Incentivising sustainable and collaborative research

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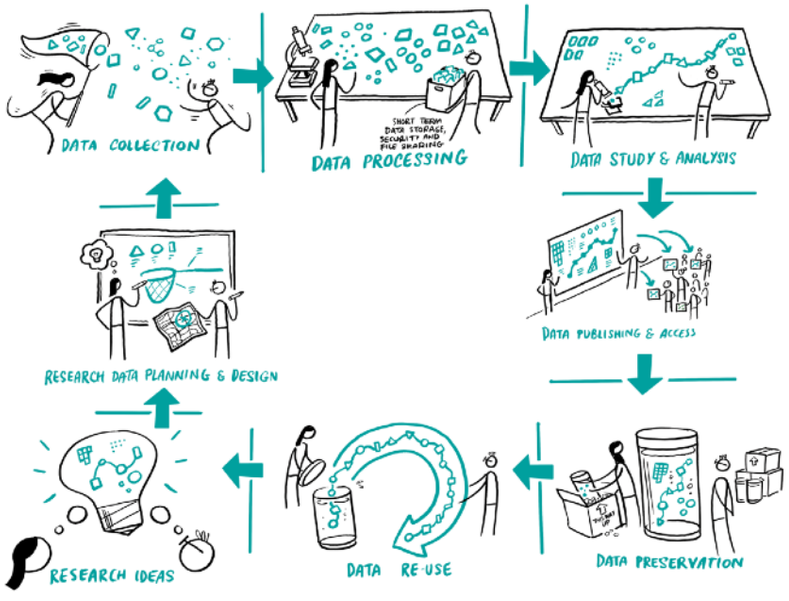
Hello, I am Rachael Ainsworth and I am the Research Software Community Manager at the Software Sustainability Institute, the UK's national facility promoting the advancement of software in research. Thank you to the organisers for inviting me to share my thoughts on incentivising sustainable and collaborative research.



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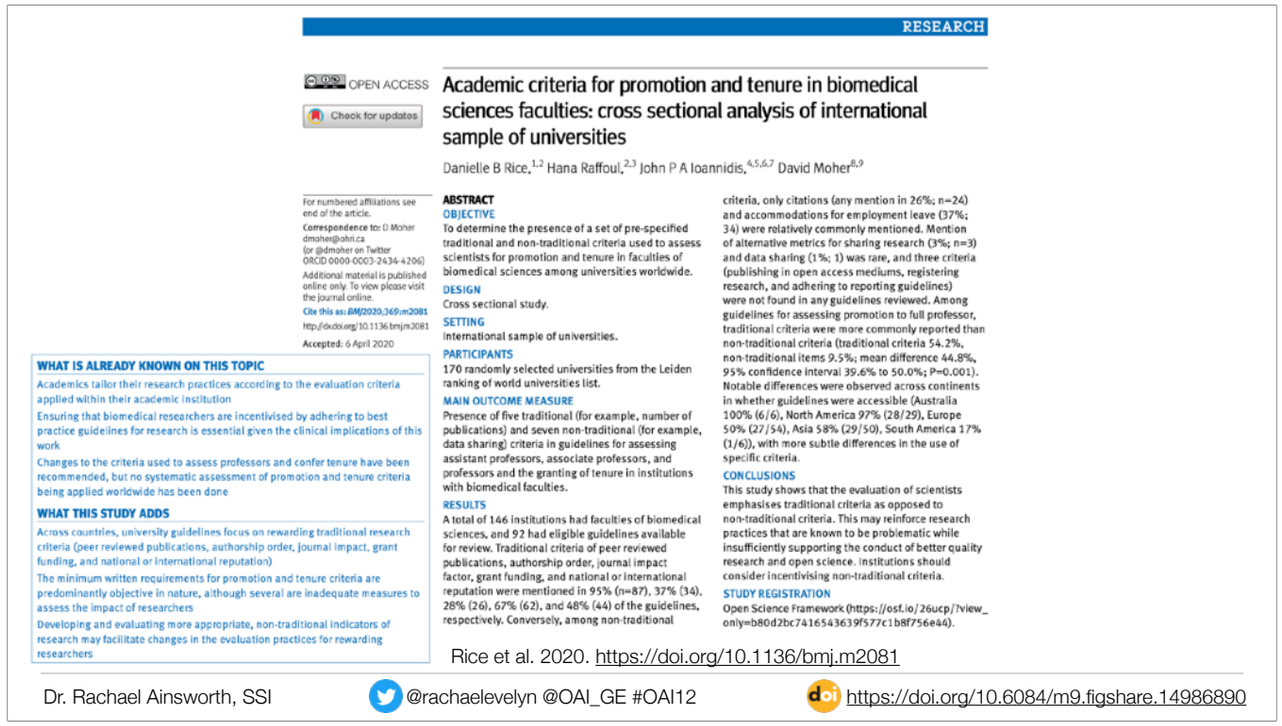
We are experiencing a strong movement towards reproducible and open research, which has presented new challenges and opportunities with regards to ensuring the rigour and integrity of data-intensive science.

Embedding openness and reproducibility within every stage of the research workflow is not trivial: from the initial research questions, planning and design, to the collection, processing and analysis of research data, to the publication, accessibility and preservation of research outputs to enable reuse. It is also not yet fully supported or incentivised within modern research culture.



RESEARCH

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Academic criteria for promotion and tenure in biomedical sciences faculties: cross sectional analysis of international sample of universities

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WHAT IS ALREADY KNOWN ON THIS TOPIC

Academics tailor their research practices according to the evaluation criteria applied within their academic institution

Ensuring that biomedical researchers are incentivised by adhering to best practice guidelines for research is essential given the clinical implications of this work

Changes to the criteria used to assess professors and confer tenure have been recommended, but no systematic assessment of promotion and tenure criteria being applied worldwide has been done

WHAT THIS STUDY ADDS

Across countries, university guidelines focus on rewarding traditional research criteria (peer reviewed publications, authorship order, journal impact, grant funding, and national or international reputation)

The minimum written requirements for promotion and tenure criteria are predominantly objective in nature, although several are inadequate measures to assess the impact of researchers

Developing and evaluating more appropriate, non-traditional indicators of research may facilitate changes in the evaluation practices for rewarding researchers

ABSTRACT

OBJECTIVE
To determine the presence of a set of pre-specified traditional and non-traditional criteria used to assess scientists for promotion and tenure in faculties of biomedical sciences among universities worldwide.

DESIGN
Cross sectional study.

SETTING
International sample of universities.

PARTICIPANTS
170 randomly selected universities from the Leiden ranking of world universities list.

MAIN OUTCOME MEASURE
Presence of five traditional (for example, number of publications) and seven non-traditional (for example, data sharing) criteria in guidelines for assessing assistant professors, associate professors, and professors and the granting of tenure in institutions with biomedical faculties.

RESULTS
A total of 146 institutions had faculties of biomedical sciences, and 92 had eligible guidelines available for review. Traditional criteria of peer reviewed publications, authorship order, journal impact factor, grant funding, and national or international reputation were mentioned in 95% (n=87), 37% (34), 28% (26), 67% (62), and 48% (44) of the guidelines, respectively. Conversely, among non-traditional criteria, only citations (any mention in 26%; n=24) and accommodations for employment leave (37%; 34) were relatively commonly mentioned. Mention of alternative metrics for sharing research (3%; n=3) and data sharing (1%; 1) was rare, and three criteria (publishing in open access mediums, registering research, and adhering to reporting guidelines) were not found in any guidelines reviewed. Among guidelines for assessing promotion to full professor, traditional criteria were more commonly reported than non-traditional criteria (traditional criteria 54.2%, non-traditional items 9.5%; mean difference 44.8%, 95% confidence interval 39.6% to 50.0%; P=0.001). Notable differences were observed across continents in whether guidelines were accessible (Australia 100% (6/6), North America 97% (28/29), Europe 50% (27/54), Asia 58% (29/50), South America 17% (1/6)), with more subtle differences in the use of specific criteria.

CONCLUSIONS
This study shows that the evaluation of scientists emphasises traditional criteria as opposed to non-traditional criteria. This may reinforce research practices that are known to be problematic while insufficiently supporting the conduct of better quality research and open science. Institutions should consider incentivising non-traditional criteria.

STUDY REGISTRATION
Open Science Framework (https://osf.io/26ucp/?view_only=b80d2bc7416543639f577c1b8f756e44).

Rice et al. 2020. https://doi.org/10.1136/bmj.m2081

Studies show that the evaluation of researchers still emphasises traditional criteria (such as number of publications, authorship order in publication, journal impact factor, and grant funding status) over more collaborative criteria (such as data sharing, open-access publication, registration of studies, and alternative metrics for sharing research). [1]

This emphasis on traditional criteria in evaluation and promotion is highly focused on the publication outputs of the individual, instead of the process by which the research is conducted. It does not reward reproducible research or open and collaborative science.

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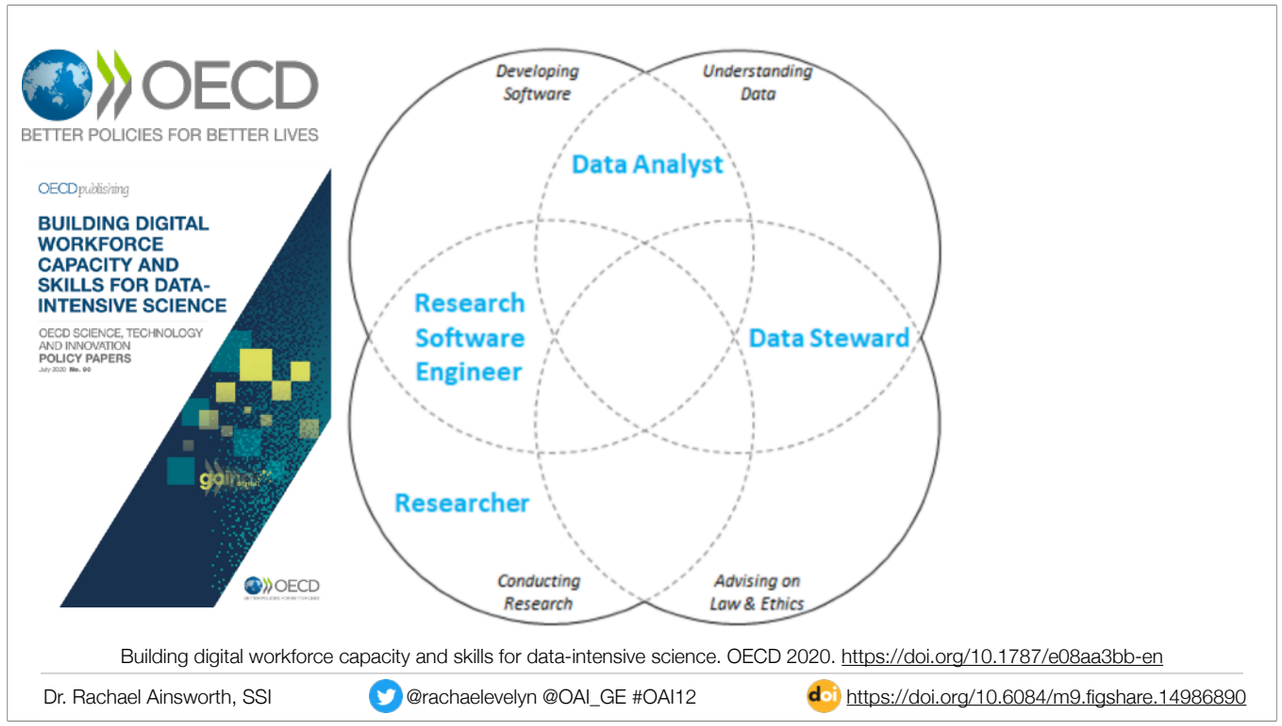
[1] Rice et al. 2020. https://doi.org/10.1136/bmj.m2081



Building digital workforce capacity and skills for data-intensive science. OECD 2020. https://doi.org/10.1787/e08aa3bb-en

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But modern research requires collaboration between individual scientists, research teams, data service providers, research infrastructures and institutions. It is increasingly recognised that data intensive science requires not only technical skills in experimental design, software development, and data management, but also people-focused skills, such as communication and team working. In many fields there is also a need for ethical and legal expertise, particularly when sensitive data is being used. Science needs both digitally skilled researchers and a variety of professional research support staff, in order to ensure rigour and integrity along the entire research workflow. [2]

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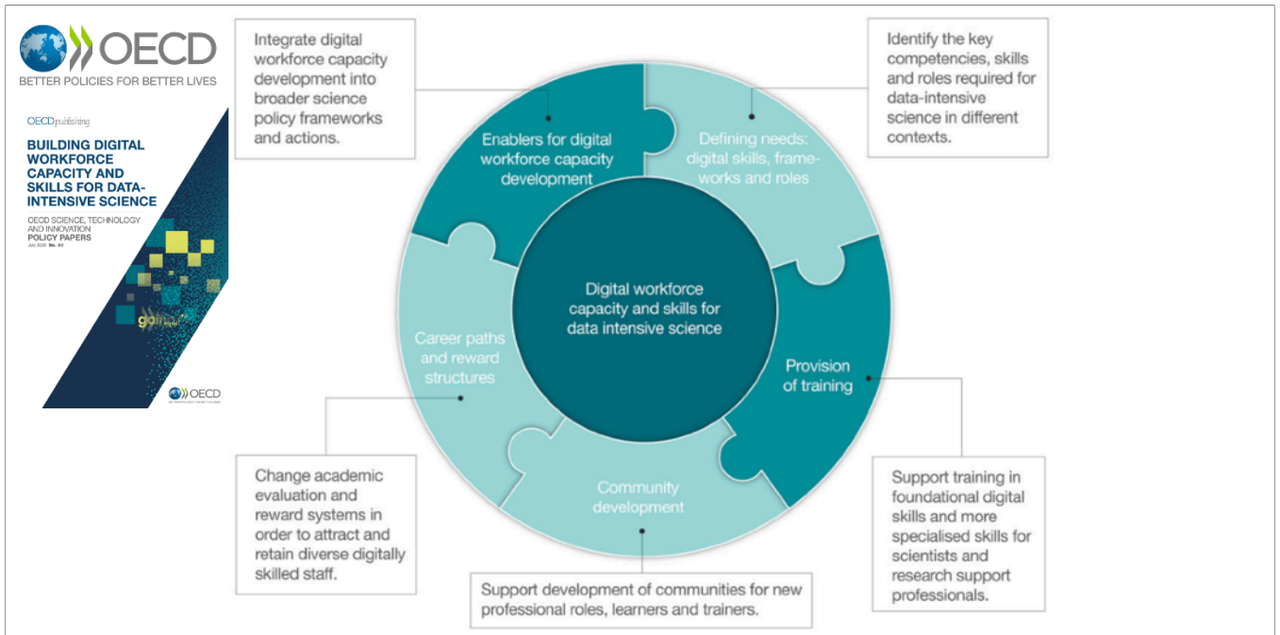
[2] Building digital workforce capacity and skills for data-intensive science. OECD 2020. https://doi.org/10.1787/e08aa3bb-en



Building digital workforce capacity and skills for data-intensive science. OECD 2020. https://doi.org/10.1787/e08aa3bb-en

The Organisation for Economic Co-operation and Development identified key action areas that need to be addressed in order to build and maintain this digital workforce capacity for science. They include supporting the development of communities for new professional roles, learners and trainers, and changing academic evaluation and reward systems in order to attract and retain diverse digitally skilled staff. [2]

In this talk, I will highlight some of the progress in these areas to build systemic change towards reproducible, sustainable and collaborative research.

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[2] Building digital workforce capacity and skills for data-intensive science. OECD 2020. https://doi.org/10.1787/e08aa3bb-en

Emerging roles that enable reproducible, sustainable and collaborative research

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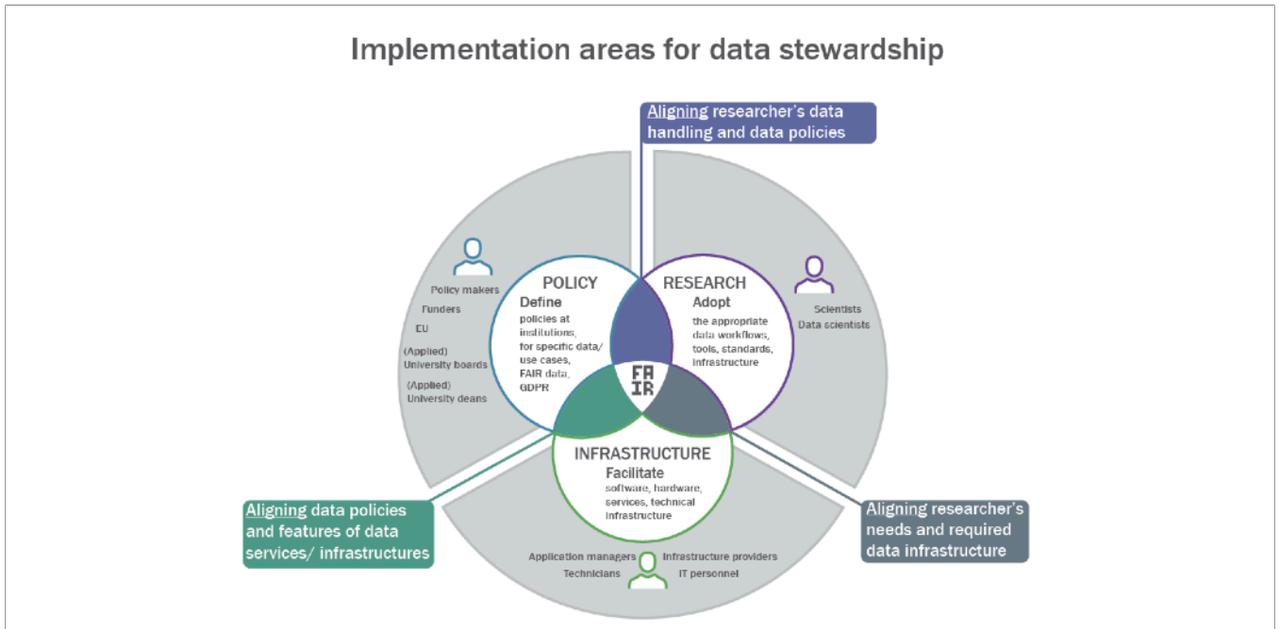
I will begin by highlighting some of the professional research support roles that are emerging.



The first is the Data Steward.

Data stewardship is the responsible planning and executing of all actions on digital data before, during and after a research project, with the aim of optimising the usability, reusability and reproducibility of the resulting data. It is crucial for good scientific practice and research excellence as it enables long-term and sustainable care across multiple research cycles. [3]

There has therefore been a lot of effort, particularly in the Netherlands, to professionalise the data steward function. However, there is currently a lack of consensus around the responsibilities, tasks, required knowledge, skills, and abilities, which hampers adequate data steward capacity and complicates efficient data management and handling in the various scientific disciplines. It also makes recognition, reward, training and progression for the data steward as an essential part of the research process difficult. [3]

This report by Scholtens et al. works towards a common job description and agreement on the required competencies, and identifies that Data Stewards at the interfaces of policy, research, and infrastructure ensure that research carried out at institutions and in projects produces FAIR data - that is ensuring that research data are findable, accessible, interoperable and reusable - along the data life cycle.

Furthermore, Data Stewards will be essential to help researchers interact with emerging national and international data infrastructures (such as the European Open Science Cloud) which aim to provide a trusted virtual environment enabling open and seamless services for data storage, management, analysis, sharing, and reuse, across disciplines. [3]

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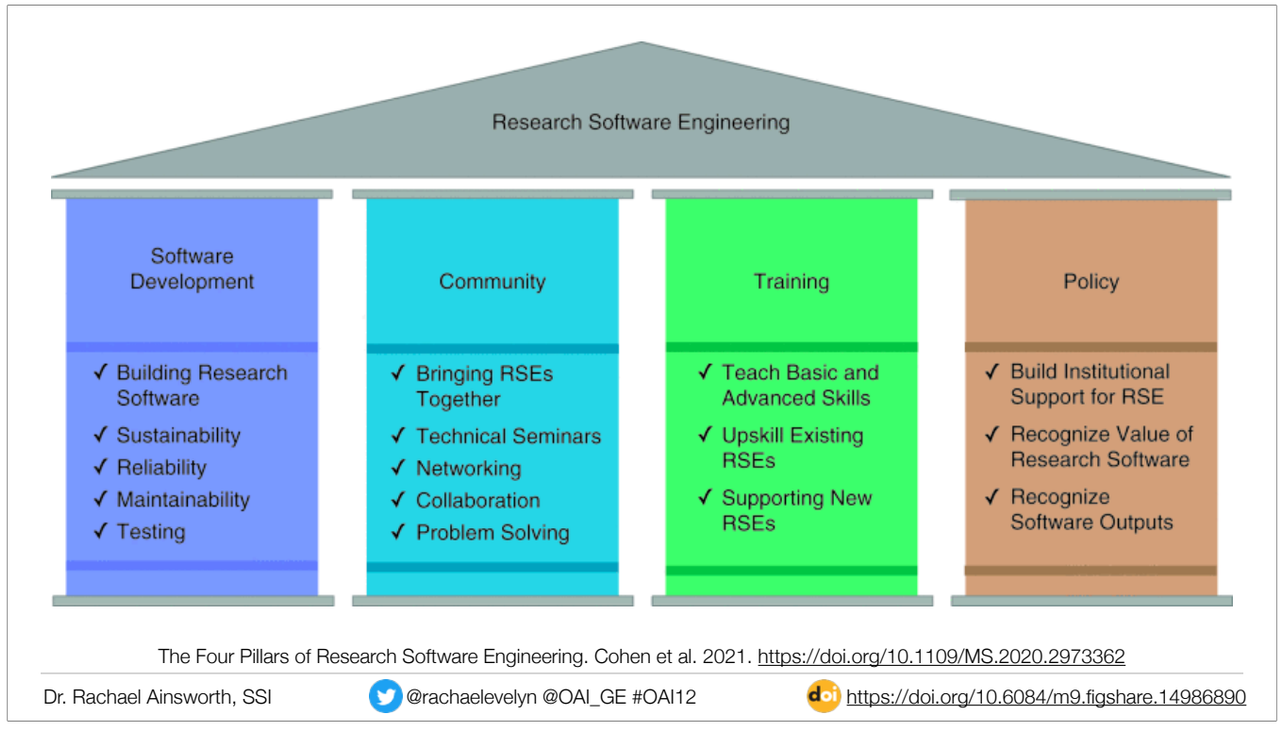
[3] Report: Towards FAIR data steward as profession for the lifesciences. Scholtens et al. 2019. https://doi.org/10.5281/zenodo.3471707



The Four Pillars of Research Software Engineering. Cohen et al. 2021. https://doi.org/10.1109/MS.2020.2973362

The second research support role that I want to highlight is the Research Software Engineer.

Software is vital to research and data-intensive science, which increasingly needs to adopt advanced computational processes to manage and understand research data. This article on the Four Pillars of Research Software Engineering illustrates that good research software can make the difference between valid, sustainable, reproducible research outputs and short-lived, potentially unreliable or erroneous outputs. [4]

The past few years have seen the emergence and rapid growth of the concept of research software engineering, which combines professional software engineering expertise with an intricate understanding of research. Discussions initiated by the Software Sustainability Institute in 2012 identified that this combination of skills was extremely valuable, but there was no formal place in the academic system at the time for the people who write, maintain, and manage research software. This meant that there was no easy way to recognise their contributions, reward them, or represent their views. [5]

Since then, the Institute has campaigned to raise awareness of the role of the Research Software Engineer and to build a community around it, with the aim that if we could support the rise of expert software developers in academia, there would be a growth of reliable, well-engineered research software which provides reproducible results. Research Software Engineers are now increasingly seen as critically important members of research teams and institutions to facilitate this. [5]

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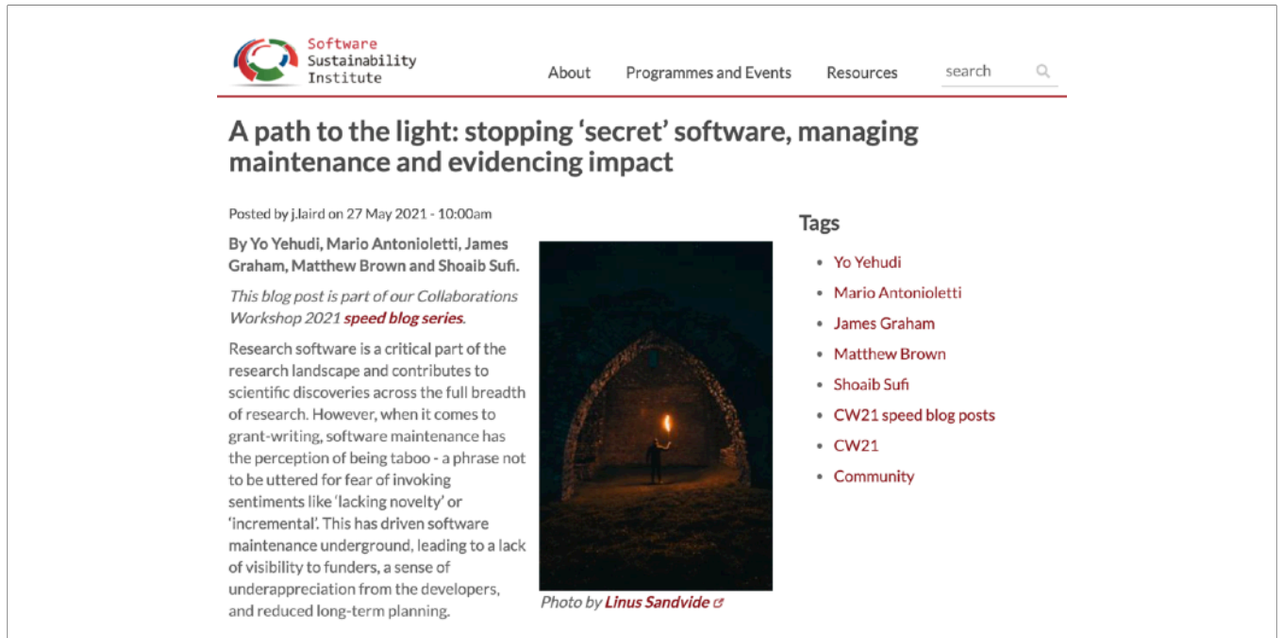
[4] The Four Pillars of Research Software Engineering. Cohen et al. 2021. https://doi.org/10.1109/MS.2020.2973362
[5] https://software.ac.uk/research-software-engineers



Although more funders are recognising the importance of providing funding for research software development, this is normally focused on the development of new or novel software for a particular research project and not on its long-term sustainability or maintenance. [6]

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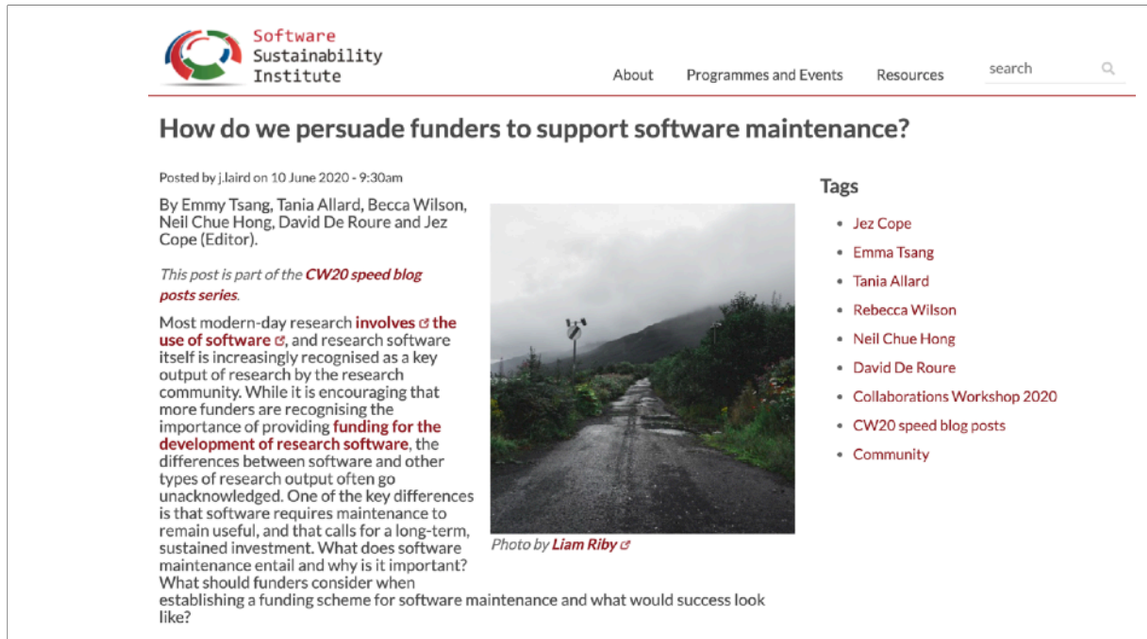
[6] https://software.ac.uk/blog/2021-05-27-path-light-stopping-secret-software-managing-maintenance-and-evidencing-impact



https://software.ac.uk/blog/2020-06-10-how-do-we-persuade-funders-support-software-maintenance

However, research software often continues to be of use for years, if not decades, requiring maintenance to realise its full value. I love the quote from this blog post which states, “Hardware changes, languages and tools develop, bugs are found, needs evolve, and unless the software is updated to reflect this it will become increasingly full of potholes, like an unmaintained road.” [7]

Furthermore, as research teams seek to work in a truly open manner, using open source software can become an issue to reproducibility. This is because these tools rely on their communities to maintain them, which is not always sustainable, or they get bought out and merged into commercial offerings. So as a researcher, you can work entirely openly and still discover in a few years’ time that your work is not reproducible because the software has not been maintained or no longer exists.

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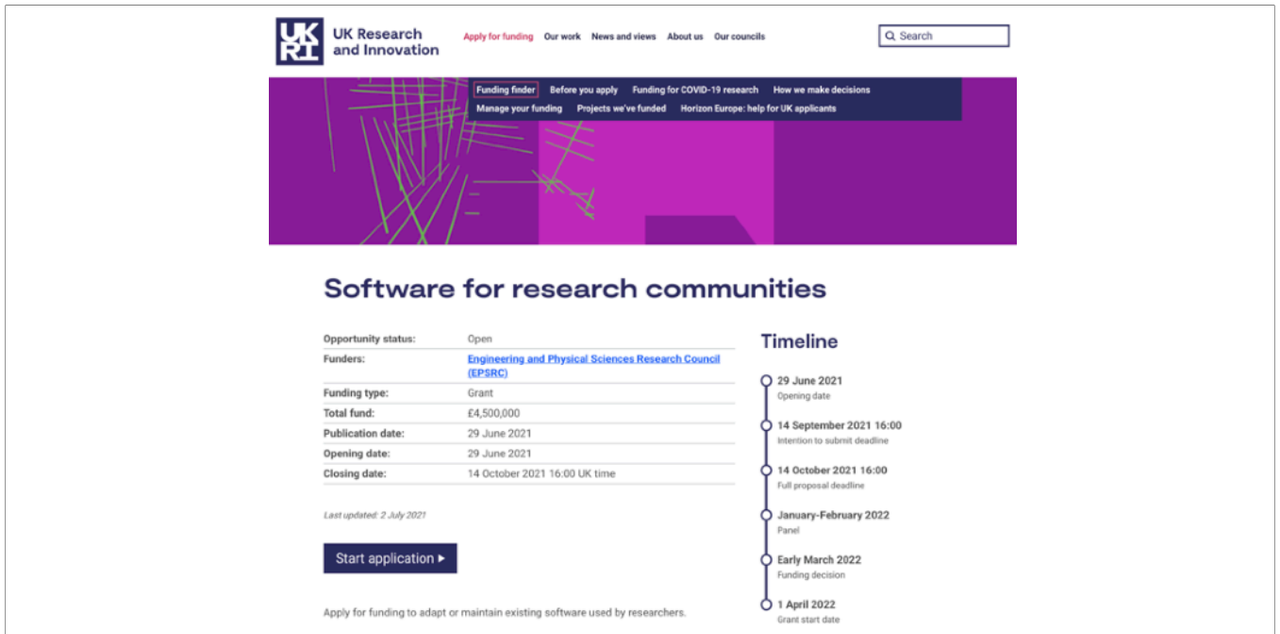
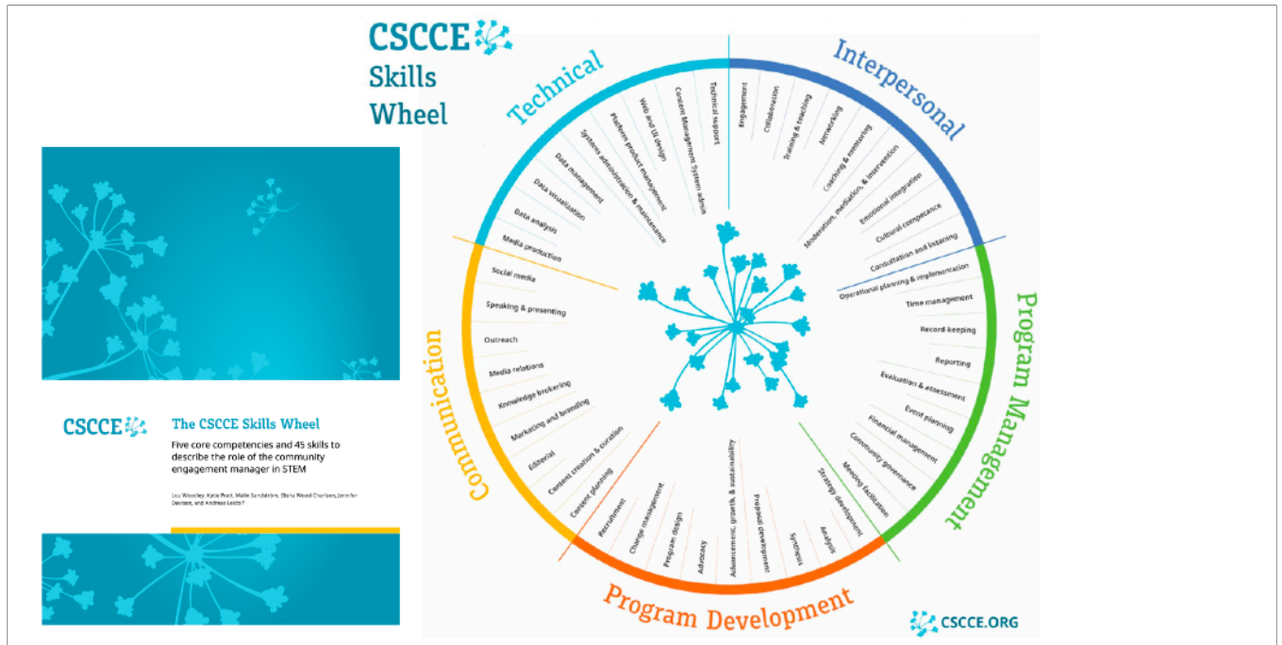
[7] https://software.ac.uk/blog/2020-06-10-how-do-we-persuade-funders-support-software-maintenance



https://www.ukri.org/opportunity/software-for-research-communities/

So in addition to fully professionalising and supporting career paths for Research Software Engineers, software maintenance must also be incentivised and funded to facilitate reproducible research. This initiative to provide funding to adapt or maintain existing software used by researchers by UK Research and Innovation is a very welcome start.



The Center for Scientific Collaboration & Community Engagement Skills Wheel. Woodley et al. 2021. https://doi.org/10.5281/zenodo.4437293

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The third research support role that I want to highlight is the Community Engagement Manager.

Science is inherently a community-based endeavour. The generation, validation, and dissemination of knowledge requires a network of diverse roles and a range of community configurations to meet specific needs. [8]

Communities in science are also key to the ongoing cultural shifts in how science is carried out - from reproducibility and open science to diversity, equity and inclusion efforts, communities provide places to try, iterate, and adopt new norms. They are the best places to cultivate and nurture a culture of sustainable and collaborative research. [8]

Scientific community management is an emerging role found in a range of different contexts including communities of practice, professional associations, infrastructure organisations, and research collaborations. The essential function of a community manager is to align community member goals and create and maintain pathways by which members can engage with one another and/or the community's projects. The Centre for Scientific Collaboration and Community Engagement is working to professionalise and institutionalise the role of the community engagement manager within science. [8]

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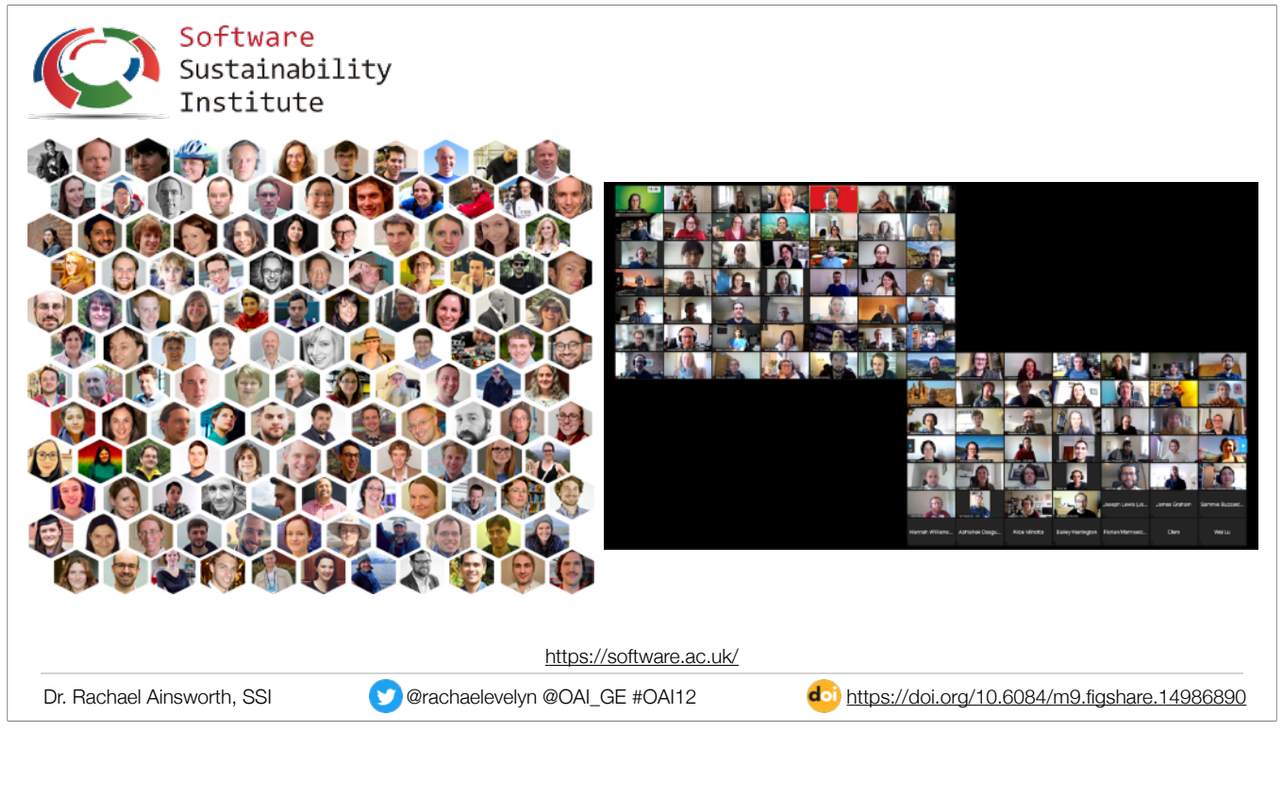
[8] The Center for Scientific Collaboration & Community Engagement Skills Wheel. Woodley et al. 2021. https://doi.org/10.5281/zenodo.4437293



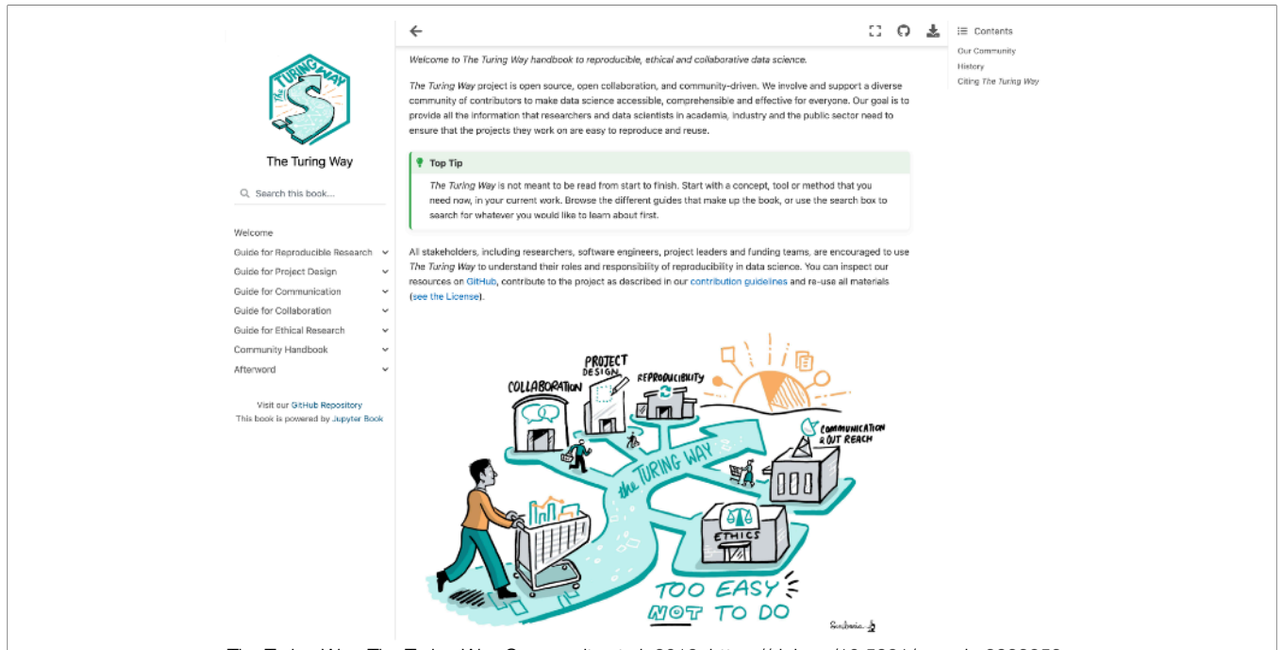
As a Community Manager at the Software Sustainability Institute, I build community through activities such as the Institute's Fellowships Program, which provides funding for researchers who want to improve how research software is used in their domains and/or area of work. I also manage the Institute's premier annual unconference event, the Collaborations Workshop, which brings together all stakeholders within the research software community to explore best practice and shape the future of research software.

It was through discussions at Collaborations Workshop 2012 where the Research Software Engineering movement began. There have also been ongoing discussions through Collaborations Workshop and the Fellowship network on how we can ensure the long-term sustainability and maintenance of research software, which resulted in the blog posts I showed a few slides back.

Building community is important for promoting and empowering new and collaborative ways of working.

Collaborative ways of working

Now I will highlight some initiatives which are not only successfully providing resources and training to improve practices within data-intensive science, but are also inspiring examples of open and collaborative projects.



The Turing Way. The Turing Way Community et al. 2019. https://doi.org/10.5281/zenodo.3233853

The first is The Turing Way project.

We know that reproducible research is necessary to ensure that scientific work can be trusted, and we've seen that it means understanding data management and software development: skills that are not widely taught or expected of academic researchers and data scientists. [9]

The Turing Way is an open source collaborative project that aims to help researchers, software engineers, project leaders and funding teams understand their roles and responsibilities of reproducibility in data science. It involves and supports its members of diverse skills and backgrounds to ensure that data science is accessible and useful for everyone. Its moonshot goal is to make reproducible research "too easy not to do". [9]

It comprises a handbook, with guides for reproducible research, project design, communication, collaboration and ethical research. The project and community has grown significantly in the past two years as a result of absolutely brilliant community management. There are currently over 170 sub-chapters across the five guides and more than 275 direct contributors on GitHub where the resources are openly developed. Contributors include researchers, research software engineers, data stewards, librarians, community managers and YOU! Everyone is invited to get involved and there are already thousands of users. [9]

In order to ensure that community members are able to participate irrespective of their previous experience of working with the open source or data science community, the project provides the resources, guidance, templates, training and pathways to stay involved in the community. All these practices are recorded within the community handbook so that they can be adopted by other open source communities. [9]

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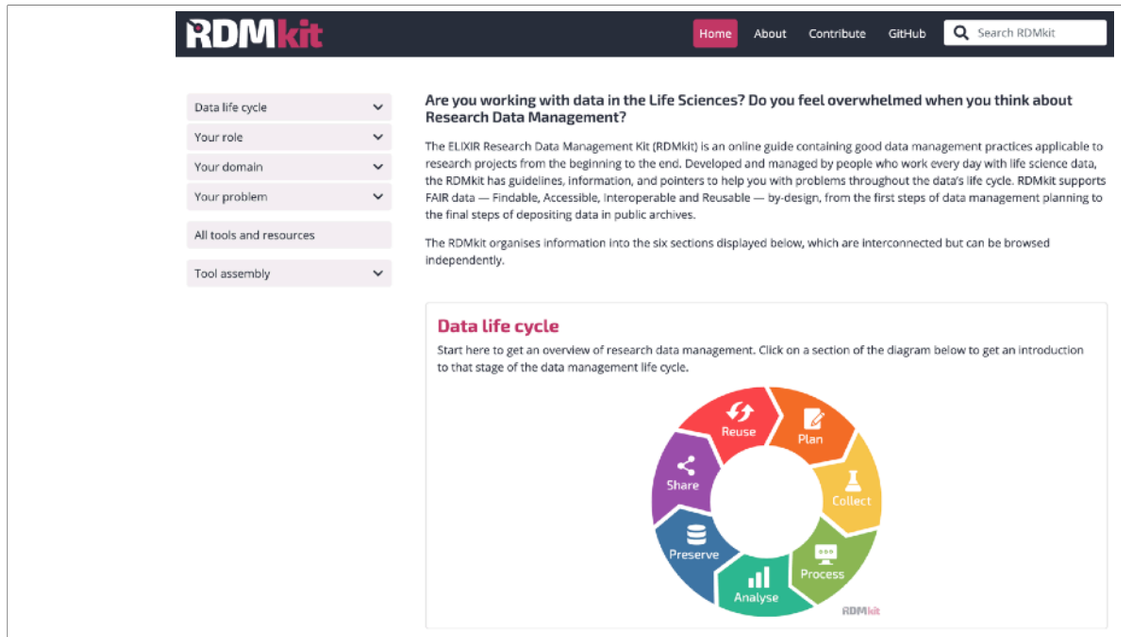
[9] The Turing Way. The Turing Way Community et al. 2019. https://doi.org/10.5281/zenodo.3233853



ELIXIR (2021) Research Data Management Kit. https://rdmkit.elixir-europe.org

A similar project is the RDMkit.

We have talked about how the increasing volume, complexity and speed of data creation has required researchers to increasingly rely on computational support. The FAIR principles place specific emphasis on enhancing the ability of machines to automatically find and use data, as well as supporting its reuse by other researchers, which facilitates knowledge discovery and improves research transparency. [10]

However, researchers need relevant tools and guidance to better manage their data and make FAIR a reality. The ELIXIR Research Data Management Kit (or RDMkit for short) is another open source community project to develop an online guide containing good data management practices applicable to research projects from the beginning to the end. It is also openly developed on GitHub and provides multiple pathways to contribute. [10]

Both The Turing Way and RDMkit projects solve skills gaps and demonstrate collaborative ways of working by actively nurturing their respective communities, and valuing and acknowledging the diverse range of contributions to the projects.

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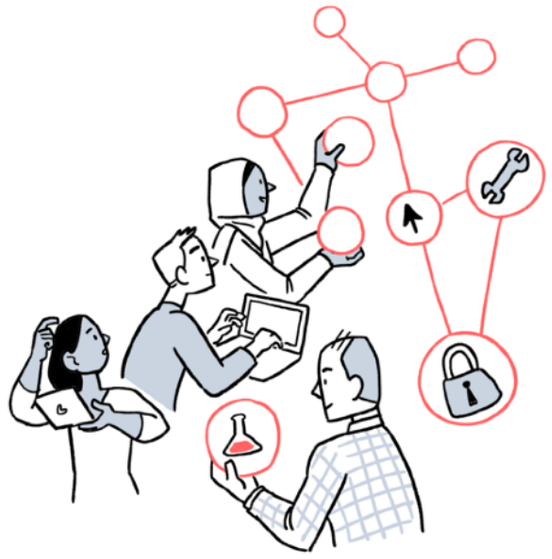
[10] ELIXIR (2021) Research Data Management Kit. https://rdmkit.elixir-europe.org



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These emerging roles and ways of working highlight how unfit current measures of success in research are, which are still highly focused on the publication outputs of the individual researcher. It means that there are a myriad of contributors to the research process who are undervalued and unrewarded within the current evaluation system, and have difficulty progressing even though they are crucial for research data, software and project management. Recognising the value of each skill set and providing progression opportunities is critical. However, the long-term career pathways needed for these new professional research support roles are only emerging very slowly.

Systemic solutions such as promoting collaborative ways of working and professionalising these alternative but essential roles to support them, such as Research Software Engineers, Data Stewards and Community Managers, can lead to more sustainable, reproducible and efficient research and a much healthier research culture.