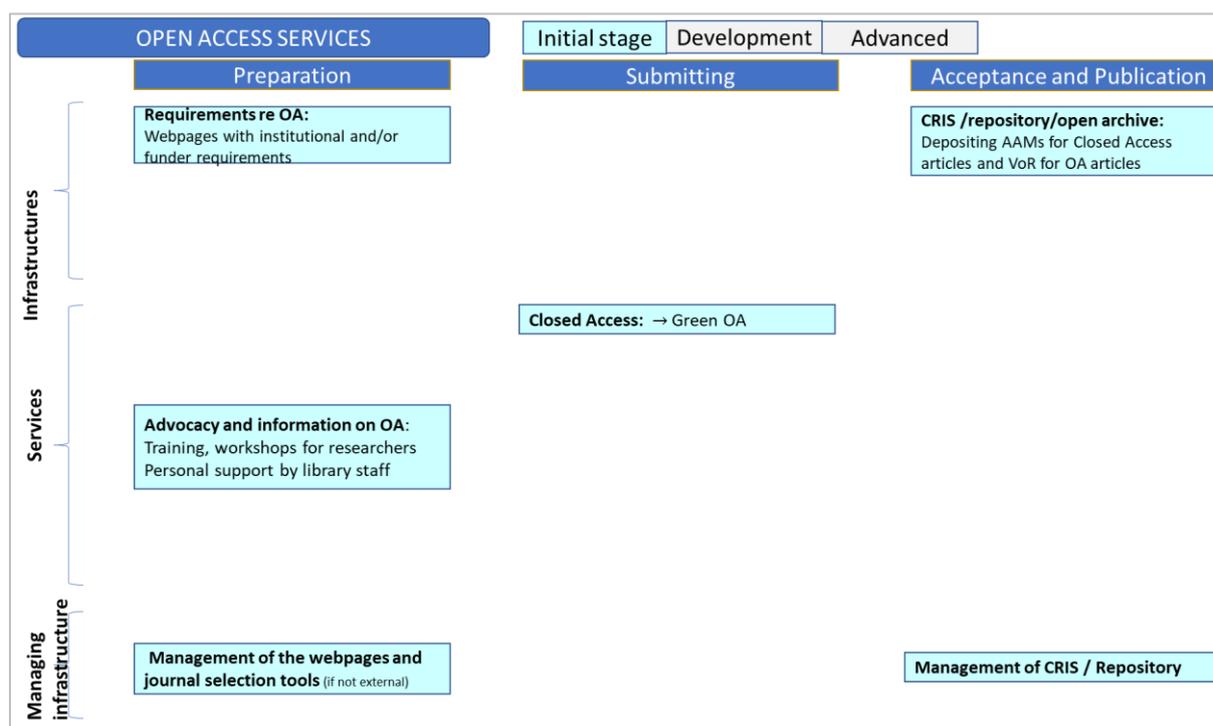
Figure 12 Initial stage OA services

The initial stage of OA services describes basically the services and tasks related to an institutional repository. In some institutions, a Current Research Information System (implemented at a later stage) is used for registering the research output of the researchers at the institution, while the full text of publications is simultaneously deposited in the repository.

ORGANISATIONAL STRUCTURE

Generally, the training, workshops and personal support regarding the repository and Green Open Access is included in the service portfolio that is carried out by the existing library staff, such as information specialist or faculty liaison librarians. For the institutional repository management, a new position is generally created. Support regarding the metadata production is sometimes provided by the cataloguing department. In short, there are generally no or small changes to the organisational structure of the library.

COMPETENCES

As stated earlier, the management of the institutional repository has created a focus of the library on the researchers of the institution and their publications. In addition, competences regarding copyright and regarding (the technical aspects of) digital publishing and the various forms of Open Access have been gradually acquired by the library staff. This has laid the foundations for the services in the developed stage of OA services.

4.4 DEVELOPED STAGE OA SERVICES
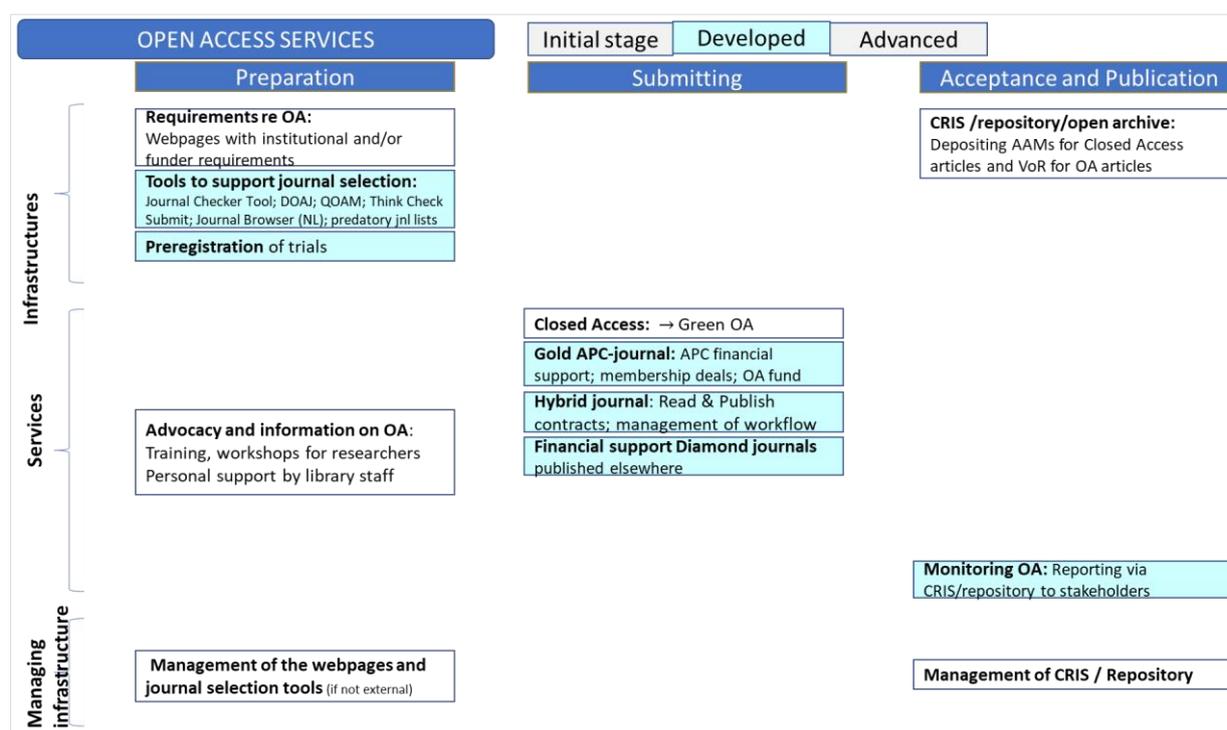
Figure 13 Developed stage OA services

The developed stage of OA services by libraries is characterised by the following:

- **Tools to support journal selection and preregistration of trials**: In order to support authors to find OA journals for their publications, libraries offer tools such as the journal checker tool (from cOAlition S), the journal browser (Dutch universities) or lists of journals such as DOAJ or QOAM to publish in and predatory journal lists to prevent authors to publish in. For trials in disciplines such as clinical medicine and psychology, preregistration of the trial is required, and libraries offer support in that area as well.
- **Support for Gold or Hybrid OA journal articles**: Many research libraries offer financial support for APCs for institutional (corresponding) authors who publish in Gold journals with an OA fund. Other libraries have concluded Read & Publish contracts, which enables institutional authors to publish their articles Open Access in hybrid journals. It has to be noted that both services are seen by some as controversial: the OA fund can be seen to support the APC model, while the Read & Publish contracts can be seen as supporting the large publishers. Therefore, some libraries have made a choice for one or for the other, while other libraries champion Diamond OA.
- **Financial support for Diamond OA**: The increasing awareness of Open Access has led to the financial support by research libraries of Diamond OA initiatives, such as SCOAP or the Open Library of Humanities.
- **Monitoring OA:** The expansion of OA services is mostly related to institutional policies regarding Open Access and therefore, many libraries have also the task to monitor the OA status of the publications by the institutional authors.

ORGANISATIONAL STRUCTURE

This enlarged portfolio of OA services often lead to new tasks that are sometimes grouped in a specific function:

- **Open Access fund management**: Sometimes, the management of the OA fund has been dedicated to an OA fund manager who administers the APC compensations for authors that fulfil the eligibility criteria of the fund.
- **Read & Publish licence management**: The licence management of Read & Publish agreements includes the workflows that determine the eligibility of articles to be Open Access published under the agreement. Publishers increasingly provide dashboards in order to support these workflows in order to facilitate this.

The librarians in the front-office who liaise with the researchers and deliver training, workshops and consulting services sometimes have a specific job title, such as digital scholarship librarian. Also, they are often combined in separate units or teams, in some cases combined with the RDM supporting librarians.

COMPETENCES

As stated earlier, the competences needed for the OA fund and for the Read & Publish licenses are in line with the existing competences within the library.

4.5 ADVANCED STAGE OA SERVICES
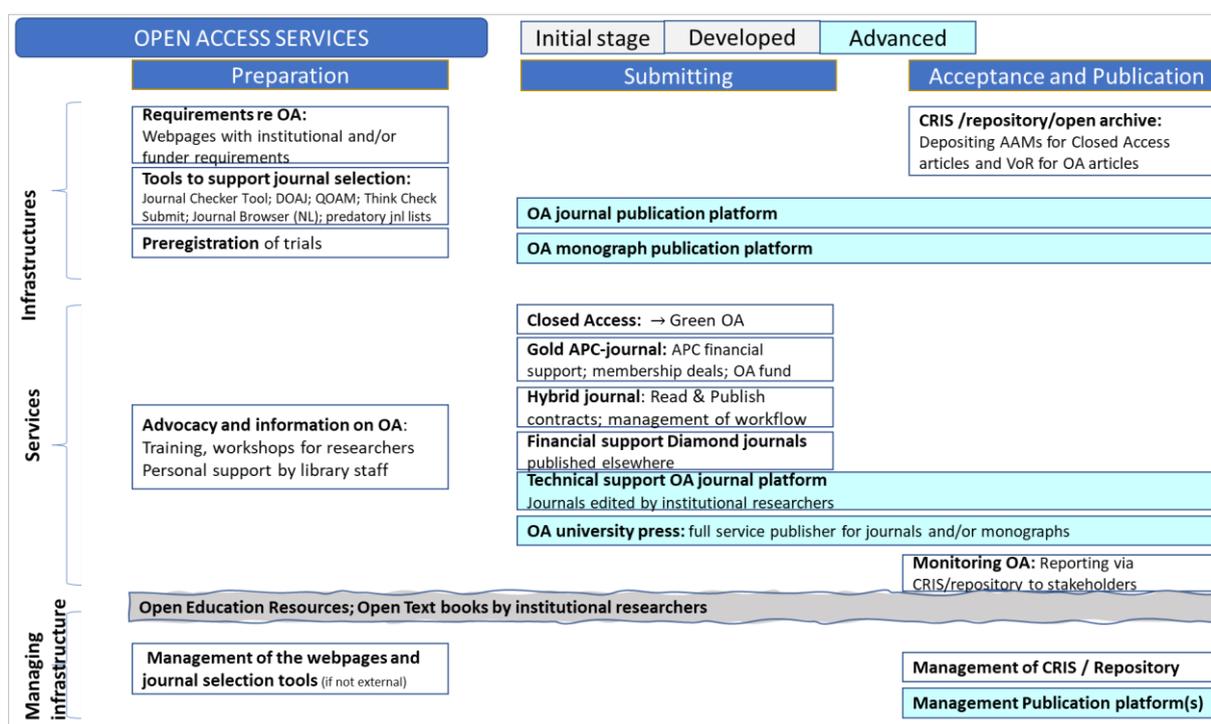
Figure 14 Advanced stage OA services

The advanced stage of OA services is characterised by **institutional OA publishing**: Some research libraries have implemented a publication platform for Diamond OA journals edited by researchers from their own institution. The library helps the editors to set up a new journal title and delivers technical support for running journals. Other libraries have a full-service University press for Diamond OA journals and in many cases also for OA monographs (not necessarily Diamond OA as a book publishing fee might be required). Some of these full-service University presses are also starting to publish Open Textbooks authored by institutional authors and use the collection budget for commercially published Textbooks to finance this endeavour. This service is in line with other services provided by research libraries regarding Open Educational Resources.

ORGANISATIONAL STRUCTURE

If the library offers a journal publication platform with some technical support, this task is generally carried out by one or two employees, who are part of an existing unit in the library. However, in case the library offers a full-service University press, this is in many cases a separate organisational unit within the University and in a singular case a shared University Press by several universities.

COMPETENCES

As stated earlier, while the competences needed for the other OA services are in line with existing competences within the library organisation, for the institutional publishing services, employees with a background in publishing are often hired because the competences needed are seen as new for the library organisation.

4.6 THE NEXT STEP: LIBRARY ROLES IN OPEN SCIENCE COORDINATION

Different universities have different structures for coordinating the various elements of Open Science. In this report, we highlight the structure at the University of Lorraine – with an important role for the library – and the structures at the universities of Edinburgh, Mannheim, and the University College London, where the Open Science coordination is carried out by an office within the library.

OPEN SCIENCE COORDINATION AT THE UNIVERSITY OF LORRAINE

At the University of Lorraine, the Open Science policy consists of eight pillars (see textbox). The entire Open Science policy is coordinated by a Steering Committee in which three vice presidents participate: the VP for research, the VP for culture and the VP for relations with the social-economic world. The library is directly involved in operational services regarding 3 of the 8 pillars (Open Access, FAIR research data and Education). However, the library also is indirectly involved in other areas. For example, the library supports various participative research projects with guidance on research data, supports the open publishing unit with their expertise on metadata and identifiers, et cetera. In all, this strengthens the position of the library as (1) expert in certain areas and (2) as coordinator and connector of various units of the University that otherwise would work as separate silos[6].

> **8 pillars of Open Science**
> 1. Open Access
> 2. FAIR research data
> 3. Open publishing
> 4. Education on Open Science competences
> 5. Research integrity
> 6. Research evaluation
> 7. Dissemination and co-creation knowledge
> 8. Participative research/citizen science.

OPEN SCIENCE COORDINATION OFFICES WITHIN THE LIBRARIES

- The Open Science office at the Library of the University of Mannheim has been set-up in close interaction with the senior management of the University and combines a grassroots movement (with Open Science meet-ups between researchers) and a top-down movement (the University wanting to foster Open Science). Its focus is on implementing Open Science throughout the University with elements such as pre-registration for research projects in Social Sciences and awareness-raising on reproducibility of research. In addition, the office gives out modest Open Science Grants to young researchers which appears to be a very good incentive for Open Science practices and has already had some impressive results.

- The Open Science office at UCL has a senior manager and two colleagues that work on citizen science and is associated with the repository team, the RDM support team and the Open Access

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[6] Some comments by respondents suggest also limitations to the role of libraries in Open Science: (1) Open Science policy-making: one interviewee emphasised the importance of the involvement of representatives of the research community; (2) Research evaluation: one interviewee felt that changing the research evaluation is outside the domain of research libraries; (3) FAIR and Open research software: one interviewee stated that 'research software is a new frontier for libraries to be crossed' but emphasises a potential larger and more leading role for the IT department in this because of the nature of the materials.

University Press. The office collaborates with dozens of other people that work throughout the University on Open Science and provides leadership, advocacy, and engagement in Open Science practices. In other words, the office is a 'spin in the web' of all activities related to Open Science. In addition, the office collaborates with the subject liaison librarians, who offer basic training in Open Science to researchers and teachers in the faculties. As UCL is a very large university with about 43,000 students and 13,000 staff members, many projects related to Open Science run in isolation. The challenge for the Open Science office is to become a central coordinating point and conduct workshops with the aim of exchanging knowledge and experiences, training, and promoting advocacy.

- The brand new Open Research support team at the library of the University of Edinburgh will take up the role of coordinating Open Research activities within the University. As the university has a very devolved organisational structure, an essential competence here is building networks and participating in networks. This means sometimes participating in existing networks, but also building new networks from the ground up. Advocacy, networking, and engaging stakeholders are key in this. An active and proactive attitude is crucial: 'Sometimes, you have to invite yourself to meetings'.

The report 'Towards a 2030 vision on the future of universities in the field of R&I in Europe' emphasises the importance of FAIR research data, which will enable the verification of research results, will eliminate unnecessary duplication of research activities, and help creativity that originates from combining datasets from various disciplines. With regard to the role of libraries, the report contains following statement: 'Current support is usually centred in the University libraries however this needs to be integrated into an institutional strategy that recognises the core nature of Open Science services, *the central role of the library* and provides the appropriate support' (Research and Innovation; European Commission, 2020).

Another report focuses on Open Access and states about this central role of libraries: 'Libraries possess extensive knowledge and often capacities to actively support researchers in their publication activities. In the future, this will be a central task for them' (German Science And Humanities Council, 2022).

This central role of the library is also seen by the other stakeholders (within institutions and from (inter-)national organisations) in this report. A few quotes from the interviews:

> 'Libraries make the link between the senior management of the University at one hand and the researchers at the other hand. The leaders of the universities make policies such as the policies in the field of Open Science, but for the implementation of these policies the libraries are an essential link in the chain'.

> 'Libraries are hubs with close contacts with researchers. Librarians do understand the research process, the research reward system and are good in community building. This makes them able to team up with the researchers'.

> 'Librarians are in the middle of things and therefore, they can organise the collaboration between the various internal stakeholders that is necessary for advancing Open Science. You have to link and connect different units and people and librarians can organise this. This intermediary role is made possible because librarians know a bit of everything. Librarians play a key role in Open Science but cannot play all the roles. Therefore, the involvement of the other stakeholders is crucial and hence the importance of this intermediary and connecting role of the library'.

> 'With regard to research data, there is an implementation gap between the policies and the practices. An important role for libraries lies in closing this implementation gap by setting up infrastructures, have RDM support professionals who deliver services to researchers and give training to researchers'.

> 'The role of the IT department is providing and managing the platforms and the infrastructures needed. The role of the Research office lies in the connection to policy-making and in offering advice on research ethics. The role of the library is to provide practical services to the researchers. The library is well equipped for this as they understand the context of research'.

A researcher concurs: 'The library listens to you and understands what you need. Because they really understand your research project they can really support it'.

Apart from this role as intermediary – coordinating and connecting services by all the internal stakeholders based on its understanding of the context of research and the environment in which the researchers operate – the library has specific competences that are relevant to Open Science services. The respondents list the following:

- Comprehensive overview of the regulation and policy environment of institutions and research funders with regard to Open Science, Open Access, FAIR research data, research integrity, ethics et cetera.
- Technical expertise regarding digital publishing regarding metadata standards, ontologies, licenses, copyright, and identifiers
- The fact that libraries do already support the research output in the form of publications makes them a suitable party to support the research output in the form of research datasets.
- Expertise with regard to long-term preservation of digital research outputs.

6. DISCUSSION OF RDM AND OA SERVICES AND A LOOK AHEAD

6.1 RDM SERVICES

STARTING-UP RDM LIBRARY SERVICES

Starting RDM support services might look like a difficult step for research libraries. However, as discussed, many research libraries have set up successful RDM support services. The following factors were mentioned in the interviews:

- Already 'hidden' services regarding research data by reference librarians supporting researchers can be a start to make the services more explicit and formal. One respondent stated that his library could take the initiative based on the expertise of one staff member that had already supported researchers for years in this domain. Another respondent stated that his library had already taken the initiative with regard to Open Access services and had therefore the ear of the senior management.

- Senior management buy-in in order to start RDM support services was in many cases a prerequisite. In some cases, some perseverance is required by the librarian as the first proposals might not be accepted immediately. In other cases, a survey among researchers or an external audit triggered the senior management.

> **Institutions' and researchers' perspectives on RDM**
>
> One respondent draws attention to the different perspectives on RDM from an institution and researchers:
>
> Added value for researchers: (1) research becomes more efficient; (2) continuity in research is better guaranteed by research data management.
>
> Added value from the perspective of the institution: (1) properly conducted research based on research data that can be retrieved in the future; (2) security of research data to prevent data leaks that can lead to reputational damage.

- For most libraries, the starting point was a support service for data management plans because of requirements by research funding organisations. However, starting points for some libraries were a discovery portal for research datasets (in a library specialised in Economics) or a data repository, originally set-up for another type of data.

WHO DOES WHAT?

RDM support services along the entire data life-cycle require the collaboration between the various stakeholders within a research institution: the IT department, research office, data protection officers, ethics board and technology transfer office. Two observations about this:

- A good collaboration with the IT department is crucial. This can take various forms: for example, at one institution the role of the IT department was strictly defined as providing IT infrastructures, while the library had the role of providing services based on these infrastructures. The reason given: the library understands the context of the research environment. However, at another institution, the IT department had developed a specialised team under the name scientific IT services. Here, the library was in the lead for the services related to data management planning and publishing/archiving datasets, while the IT department was in the lead for the services during the research project. In other cases, there is

an intensive collaboration between the two stakeholders, sometimes even with the RDM support professionals of the library and IT department working in one team.

- With RDM support professionals/embedded data stewards spread over faculties, a central team at the library and others in the IT department or other units, the need for connection and coordination grows. A number of research libraries have taken up this challenge by implementing a community manager with the task of setting up and coordinating a network with data stewards and other RDM support professionals.

FIRST LINE/SECOND LINE ORGANISATIONAL STRUCTURE FOR RDM SERVICES

With regard to the developmental stage with the first/second line organisational structure for RDM support services, a number of observations have been made by the respondents. Such a structure is only relevant for larger universities. There appear to be two approaches: one is setting up a formal structure with embedded data stewards of the first-line part of the library or part of the faculties. Another approach is that the task of embedded data stewards will be informally fulfilled by researchers within the research departments as a function of the increasing datafication of research. The RDM support professionals in the library will then connect and collaborate with these RDM supporting researchers. In other words, this approach can be seen as a more organic and bottom-up way of implementing embedded data stewards. However, the risk of this approach is that the continuity of such an informal data steward network is not guarantees, as these tasks are often carried out by PhD students or early career researchers.

COMPETENCES AND TRAINING

An often expressed concern is that it is difficult to acquire the competences for RDM support services as there is hardly any formal training because this domain is relatively new. However, the respondents in this study were rather practical about this. Many of them stated that the competences needed for discipline-agnostic RDM support services can be learnt on the job by librarians if the will and the curiosity are there. The role of LIBER and ADBU in exchanging experiences among professionals was seen as important in this. However, for the discipline-oriented RDM support services, a research background in the discipline was generally seen as essential while knowledge and skills regarding RDM could eventually be learnt on the job. In other words, these competences are not generally within reach of traditional librarians, and this can therefore be characterised as a fault line.

RDM SERVICES KEEP DEVELOPING

As the datafication of research is rather recent, the researchers' competences in this as well as data sciences themselves are still developing. Thus, also RDM support services are developing further. One respondent observed already less questions from researchers about data management plans as these become increasingly normal practice in their institution. Other infrastructures such as electronic laboratory notebooks are in the process of being developed and implemented, so training and advisory services on this will have to be built up. As more datasets will be archived, the workload for data curators will increase. Finally, services with regard to research software need to be developed: this becomes increasingly important in research and with it the need for research software planning and the archiving of research software.

MULTI-ROAD APPROACH TO OA

The debate on the transition to Open Access of scholarly communication has become increasingly a financial debate. Practically all European research libraries support Green OA with their repository infrastructure. However, supporting Gold OA with APC funds or Hybrid OA with Read & Publish agreements is financially costly and therefore controversial. This and the argument that not one OA business model should become dominant, the multi-road approach to OA is now generally accepted.

GREEN OA AND RIGHTS RETENTION

Research libraries have a strong position in Green Open Access with the publishing of the publications of their researchers in repositories. It can be expected that in the coming years there will be a renewed emphasis on Green OA in combination with Right Retention efforts.

DIAMOND OPEN ACCESS

The multi-road approach to OA means also that there will be continuing efforts to strengthen the Diamond OA route. Many research libraries have already responded to these efforts by setting up publication platforms for Diamond OA journals and many other libraries are following. With regard to competences, it can be said that research libraries acquired many new competences in the past with setting up institutional repositories. The competences needed for managing APC funds or negotiating and managing Read & Publish agreements can be seen as add-on of existing competences within the library. However, with regard to Diamond OA publishing services, a number of respondents stated that for these positions they also hired people with a background in publishing: these publishing professionals bring expertise regarding editorial and production workflows while librarians add insight and guidance to Open Access and Open Science. This can be characterized as another second fault line: specific competences are needed here that are for librarians difficult to develop.

6.3 A LOOK AHEAD: OPEN SCIENCE AND RESEARCH LIBRARIES

The earlier mentioned report on the 2030 vision for universities remarks about the present status of Open Science: 'Only a small proportion of universities in Europe are already fully embracing Open Science'. And: 'Universities need to develop permanent teams to be able to provide Open Science services to the researchers that not only rely on external funding through research grants. Libraries are in the process of developing such services'. The report goes on to call for the development of holistic strategies on Open Science by universities that includes funding provision to ensure adequate staffing.

Against this background, this study focused on libraries at the forefront of developing Open Science services and found that there is a clear role for libraries that is based on two pillars: (1) the library as a coordinating and connecting intermediary between the researchers on the one hand and the other internal stakeholders on the other hand and (2) the expertise of the library in a number of domains of scholarly communication. Libraries that have taken up this role in OA and RDM support see their

role strengthened and sometimes even expanded to a coordinating role of all aspects of Open Science. This study hopes to contribute to an acceleration of Open Science services by research libraries throughout Europe. To this end, LIBER and ADBU will develop a toolkit focused on RDM support services for research libraries and a communication package for other stakeholders, based on the results of this study.

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