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The role of CRIS’s in the research life cycle. A case study on implementing a FAIR RDM policy at Radboud University, the Netherlands

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Abstract

In 2015, Radboud University (Nijmegen, the Netherlands) started a project to extend its CRIS (Metis) with functionalities that allow researchers to register (metadata) and archive (uploading files) their research data, while at the same time making the data available for reuse in a FAIR way (via national Dutch data archive DANS). The new functionality was integrated with already existing functions in the CRIS, thus offering a one-stop-shop interface to researchers in which registration and archiving of data is combined with registration of publications, the uploading of full text to the university’s repository, the linking of datasets and publications and the creation of researcher’s profile (CV) pages. Next to the functional extension of the CRIS, the project also included an organizational element: the establishment of support and management structures and workflows, including data curation processes, in order to assure the quality of the data registration process and to foster the FAIRness of the research data.

In the period up to now, we continued to transform the university’s CRIS, by bringing it in line with the research life cycle perspective and policy changes in Research Data Management (RDM), including a Data Management Plan (DMP) module and FAIR data.

In this paper, it will be argued and demonstrated that both for researchers and research institutes, a CRIS oriented approach to RDM brings added value. We also point to future use cases that put a central role for CRIS’s even earlier within the research life cycle, e.g. at pre-registration of research questions and informed consent/ethics approval procedures. We further envision our CRIS to play a linking pin function between storage and service locations of data during research and at publication. The paper will use Radboud University as a good practice of past, present and future use of CRIS’s in the research life cycle that universities and research institutes as well as researchers and research support desks are currently dealing with in the FAIR data era.

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1. Preamble: the added value of a CRIS oriented approach to RDM

Modern CRIS’s cover all aspects of research information (metadata) and offer advanced, extensive and user-friendly interfaces to researchers. This makes them primary candidates to function as a one-stop-shop for researchers when it comes to the registration, management and online exposure (e.g. through CV or profile pages) of information about their research, be it information on the projects as such, their funding, the organisations and researchers participating, the equipment used, the time spent for the research or the results the research yields.

To this list also belongs the information on the datasets being created and used in the research, as they too are a result or product of the research and – perhaps even more importantly – because registering datasets in the CRIS holds the added value that these datasets can be linked to the publications based upon them, the project they belong to, the researchers creating and working with the data, as well as to software or other tools used in analysing the data, or the organisations involved in the research. Linking the datasets automatically and directly to the extensive and rich metadata of other research objects and attributes present in the CRIS, is furthermore of crucial importance for the FAIRness of the data, and thus for Open Science. After all: on top of the metadata of the dataset itself, the linked metadata (project, publication, researchers, institute etc.) provides an extensive set of additional search and information terms to find the dataset, and interpret or judge its possible use and value as well as the conditions for access to and reuse of the data.

What applies to the dataset also goes for the Data Management Plan (DMP), holding key information on the management and preservation of the research data throughout the research life cycle. Therefore, the metadata of the DMP belongs in the CRIS, linked to the rest of the information on the research it is part of.

At Radboud University, we are taking this reasoning and the concept of a one-stop-shop a step further, both regarding the dataset and the DMP. For datasets, we not only provide the possibility to register the metadata, but we actually also have integrated a function in the CRIS to archive the data files themselves. More concretely: to upload the data files to DANS, the national data archive in the Netherlands. As for the DMP, we have developed and integrated a special module in the CRIS for the creation (drafting) of DMP’s, which allows co-authorship by various (including external) researchers, the possibility to implement and choose different (funder and institutes) formats, as well as full monitoring and feedback by our Research Information Services unit (RIS service desk).

We thus integrate the use of the CRIS in the full research life cycle from the start of a project and create, both for the researcher and the management, an unambiguous resource, with extended metadata of a research project; information which is approved and accounted for by the institution in which the research takes place. It contributes to optimal Research Data Management (RDM), which is vital to the monitoring and assessment of the quality and integrity of research. And it is accompanied by a well-organized service desk structure, as a fundamental part of the proper functioning of a CRIS in the context of the data life cycle. Finally, a one-stop-shop CRIS solution will help implementing a FAIR data policy, making Open Science as feasible as possible. To have such a reliable ‘accountable resource’ (the CRIS) may well become more and more important for a research institution in a time of growing dispersed online information resources.

2. Past developments: the transformation of Radboud University’s CRIS

Radboud University’s CRIS (Metis) has a long history, developed about 25 years ago by Radboud University and used for many years by most Dutch universities, functioning as a kind of national CRIS. Originally, Metis was developed to hold and deliver assessment and management information on the research and researchers’ performance of the university, focusing on the scholarly output, being mostly scientific articles, in answer to both the emerging national research evaluation processes in the Netherlands and a growing need of quantification of the academic processes at the institute’s level. In order to correctly understand and interpret the results of the academic work, a wealth of additional information, directly or indirectly related to the output, was added to the CRIS system, e.g. information describing the research project, the related funder and other funding resources, originating and collaborating research institutes, and information on the appointment of authors and time allocated to the research project. This led to a CRIS being a valuable and important information system holding rich and detailed metadata on all aspects of research. However, researchers themselves were mostly unaware of the existence of the CRIS, their role being limited to handing over a publication to the CRIS manager. Thus, in the early days, the primary rationale of the CRIS was to provide the management information needed for the monitoring of the research and the justification of the funding received for the research, while the engagement of the researcher in this process was of little importance. This early-day-view of the CRIS at Radboud University is summarized in figure 1.
In the last decade, developments took place that have substantially shaken things up in the academic world. Both from the political level and society in general, a demand arose on transparency and public availability of information on academic research and its results. This was caused among other things by the coming to light of examples of unreproducible science and even scientific fraud, as a consequence feeding certain scepticism towards scientific findings in general. Partly in answer to this feeling and partly as a reaction to the growing commercialisation of scientific output, the Open Science and specifically the Open Access movements gained momentum from within the scientific community, supported by national and international politics. Both trends resulted in the wish to document and have access to information of the entire scientific research life cycle; a wish that represented a substantial challenge to the research information management community in general and those involved in research information systems in particular.

The implementation at universities worldwide of institutional repositories for Open Access publications was a first concrete answer to this call for more openly and publicly available research information\(^5,6\). At Radboud University, it was decided from the start of the Open Access repository to use the CRIS (Metis) as the source to provide content to the repository, since Metis already held all necessary metadata. The decision to use the CRIS as the primary and leading source for the Radboud Repository, later on and in a broader sense, led to the vision of the CRIS as a source of metadata information on the entire scientific life cycle.

![Fig. 1. The early-day-view of the CRIS at Radboud University.](image)

In connection to this, the idea grew to provide the researcher - as the key stakeholder, directly involved in and executing the research life cycle - a leading role in supplying the metadata. As a consequence, in Radboud University’s CRIS system, a new interface (Personal Metis) was implemented - in addition to the already existing CRIS administration and service desk modules - allowing the researcher to enter her or his information directly into the CRIS.

In 2015, the new concept of the researcher being the primary user and direct source of information, stimulated the use of Radboud University’s CRIS for registering and archiving datasets complementing scientific publications\(^7\). Nowadays, funders and publishers, acknowledging the demand of academic transparency and reuse of scientific outcome, require research data to be published, in connection to the publication of scientific books and articles. This new development was internally driven as well, as Radboud University’s executive board, as part of its institutional RDM policy, decided to use the CRIS as the basic instrument and resource for registering and archiving datasets resulting from its research. Over the years, various requirements for the archiving of datasets have been formulated, the FAIR Guiding Principles (Findability, Accessibility, Interoperability, and Reusability of data)\(^8\) being the most
widely accepted. Operationalising the FAIR Guiding Principles poses a challenge on the registration and archiving of the datasets, and requires among others a detailed and complete description of the metadata of archived datasets.

In Radboud University’s concept of the role of a CRIS, it was a logical step to extend the Metis researcher interface (Personal Metis) with a functionality to register and archive datasets and linking their metadata to existing metadata on various other types of research output. For that occasion, Personal Metis was transformed into a more complete interface for researchers, referred to as RIS (Research Information Services), including a RIS service desk for support and feedback (including data curation) on the registration of publications and datasets by the researcher. From now on, researchers could use Radboud University’s CRIS to register the metadata of a dataset and upload the data files to the Dutch national DANS data archive, where these files were sustainably stored in a certified long term data archive (DANS EASY), thus potentially meeting a large part of the FAIR Guiding Principles. The RIS interface provides researchers with control over the registration and management of their research results, without having to enter metadata twice or having to access the separate DANS EASY interface for archiving their datasets. Relations between datasets and other results are part of the CRIS as well. These relations are made visible in the Dutch national publication database Narcis (https://www.narcis.nl/), via the university’s publication repository (Radboud Repository, http://repository.ubn.ru.nl/).

For the newest feature, drafting DMP’s, basic project registration and a DMP module were added to the CRIS system, allowing researchers to register DMP’s and completing the several questions on RDM posed by funders and the university’s research institutes. This development is in line with the broader view and policy that the CRIS should be the one-stop-resource for both input and export of the institution’s research information.

In summary, over the years, the rather traditional Personal Metis interface for researchers was renamed to RIS and expanded with several functions to provide services for the whole research life cycle, i.e. (1) registration of metadata of datasets, and uploading data files for sustainable archiving to the Dutch national DANS archive; (2) linking datasets to publications, and vice versa; and (3) a DMP module, including registration of the project underlying the DMP, and a collaboration and feedback function. Thus, over the past few years, at Radboud University, the CRIS was developed to act as a central system in the research information landscape, presenting information from the research life cycle and supporting primary research (administration) processes. Taking the researcher and the scientific process as basic principle reduces the administrative burden on the researcher, while enhancing the quality of the research output and enriching the metadata in the CRIS. This view on the CRIS, in the research life cycle and combined with research support, is summarized in figure 2.

Technically, Metis is a Java based application, including an Oracle relational database management system (RDBMS), following a generic Research Information System architecture. Tools used are Bootstrap, a HTML-, CSS-, and JS-framework for developing responsive web applications/mobile projects; iBATIS, a framework that automates the mapping between SQL databases and objects in Java, .NET and Ruby on Rails; and jQuery, a cross-platform JavaScript library created to simplify the client-side scripting of HTML. There are interfaces with local systems, such as the personnel system, Radboud University’s publication repository, the personal profile portals and Web of Science. The data files are uploaded from the CRIS using SWORD, a lightweight protocol for depositing content from one location to another. Data is stored in EASY, the certified long-term preservation archive of DANS, built upon the Fedora platform (https://easy.dans.knaw.nl/).
3. The CRIS DMP module: workflows, support services and FAIRness

For the latest feature, drafting DMP’s via the CRIS, a question and answering module was added to Metis. From the researcher perspective, the question and answering module itself works pretty straightforward, allowing researchers to draft a DMP in a technically quick and simple way. The functionality of the Metis DMP module was modelled after the DMP online tool (https://dmponline.dcc.ac.uk/), with its extensive and useful possibilities; including guidance via information texts, options for collaboration by drafting DMP’s together all over the world, at Radboud University via a OneSini/Surfconnext account, and feedback from the central Radboud University RIS service desk or by the institute’s data steward. More importantly, we added a direct connection between the DMP module and the Radboud University’s CRIS, making our solution innovative and, as far as we know, unique. By this end, writing DMP’s becomes part of the one-stop-shop, instead of having to log on to another tool, as well as benefiting from the richness of the research information already available in Metis; such as organizations, authors, projects, funders and FTEs. In the CRIS, DMP’s are written as well as registered and linked to other entities in the research life cycle, such as datasets and publications. Hereby, the DMP metadata can be made publicly available via researchers’ profile pages, websites, CV’s and/or the (yearly) research reports of the institute or organization. Currently, the drafted DMP’s are only accessible by the involved researchers and stored on the secured servers of Radboud University’s CRIS. In the future - and if demanded by funders, the university or the research institutes - even the plan itself (anonymized or with permission) can be made publicly available, for instance via profile pages or the Radboud Repository.

There are multiple justifications for integrating a DMP module into the CRIS. First, from the CRIS perspective, it strengthens the position of the CRIS in the research life cycle, making the CRIS part of researchers’ daily workflow, and simultaneously reducing administrative efforts, as the DMP is linked to the extensive metadata of the CRIS. Second, from the researcher’s viewpoint, adding a DMP module confirmed our experience with the previously added RIS module for dataset archiving, notably: the importance of proper workflows and a support unit for the researcher. Third, from the context of the RDM program at Radboud University, there are various benefits of a CRIS-based DMP module for meeting the FAIR Guiding Principles. In this section, we will further elaborate on these three justifications. For the CRIS workflow - the first justification - both the functionality of the CRIS as well as the functionality of the DMP module itself are relevant. The CRIS part and the question and answering module are two different elements of the DMP. Let us first elaborate on the CRIS functionality. The RIS interface is already familiar to many Radboud...
University’s researchers as they already access RIS to register publications, to upload full text to the Radboud Repository, and to register datasets and/or upload the data files to the certified DANS archive. Therefore, using the RIS interface for researchers to write a DMP as well, seems to be a logical step. After logging on and ticking the ‘data management plan’ category (in addition to the more traditional categories such as articles and books), it is mandatory to select the contributing authors, select (or add) the research project the DMP belongs to, and, if relevant, select a funder and/or related result (now or in the future, such as a publication or dataset). As a result, various links in the CRIS are made, among others between projects, authors and research output. An automatic e-mail is sent to the CRIS manager of the related faculty or research institute, who will check and update the information in the CRIS and the DMP registry. In the meantime, the researcher and other contributing authors are able to click through to the question and answering form of the DMP module. Figure 3 gives an impression of the CRIS part of the DMP.

What about the functionalities in the module itself, and the corresponding workflows? Up to now, feedback on DMP’s was provided via a personal meeting and/or e-mail contact. The RIS service desk received a Word document by e-mail and an accompanying request for feedback. This workflow has improved significantly in the CRIS DMP module, as the module has a ‘request feedback’ button, that automatically sends an e-mail to both the applicant (confirmation of request for feedback; message when feedback is provided) and the RIS service desk (request for feedback). The CRIS DMP module has three types of answering fields: one for the administrator (the main author, who drafts the plan), one for the co-authors (who contribute to the plan), and one for the RIS service desk (who provides feedback). This functionality is shown in figure 4.

Regarding the second justification - a RIS service desk for researchers - at Radboud University, we have experienced that a central service desk is a key success factor for (the use of) a CRIS based online interface as a one-stop-shop solution. This way, researchers only have to turn to one service desk (RIS service desk, http://ris.ru.nl) for help and feedback, to have data curated and ask questions about publications or data management, instead of having to use different systems and different communication channels. At Radboud University, it is an expert team (on CRIS’s, RDM, Open Access and Open Science) at the university library that operates the central service desk. Tasks of the service desk are service level management, quality management, call handling and reporting. Next to this, the service desk also provides RDM training for researchers, curates archived datasets and provides feedback on DMP’s, thus functioning as a front office for the researchers. Due to this development, the traditional publication management services that the library has been providing for many years, recently have been supplemented with new data management tasks.

Fig. 3. Screenshot of the CRIS part of the DMP.
Third, with regard to monitoring the FAIRness by those responsible for the RDM policy at Radboud University’s various research institutes: what started with FAIR datasets via the CRIS is continued in the DMP. Criteria for data curation are based upon the FAIR Guiding Principles. As making research data findable is a first step towards the FAIRness of data, metadata are always checked by the RIS service desk. Metadata should be rich, understandable and complete in order for other researchers to find it, understand it and be able to use it. Furthermore, the data files are curated by the RIS service desk, including checks on privacy protection of the subjects involved in the dataset. Files that are open accessible to others may not by any means contain privacy sensitive information which can lead to identification of subjects involved. Additionally, the data curation process implies that archived datasets entail rich documentation, as data should be well documented in order for potential other researchers to understand the data. Variables should be explained in a codebook, syntax files have to be added, questionnaires should be included, and the context, content and structure of the data should be clear to a potential reuser. FAIR data also entails reusability, and thus the data curation process by the RIS service desk also includes checks on the used software and preferred and accepted formats to ensure the long-term preservation and future access of research data.

The DMP module in the CRIS allows us to monitor the FAIRness of research data in an earlier stage than at publication of an article and/or the archiving the accompanying dataset, as it is the DMP that includes information on, among others, future plans of archiving data for the long term and/or making data available for reuse, including how the FAIR Guiding Principles are expected to be met. For the researcher, drafting a DMP is generally the first step in the awareness of proper data management and the FAIRness of data. Considering data management in an early stage of the data life cycle helps to make a research project more efficient, and above all, enhances the FAIRness of data. The CRIS-based DMP allows the data stewards to monitor RDM at their institutes via the same database (Metis) used for monitoring project and research output, both quantitative (number of DMP’s) and qualitative (content of DMP’s, as DMP’s include a wide range of information on the data life cycle and aspects of RDM).

4. Broader context: the changing role of the CRIS

The current effort on opening up scientific research data, originating from the Open Science movement, has led to a renewed focus on the position a CRIS takes as the source of information of scientific research output\textsuperscript{11}. As a consequence, an acceleration of CRIS development took place, with an emphasis on data quality\textsuperscript{12} and integration and interoperability\textsuperscript{11,13} through the use of standards for information exchange like the CERIF format\textsuperscript{14}. The developments regarding Radboud University’s CRIS (Metis), as described in the previous sections, are illustrative of the major shift in the nature and role of a CRIS. Not losing sight on integration and interoperability, we focus
foremost on adding information of the research process to the CRIS by empowering the researcher and directly connecting to the research process itself.

The integration of research data functionalities introduces a dynamic in the use of the CRIS previously not present, and significantly helps in the acceptance of the (broader use of the) CRIS by the researcher. Both the process of the DMP creation and data archiving, include frequent and immediate interaction with the RIS service desk, resulting in the CRIS being continuously ‘on the radar’ of the researcher during the research life cycle. More and more, the researcher experiences the CRIS as a natural and integrated part of her or his daily work. As a result, the other aspects of the CRIS, such as project and publication registration and management, are promoted and are more easily accepted and used by the researcher as well, leading to a significant input of metadata from all aspects of the research life cycle.

This development also has substantial consequences for other ‘traditional’ CRIS users, e.g. the functional CRIS administrators and managers at the institutes and faculties as well as the central research managers and policy makers. For the latter, a broader acceptance and use of the CRIS ‘on a daily base’ by the researchers clearly will have a positive effect, as the information in the system will be more up to date, compared to the situation in the past when the information was more sporadically updated - with sometimes weeks if not months in between - by the research administrator’s office(s). Also, these offices will see a significant change in the nature of their work: from a peak workload at predefined periods during the year to continuous monitoring and control throughout the year.

Apart from effects on the traditional CRIS users, the research data developments will also bring new CRIS users to the table, such as data stewards and ethics approval committees. Last but not least - and in the long run perhaps the one with the biggest impact - the integration in and management of research data information via the CRIS could have a very substantial added value for the realisation of an international FAIR data infrastructure, and as such for the worldwide scientific community. The fact that CRIS’s hold interlinked information of datasets, with a multitude of other information objects and attributes, makes them real ‘treasure chests’ for an international FAIR data network, such as e.g. envisaged by the European Open Science Cloud (EOSC), as each of these objects and attributes represent (interconnected) parameters for finding, interpreting and judging (the value and/or use of) the dataset, its accessibility and its reusability.

In this respect, it is worth mentioning that the developments in Metis concerning research data are not an isolated case, since other major commercial and non-commercial CRIS developers and/or vendors are busy implementing functionalities for the registration and archiving of datasets as well. This for instance applies to the internationally widest spread commercial CRIS, Elsevier’s PURE (200+ implementations worldwide), as well as the non-commercial, open-source DSpace-CRIS (100+ implementations). Having repository functionalities integrated in the CRIS, both PURE and DSpace-CRIS can archive datasets internally, but they are also exploring the connection to external existing data repositories. A concrete example is the UK, using the institutional PURE system as the source for data archiving at a national level, within the framework of the RDSS-initiative (Research Data Shared Service), organized and coordinated by JISC; a development that resembles the Metis DANS solution, be it that at the time of this writing (June 2018) RDSS is not yet in production, but still in bêta status.

As for the DMP: in this respect Radboud University’s Metis clearly is a forerunner, as currently to our knowledge, no other CRIS has yet integrated a function to draft DMP’s in connection to the CRIS; others merely only store the metadata of those DMP’s.

5. Conclusions: future plans

Over the past years, at Radboud University, we transformed the university’s CRIS, and aligned it with the research life cycle perspective and policy changes in RDM. We took the first steps to help the research institutes and their data stewards to monitor their discipline-specific data policies via the CRIS. To them, a CRIS oriented approach to RDM brought added value, making Open Sciences and the FAIR Guiding Principles more feasible by drafting DMP’s and archiving datasets via the CRIS. In this paper, we have outlined the past and present of the CRIS in the research life cycle. In this final section, we will describe how we envision the future of the CRIS at Radboud University in this FAIR data era.

A first aspect we are already working on is optimising the presentation of research projects, as their role becomes more and more important due to the DMP module that was recently added to the university’s CRIS. Up to now, most research institutes paid little attention to project registration in Metis, and its metadata scheme was rather marginal. However, most of Radboud University’s research institutes now advise or require researchers to write a DMP for each ‘research project’, thus making it essential to define and capture project registration as early as possible in the CRIS.
Together with the research institutes, their data stewards and CRIS managers, plans for the future are to extend the project management function. It is likely that this includes a functionality in the CRIS for the management of ethics approval documents and even the pre-registration of research questions and hypotheses, as they allow research institutes to live up to the Open Science and FAIR data demands, including documentation and monitoring.

Secondly, related to extending the metadata of projects in the CRIS is the principle of register-once-use-many, and thus efforts are made to connect the local CRIS to the database of one of the major Dutch funders, KNAW-NWO. For this, we will introduce CERIF (Common European Research Information Format) as XML format to both receive and send metadata to and from the CRIS. Ideally, in the near future, all communication between the CRIS and other stakeholders/systems (such as the DANS archive, KNAW-NWO project database, possible even the ERC project database) will be built upon the CERIF exchange model of research objects and relations.

Thirdly, plans for the future are to connect the CRIS to (metadata from) other data storing and archiving services at Radboud University, among others the (big data) repository of the Donders Institute for Brain, Cognition and Behaviour, and the Digital Research Environment (DRE) of Radboudumc, the university's Medical Faculty and Academic Hospital. We have taken first steps by connecting the Donders Repository (for internally archiving and publicly sharing research data for the long term) via our CRIS to the Dutch national database Narcis, making the archived datasets truly FAIR. A similar approach is taken for the DRE, a cloud-based IT-platform which helps researchers to handle their data and create dedicated and secure shared workspaces for any kind of data project. Extending it with the DMP and data archiving modules of the CRIS will make the research data stored in the DRE (more) FAIR. Both systems will benefit from exchanging metadata with the CRIS, as it guarantees that data is registered as research output as well. They will further benefit from the connection between the local CRIS (Metis) and the national CRIS (Narcis), as data stored in these two systems is or can be made visible and findable through the wider internet as well, via the CRIS.

Fourthly, in addition to efforts in the research life cycle, data in the context of education could also benefit from a CRIS oriented approach. Part of Radboud University’s RDM policy is the requirement to archive datasets of approved Bachelor and Master theses. Although these datasets will not automatically be made public, archiving these datasets in a FAIR way is still really relevant, as is also the case for research data that can’t be made public for privacy or legal reasons. Although sharing data is a main aspect of the FAIRness of data and a CRIS certainly assists in doing this, internally archiving data for scientific integrity or archiving student data could definitely benefit from the connection to the CRIS as well. At Radboud University, in the near future, we will therefore also register this type of data in the CRIS. Using the CRIS enables us to monitor this data over the ten years that it has to be archived, according to the university’s central RDM policy.

A final future aspect that requires our attention is the observation that the roles and functionality of (traditional) content repositories, data repositories and CRIS systems are increasingly overlapping, requiring interoperability and integration. This is a big challenge, and it demands a clear and sustainable strategic vision. In developing the CRIS over the past years, at Radboud University we have been cooperating with researchers to make sure that the CRIS is in fact useful for the researchers. While we continue to do that, and adjust the CRIS to their needs, we are aware that we also have to team up with the university’s policy makers and managers, such as the executive board, the faculty and institutes managers, and their data steward and CRIS managers. We need to make sure that the policy makers and managers are involved when developing infrastructures, including CRIS’s, as it are the policy makers and managers who decide on and monitor if and how research information is going to be FAIR. The availability of optimal research metadata registered in an integrated system, is essential to guarantee the findability of research information and is therefore a cornerstone to Open Access and Open Science. This is an important conclusion that should be taken to heart by managers and policy makers.

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