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DISCUSSION

Open Science

Towards Greater Transparency and Openness in Science

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1 Introduction

Alexander Maedche

Open Science is a movement for greater transparency and openness in science, which is increasingly having an impact on everyday scientific work and life in all scientific disciplines. Open Science is an umbrella term that "…combines various movements and practices aiming to make multilingual scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community" (UNESCO 2021). In this sense, Open Science activities are not limited to providing open scientific knowledge (e.g., through open access, open data, open source, open methodology, open educational resources, etc.) using Open Science infrastructures, but in addition emphasize accelerating an open dialogue and open engagement with societal actors (e.g., through citizen and participatory science, inclusion of marginalized scholars, etc.). Figure 1 depicts the spectrum of Open Science activities along the pillars proposed by UNESCO (2021):

The adoption of Open Science activities differs greatly between scientific disciplines and there are many understandable reasons for this, including specific disciplinary priorities, established norms and standards as well as possible constraints (e.g., data privacy considerations). Open Science activities also are gradually becoming part of the everyday scientific work and life of researchers in the BISE Community. This was also the reason for triggering two Open Science-centric initiatives within the BISE community in 2022/23: 1) a survey study, and 2) a panel discussion.

First, to better understand the status quo of Open Science activities in the BISE community a survey study was carried out in the fall 2022. The survey study replicated an existing study on the topic of Open Science in Economics and Management carried out by the Leibniz Information Centre for Economics (ZBW) in the year 2019 (Scherp et al. 2020). Overall, 76 responses from BISE researchers were collected. The study results confirm that Open Science is considered to be a very important topic in the BISE community. However, currently only open access and open source software seem to play an important role in the daily life of BISE researchers. Thus, there is a gap between the broad range of potential Open Science activities and the performed activities in the BISE community. Multiple reasons were raised in the survey that hinder consequently following the Open Science approach. This includes, for example, a considerable time effort, high costs, unclear legal frameworks, a lack of incentives, or limited community awareness. Participants in the survey also expressed

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the need for further support, e.g., dedicated workshops, community-centric knowledge transfer platforms, etc. Overall, the results of the survey show that there is a need for action in the BISE community with regard to Open Science.

Second, a panel discussion on the role of Open Science in the BISE community was organized and carried out at the 18th International Conference on Wirtschaftsinformatik (WI 2023) in Paderborn on 18 September 2023. At the event, the spectrum Open Science activities as well as selected results of the survey study were presented. Subsequently, challenges and opportunities of implementing Open Science were discussed by the panelists. Different opinions with regard to expected Open Science benefits such as higher efficiency and quality, the intensification of collaboration, increased impact and visibility as well as faster knowledge accumulation and better knowledge transfer were exchanged. Also, in terms of challenges, the panelists took different perspectives on possible issues ranging from reluctance to change, time and effort, lacking incentives, legal issues, costs, or lack of knowledge.

With this BISE discussion we hope to stimulate a fruitful debate and intensify an exchange within the BISE community on the increasingly important topic of Open Science.

2 The Social Dilemma of Open Science: Balancing Collaboration and Competition in Academic Research

Edona Elshan

The transition to Open Science heralds a profound cultural shift, proposing a reimagining of the academic landscape with a view to creating a more inclusive and collaborative environment for research (Mancini et al. 2019). This movement aims at making scientific research and educational resources universally accessible and reusable by dismantling the ivory towers of knowledge gatekeeping (Friesike et al. 2015). The ambition is clear: by facilitating freer and earlier access to scientific processes and results, Open Science endeavors to bolster public trust in scientific findings and catalyze the pace of innovation. In doing so, it aspires to a future where scientific knowledge is not just a commodity to be consumed but a shared asset that can be built upon collectively (Minelli et al. 2018).

Central to the ethos of Open Science is the resolution of a persistent social dilemma, reminiscent of the ’tragedy of the commons’ that Ostrom (1990) elucidated. Knowledge, when considered a common property, is a resource that requires judicious management to prevent its depletion by individualistic pursuits. The academic sphere, traditionally marked by a competitive drive for personal achievement and tenure, finds itself at odds with this communal approach. Open Science posits a scenario where the individual’s rational decision to withhold knowledge for personal advancement must be weighed against the collective advantage of shared intellectual capital. This dilemma underpins a significant tension in Open Science: the theoretical support for a collaborative ethos is often overshadowed by the practical realities and incentives that prioritize individual achievement. Such a paradox challenges the community to devise a framework that promotes sharing and openness while also protecting individual academic contributions from being overlooked or exploited (Murphy et al. 2020).

Thus, Open Science imposes upon scholars a duty that extends well beyond traditional academic endeavors. The

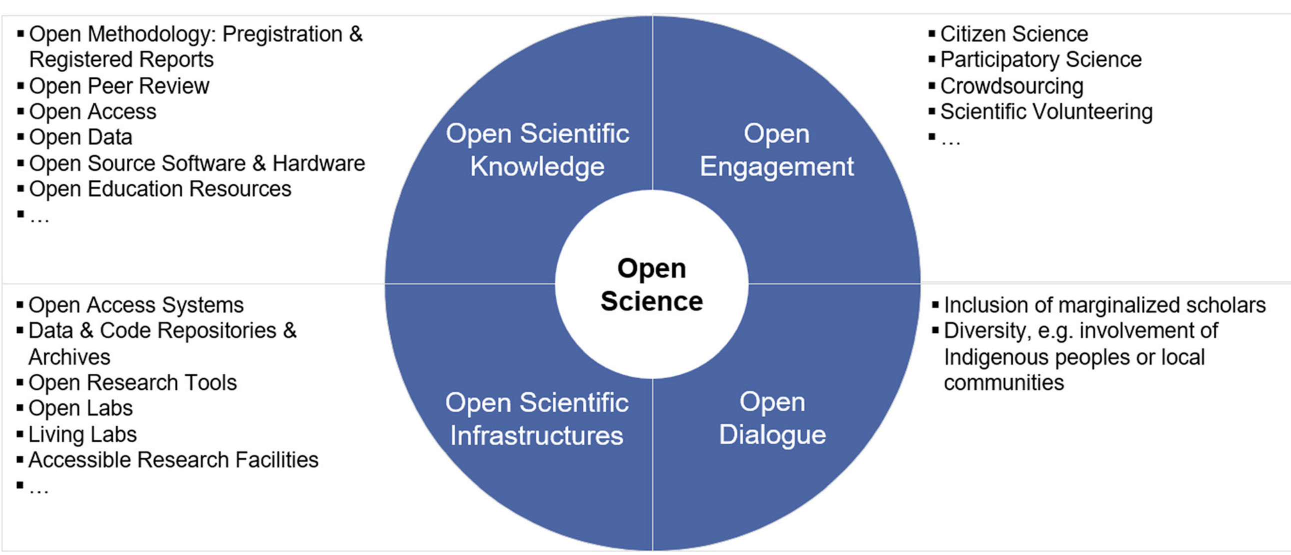

Fig. 1 Spectrum of Open Science Activities

researcher's role is expanded to include the meticulous documentation and sharing of the scientific process, from preliminary hypotheses to methodologies, from raw data to negative results. This practice embodies the ideal of transparency, presenting the entirety of the research life-cycle to public scrutiny. However, the practicalities of this approach are fraught with challenges. The preparation of transparency materials is a labor-intensive endeavor that, in the absence of universally accepted guidelines, can be burdened with uncertainty (Mancini et al. 2019). Researchers grapple with questions of how much detail is sufficient, which aspects of their work might be of value to the community, and how to effectively communicate the complexities of their research to a diverse audience (Robson et al. 2021).

This additional labor comes at a cost, both in terms of time and resources, and the current academic reward structures do not adequately compensate for these investments. Furthermore, the pressure to maintain high productivity levels adds to the already significant workload of researchers, potentially leading to burnout and a dilution of research quality (Banks et al. 2019). The stakes are particularly high for early-career researchers, who must establish their credibility in an environment that may not yet fully value the principles of Open Science (Cook et al. 2018).

The ambiguity surrounding the expectations for transparency materials also poses a dilemma: while comprehensive documentation can enhance the reproducibility and integrity of research, it also increases the risk of intellectual property issues, including misappropriation and misinterpretation. Researchers must navigate the fine line between sharing enough to contribute to the collective knowledge pool and protecting their own scholarly interests (Ignat and Ayris 2020).

The systemic issues that impede the full realization of Open Science are rooted in long-standing academic traditions. The prevailing metrics of academic success – publication in high-impact journals, citation counts, and the securing of competitive grants – are often misaligned with the values of Open Science. These traditional markers of success emphasize scarcity over abundance, exclusivity over inclusivity, and individual achievement over communal progress (Sidler 2014).

The reluctance to embrace Open Science is further compounded by the apprehension that sharing one's work openly could lead to being scooped by competitors or criticized for incomplete or preliminary findings. This fear is not unfounded, as the nature of academic progression can often penalize those who deviate from established paths to success. To mitigate these systemic issues, there is a need for a fundamental reevaluation of what constitutes academic excellence. Institutions must begin to recognize and reward the contributions of researchers who are committed to the principles of Open Science. This could include the development of alternative metrics that value transparency, reproducibility, and collaborative endeavors. Moreover, funding agencies and academic journals must also play their part by incentivizing Open Science practices through their policies and requirements (Hekler and King 2020).

The advent of digital technologies has been a double-edged sword for Open Science (Lievrouw 2010). On one hand, it has facilitated the dissemination of knowledge at an unprecedented scale, enabling researchers to share their findings instantaneously with a global audience through conceptual data systems on the cloud (Bugbee et al. 2020). Navigating the complexities of copyright, data privacy, and digital rights management has also become an essential skill for the modern researcher. For young scholars, this means not only mastering their scientific expertise but also developing proficiency in digital communication and data management. The increased visibility afforded by digital platforms can also be a double-edged sword. While it can lead to greater impact and recognition, it also subjects researchers to heightened scrutiny and criticism. This can be particularly challenging for early-stage research, which may not yet be fully developed or validated. The risk of misinterpretation or misuse of open data is a real concern, requiring careful consideration of how much and in what form information is shared (Syed and Kathawalla 2020).

On the other hand, young scholars, often more adept with digital technologies and social media, can leverage the power of Open Science to build their academic profiles. Open access publications and data sharing platforms can amplify their research impact, leading to increased citations, networking opportunities, and potential collaborations. This visibility can be particularly advantageous in the early stages of an academic career, when establishing a reputation and a research trajectory is crucial. However, these opportunities come with significant responsibilities. Young researchers must learn to balance the openness required by Open Science with the need to protect their intellectual property. They must also be savvy in managing their online presence, ensuring that their digital footprint reflects their professional image and research integrity. This balance is not easily achieved, as the pressure to "publish or perish" persists, even within the context of Open Science. The challenge for young scholars is to navigate these pressures while embracing the principles of openness and collaboration that are central to the Open Science movement (Cudennec et al. 2022).

In general, embracing Open Science requires a prosocial stance, where researchers are willing to share their work for the collective benefit of the scientific community and the broader society (Vicente-Saez and Martinez-Fuentes 2018). This shift towards prosocial behavior is essential in fostering trust within the academic community and encouraging the collaborative spirit that is the hallmark of Open Science. Engaging in Open Science practices, such as data sharing and open peer review, requires a belief in the collective advancement of knowledge. It involves a commitment to transparency and the understanding that science is a communal endeavor that thrives on the sharing of ideas and findings. This commitment, however, is not without its challenges. Researchers must be willing to share their work in the face of potential risks, such as the possibility of being scooped or having their data misused. They must also be open to receiving and responding to feedback from a much broader audience than traditional peer review would entail. The resolution of the social dilemmas inherent in the scientific community relies on the widespread adoption of such prosocial behaviors. By prioritizing the communal benefits of shared knowledge over individual gains, researchers can contribute to a more open and collaborative scientific ecosystem. This, in turn, can lead to more robust and reproducible research, fostering a culture of trust and cooperation (Formica and Curley 2018).

To fully harness the benefits of Open Science, the academic community must transition from a culture of competition to one of collaboration. While competition can stimulate innovation and drive researchers to achieve excellence, it can also lead to redundancy, secrecy, and an inefficient use of resources. Collaboration, on the other hand, promotes the sharing of ideas, resources, and data, leading to a more efficient and productive scientific process. The collaborative nature of Open Science facilitates the replication and verification of research, which are essential for the advancement of science. By working together, researchers can build upon each other's work, leading to a cumulative progression of knowledge. This collaborative approach is particularly important in addressing complex, interdisciplinary challenges that no single researcher or team can tackle alone. However, shifting to a more collaborative model requires not only a change in individual attitudes but also systemic reforms. Academic institutions, funding agencies, and publishers must create incentives for collaborative behaviors and recognize the contributions of all researchers involved in a project. This includes developing new metrics for evaluating research impact that go beyond traditional measures such as citation counts and journal impact factors (Kunz 2021).

Open Science is not merely an abstract ideal; it is a practical imperative for the advancement of knowledge in the twenty-first century. Its promise of a more collaborative, transparent, and accessible scientific enterprise has the potential to revolutionize the way we conduct and communicate research. However, realizing this promise requires a concerted effort to overcome the social dilemmas and systemic barriers that currently hinder its full implementation.

To navigate the cultural shift towards Open Science, the academic community must embrace both individual and collective changes. Researchers must adopt prosocial behaviors that prioritize the communal benefits of shared knowledge, while institutions must reform the academic reward system to align with the values of openness and collaboration. By working together to bridge the gap between the ideal and the reality of Open Science, we can create a future where knowledge is truly a common property – a shared resource that benefits all of humanity (Ramachandran et al. 2020).

3 How the BERD@NFDI Platform Fosters Open Science

Hartmut Höhle

As mentioned in the introduction, the Open Science movement aims to make scientific knowledge openly accessible, available, and reusable for scientists. One of the four open science pillars proposed by UNESCO (2021) is the concept of Open Science infrastructures. The goal of the BERD@NFDI platform matches the concept of Open Science infrastructures in aiming to manage publicly available Business, Economic, and Related Data (BERD). BERD aims to offer an extensive array of services and tools designed to streamline the search, collection, indexing, processing, analysis, and preservation of both data and algorithms. This comprehensive suite simplifies scientific data management throughout the entire research process. It provides scientists access to a data portal, algorithm collections, training and education offers, and tools and guidance services for working with unstructured data. Below, the BERD platform is discussed in greater detail.

The research domains of business, economics, and other social sciences deal with the relationships among individuals and organizations within a society. Social science disciplines have been using empirical methods for a long time to understand these complex systems. However, unstructured and non-standard data, i.e., new data types that either do not have a previously defined data model or are not organized in a predefined manner (e.g., image, video, audio, or text data), are on the rise. By 2025, 80% of the data processed in economic applications will be available in unstructured form. Music streaming services, for instance, create an unprecedented wealth of data to understand peoples' preferences for music art by capturing who listens to which music, how often, at which time, what music is shared, what the listeners talk about, what images they post, and what they have in common with other musical listeners. In the traditional empirical research model, however, only structured data from standard sources were available to the researcher where analytical methods could be directly applied. In contrast, such unstructured and non-standard data are usually not ready for direct use in empirical models. Hence, a new and enriched empirical research model that accounts for unstructured data and allows for exciting discoveries and social gains through the analysis of unstructured data is required (see Fig. 2). It is at this point that BERD@NFDI comes into play.

BERD@NFDI is a platform for collecting, processing, analyzing, and storing data from business, economics, and related data, with a particular focus on unstructured (big) data such as video, image, audio, text, or smartphone data. As such, BERD is part of the National Research Data Infrastructure (NFDI), which seeks to collect and make datasets reusable for various disciplines in the German science system. The work on BERD was launched in the fall of 2021. Since then, an online platform has been created that facilitates all BERD services and enables easy accessibility. Four key portals will serve as critical access points for the BERD services: the data portal, the analytics portal, the training and education portal, and the services portal. We subsequently describe each of these portals in more detail.

First, the BERD data portal offers an exclusive selection of high-quality unstructured datasets, such as the Youtube 8 M-dataset, the Yelp Business Review data, or Spotify's Million Playlist dataset. These have a high research relevance, as proven by their past use in top research publications within the social sciences. For each dataset on the portal, comprehensive metadata are provided, including author information, general descriptions and variable explanations, dataset size, license information, and keywords. Users can also find previous versions of a dataset, if any, to replicate results from past scientific studies. Finally, BERD also provides publication information for each dataset, i.e., the context in which the data has already been used in other scientific studies. Furthermore, BERD links a dataset to tailored methods that one can use for analysis purposes, including links and first-hand advice for quick implementation (see the section on the analytics portal). Through this, a user can understand the context in which a dataset has already been used and how it can be analyzed and processed to achieve optimal value and insights. In the future, these datasets will also be complemented by a broader, less restrictive collection of data from various sources. These build on the datasets cited in top journals (i.e., the current "demand" of the user community) and provide additional datasets from other resources on top, which are not cited yet but represent novel data sets likely relevant to upcoming research. Next to already scientifically published and used datasets, the data portal also includes a secure data marketplace for controlled data exchange between researchers and industry corporations. Users can submit a research proposal to a participating organization and use the organization's data to answer specific questions with unique datasets unavailable elsewhere. Finally, users can also upload their own datasets from, e.g., funded research projects and share them with co-authors or the corresponding funding institutions. Like this, the data portal allows vast access to unstructured data from past and recent scientific research as well as valuable proprietary corporate data.

Second, the analytics portal extends the data portal to make the available data analyzable, thereby connecting unstructured data to the traditional empirical research model (see Fig. 3). To do so, it interconnects methods

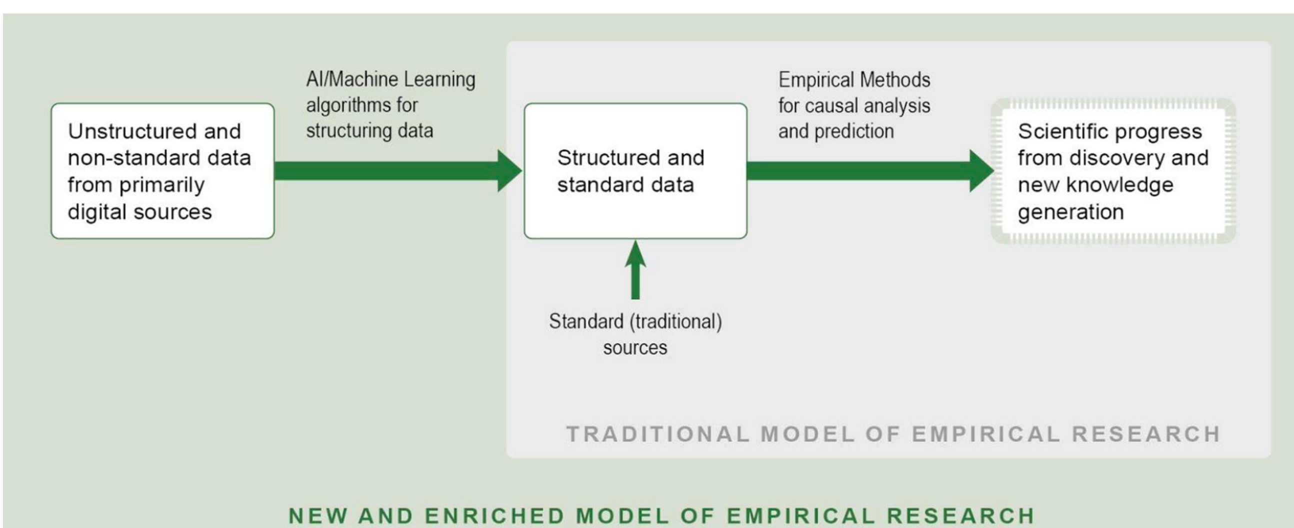

Fig. 2 New and enriched model of empirical research in the social sciences

(both pre-processing and machine learning), general tasks (e.g., sentiment analysis or topic modeling), and datasets from the data portal. Consequently, a user can search for a specific pre-processing method (e.g., related to normalization, feature extraction, filtering, and feature learning techniques), machine learning technique (e.g., support vector machines), or task relating to the analysis of unstructured data. The results will contain metadata and links to all publications in top social science journals that use the searched technique. Alternatively, the user can find method suggestions for a given dataset on the dataset details pages of the data portal. The analytics portal will also enable researchers to find out how the use of a given method or task in top social science journal publications has developed over time. Consequently, the portal helps researchers interested in unstructured data learn how to analyze it, which data is suitable for which task, and which publications using similar methods or datasets already exist. In addition, the portal includes features to process digitized documents, which is a need specifically for historical data sources. Printed (non-digitally created) sources in the social sciences, especially in economics, must first be digitized using text recognition methods to be useful for empirical analyses. It is an essential pre-processing step for non-digital data sources. BERD will, therefore, provide tools that help extract unstructured text from digital images and elaborate a structure.

Third, the training and education portal (also labeled as "BERD Academy") is another integrated module in BERD. Under this name, BERD bundles all educational offers and provides a range of courses, workshops, and other educational materials to promote data literacy in general and the handling of unstructured data in particular. As such, it gives users a vast skill set to use the provided data and analytics methods on BERD for their research purposes. The offers include in-depth workshops, informative webinars, and multiple self-paced data science and analytics learning modules. The courses are freely and openly available, in person or online, and address a mixed audience, including beginners and professionals. 2023 offerings included an in-person series on statistics for the public good, an in-person workshop on AI-based methods for using text as data in the social sciences, online flipped-classroom courses on how to make your research reproducible, lectures and talks on FAIR data and data privacy, as well as events like the DataFEST Germany or Women in Data Science. The established offers will be continued and further developed in the future. The workshops and courses designed for the target groups of researchers and data stewards will be offered regularly and supplemented with customized offers. One focus will be on a needs-specific course on research data management.

Finally, the services portal rounds up the BERD platform by providing additional research-related services and tools. First, it contains an optical character recognition (OCR) recommender service. This service offers recommendations regarding automatic transcription, text recognition, and pre- and post-processing options based on several questions. These outputs can ultimately be used for planning and executing an editorial or digitization project, full-text digitization of specific works, series of works, collections, or corpora. Second, it also provides legal assistance concerning data-related issues. In particular, it helps users to understand the implications of privacy regulations on their work with datasets and data sharing with others. As such, an interactive Virtual Assistant (iVA) has,

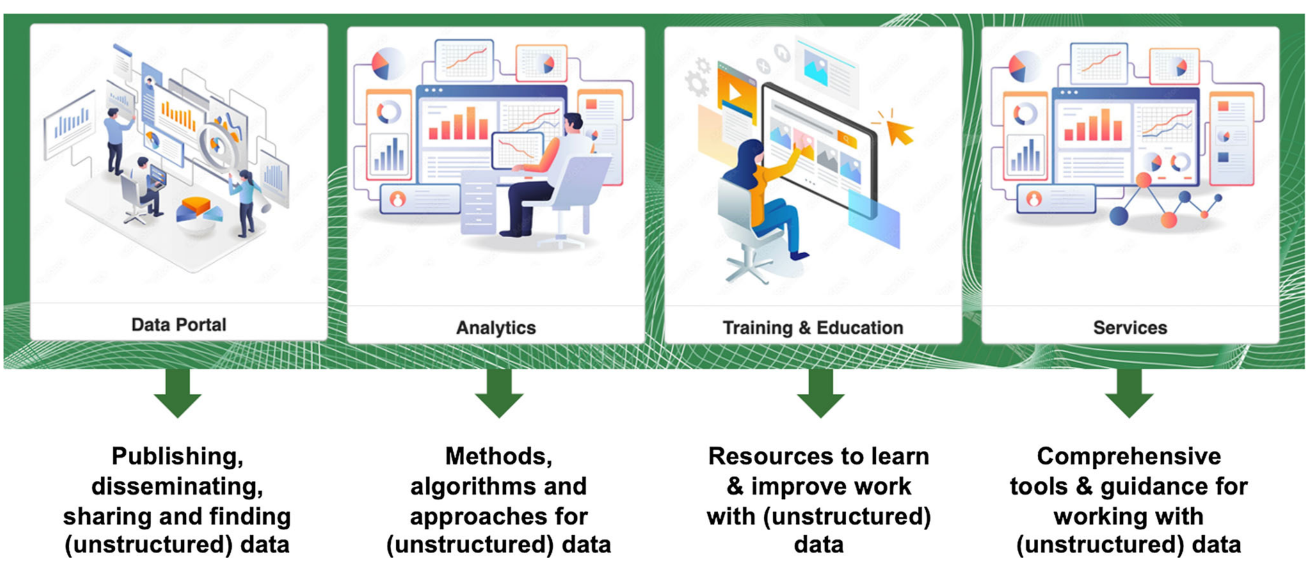

Fig. 3 Four key portals function as key access points of BERD@NFDI services

for instance, been developed that guides the user on whether his or her research data needs to be GDPR-compliant, which requirements need to be fulfilled for lawful data processing consent, and whether the data processing also needs to follow federal or state-based regulations. Third, the services portal also contains knowledge graphs for German company data based on various providers, registers, and time horizons. Notably, the knowledge graph includes information from analog books that are now digitized for the knowledge graph creation using OCR. For instance, the "Aktienführer Knowledge Graph" contains structured (meta) data for the German-listed stock companies from the Hoppenstedt-Aktienführer from 1956 to 2018. It has several external identifiers so that users can easily match it to existing research datasets. Knowledge graphs containing additional information from the German "Reichsanzeiger" and the "Maschinen-Industrie im Deutschen Reich" are currently under development. Using the services portal, a user can, therefore, access additional legal and pre-processing aid while also obtaining access to vast knowledge graph corporate information. Jointly with the data, analytics, and training resources on the platform, BERD users thus experience vast opportunities to work with particularly big and unstructured data in the social sciences.

In sum, the BERD initiative provides an Open Science infrastructure, and each of its four portals is in line with the goals of Open Science, as proposed by UNESCO (2021). BISE readers and scientists will have access to data, algorithm collections, and accessible research facilities.

4 Engaging Societal Actors in BISE Research: From Data Source to Active Collaborator

Christiane Lehrer

The Open Science movement aims to bring science closer to society by promoting accessibility, transparency, and inclusivity in scientific research for the benefit of science and society UNESCO (2021). At its core, it seeks to democratize scientific knowledge by making research results openly accessible while fostering inclusion, equality and sustainability in the production of knowledge itself. Discussions about Open Science often focus on the aspect of open scientific knowledge, including open access to scientific publications and research data. While these are undoubtedly important aspects and rightly discussed, I would like to focus on the potential and challenges of open engagement of societal actors in the process of knowledge creation, which has received less attention so far.

The open engagement of societal actors is one of UNESCO's key pillars for Open Science and involves extending collaboration beyond the traditional scientific community by inviting diverse stakeholders to actively participate in the creation of knowledge UNESCO (2021). This inclusion aims to make the scientific process more accessible to a broader society and to foster a closer connection between research and societal needs. Various new forms of research collaboration such as citizen science, living labs, community-based participatory research, or crowdsourcing are key mechanisms within this paradigm UNESCO (2023). These collaborations are initiated and driven by researchers, policy makers, or represent "bottom-up" initiatives of local communities. Overall, the concept of open engagement represents a paradigm shift in which societal actors are not primarily seen as a source of data, but as active collaborators in the research process.

In my view, the BISE community, with its DNA of inherently crossing traditional scientific boundaries, is well positioned to reap the benefits of open engagement. BISE researchers traditionally work actively with societal actors such as organizations, entrepreneurs and citizens who contribute different perspectives, experiences, and expertise. In this way, BISE research tends to be closely aligned with societal concerns and directed towards providing technology-related solutions to relevant societal problems.

To further reflect on the opportunities and challenges of open engagement in BISE research, I draw on my first-hand experience in the EU-funded project "Digital Health in the Circular Economy" (DiCE 2023), which serves as an illustrative case. The aim of the ongoing project is to develop a circular business model for digital health products like wearables and smart pill boxes. The project involves 20 partners from industry and academia across Europe. Part of the project aims to develop nudging strategies to support reverse logistics and maximize the return rates of digital health devices. What sets this project apart is its emphasis on actively engaging end users – citizens/patients and healthcare professionals – throughout the entire nudge development process. Through a living lab ecosystem across Europe, citizens and professionals participated in a user-centered design process. To account for cultural and regional differences, stakeholders from three regional clusters in Europe (i.e., Slovenia, Spain, and Belgium) participated in co-creation sessions. The close and active engagement of relevant societal actors was facilitated through living labs which have established relationships with local communities and offer an ideal environment for co-creation and real-world testing.

The open engagement approach in the DiCE project not only allowed us to gain a comprehensive understanding of health and sustainability challenges in different contexts. More importantly, it allowed us tap into the collective wisdom, creativity and expertise of local communities and healthcare professionals. This helped us to ensure that the developed reverse logistics solutions align with the actual needs and contexts of the participants. By involving diverse end users in the development phase and later pilot testing, DiCE raises public awareness of sustainability issues related to digital health and ensures that the research outcomes meet societal needs and preferences. This approach has the potential to foster a sense of ownership and empowerment among participants, increase science literacy as well as trust in science as a whole.

However, effective public engagement was not without its challenges. Engaging citizens and professionals in the research process demanded time, effort, and resources. Co-creation and participatory workshops required extensive coordination, preparation, and ongoing facilitation, which is resource intensive. In the DiCE project, this was overcome by relying on the established infrastructure and expertise of living labs. In addition, it was a challenge to ensure equitable involvement of all relevant stakeholders. Certain groups, in our case sick people, their relatives as well as healthcare professionals, usually have limited resources or time, affecting their ability to actively participate. Finally, bridging the gap in expertise and language between researchers and non-academic participants can be difficult. Thus, emphasis needs to be placed on clear communication of technical concepts without alienating stakeholders from different backgrounds.

Based on my experience, I believe that actively involving societal stakeholders in the research process has the potential to further increase the relevance and impact of BISE research in solving real-world problems. Moreover, embracing diverse and new perspectives can foster innovation. At the same time, active participation in research projects can empower societal actors through knowledge sharing and learning as well as access to scientific insights and methods.

Although the benefits of open engagement are compelling, implementing it in practice is not without its challenges, as mentioned above. From a researcher's perspective, several questions arise about the practicality of open engagement initiatives within the current academic framework. The complexity of engaging societal stakeholders requires significant time, resources and effective communication strategies, which may divert resources from core research activities if done without a support infrastructure. Closely collaborating with citizens during the research process raises questions like: How can we motivate and sustain citizen participation in what are usually lengthy research processes? How can we ensure equal participation of all social groups (especially marginalized groups or people with limited resources)? Another challenge when working with non-experts is to ensure a high level of quality in the research process, which is a primary concern of academic work. Thus, to what extend should we and how can we foster the necessary skills in untrained participants when they are involved in collecting or even analyzing data? In addition, current institutional structures and incentive schemes do not support or recognize the value of open engagement. Assessment measures are often inadequate to evaluate and recognize the immense efforts invested in community engagement. Given the resource-intense nature of conducting open engagement, this in turn can negatively impact the career development and funding opportunities for individual researchers.

Overall, given the significance of digital technologies to all actors in today's society, I advocate for the BISE community to build on its tradition and strive for collaborative and inclusive practices in creating knowledge about and designing information technologies. This entails actively engaging societal actors in various capacities, from shaping research agendas to participatory involvement in design-oriented and potentially even empirical research initiatives. However, increasing the adoption of open engagement practices in the BISE community will require more than just education and a change in mindset of individual researchers. Echoing the UNESCO Recommendation on Open Science, institutional support and dedicated funding is needed to enable researchers to facilitate public engagement and coordinate with community organizations, industry partners and policy makers. In addition, comprehensive evaluation metrics that acknowledge and reward societal impact and engagement are essential.

5 Open Science Is Great – For Some Projects, Some Methods, Sometimes

Jan Recker

Open Science is here to stay – and so it should. Adoption of open science principles such as preregistration, data sharing, and decoupling of publication and review processes provide several benefits to the scientific enterprise (e.g., Chambers 2019; Soderberg et al. 2021). It shields against questionable research practices, promotes openness and inclusiveness, protects against publication bias, and facilitates honest reporting. Indeed, the question should not be *whether to adopt Open Science* in business and information systems engineering. It should be about *how to make Open Science work* in our field.

This is easier said than done even though efforts have been and are being made. The Business & Information Systems Engineering journal has already adopted Open Science practices such as pre-registration into their reviewing and publishing models (Weinhardt et al. 2019). The MIS Quarterly has launched a transparency policy that follows the Open Science spirit (Burton-Jones et al. 2021) and is publishing a special issue to test the Registered Reports model (Ho et al. 2023). For a while, the Journal of the Association for Information Systems followed a data sharing policy based on “open data” principles (Lyytinen 2009). Several commentaries have been written to encourage information systems researchers to adopt Open Science principles such as data sharing, or instrument and hypothesis pre-registration (e.g., Doyle et al. 2019; Mertens and Recker 2020).

All these efforts, it would seem, have had limited success so far, both in uptake and impact. Business & Information Systems Engineering receives only few submissions under the registered reports model. Few IS researchers share their data openly, and those who do so typically do it because a journal demands it (Koester et al. 2020). The only reasonably broadly adopted practice in information systems, it seems, is that of publication sharing through pre-print servers and other repositories that provide some form of “open access” (Laakso and Lindman 2016). Arguably, this form of publishing comes with so many individual-level benefits for scholars (e.g., increased access, readership, and ultimately citations) that it would likely be successful even in the absence of an Open Science movement.

Does this mean that information systems as a field cannot or will not benefit from Open Science practices? No. But information systems as a sociotechnical field is different from other disciplines where open science appears to work, diffuses well, or yields clear and immediate benefits. A key reason for this situation is that information systems is not a high-paradigm field (unlike, say, chemistry) with stable phenomena, stable and shared assumptions, and a stable set of research methods. Instead, the information systems field does not have a core; it is pluralistic and diverse in terms of domains, methods, theories, and phenomena (Lyytinen and King 2006; Tarafdar et al. 2022). While being an open and inclusive marketplace for approaches and ideas has many benefits (and is something we as a field should be proud of), it brings challenges to the Open Science model. The model originated from and appears more widely adopted in high paradigm fields, especially those that follow predominantly the hypothetico-deductive approach to science. This approach is both common and popular in information systems (Mertens and Recker 2020), but we also embrace and accept different approaches to research where not only the benefits but also the application of open science principles is less obvious or perhaps even not possible. For example, preregistering hypotheses would not make much sense in inductive, theory-generating research, likely also not for design research. Sharing data might be more feasible in experimental or survey-based research than in computationally-intensive research.

What is the conclusion from these observations? Open Science is not a panacea for information systems research. We should take a phased approach to diffusion. First, we should identify those genres in IS research that are most applicable to Open Science practices and ensure that the benefits from Open Science (such as added rigor and additional protection against questionable research practices) are applied to these genres. Survey research, laboratory and (perhaps to a lesser extent) field or online experiments appear to be the most obvious choices that would benefit. For these (and similar) hypothetico-deductive genres of IS research, strictly mandating Open Science practices such as preregistration of instruments and hypotheses as well as the sharing of data appears to be a logical step, perhaps with an opt-out possibility for studies that make a reasonable exception argument.

Second, we should then identify genres where *some* Open Science principles could be applied to yield benefits and identify how those Open Science principles should be tweaked to ensure the best possible alignment to those genres. For example, it is conceivable that positivist case study research in the Yin (2009) tradition might benefit from enforcing Open Science practices even though such research does not feature hypotheses that can be registered. Still, interview protocols, code books, data structures, a priori and a posteriori propositions or interim analysis outputs (e.g., coding trees) could still be registered and/or shared to foster better transparency, easier replication, and perhaps also other desirable outcomes. Likewise, it is conceivable that research using design or computational methods would benefit from enforcing some open science traditions, such as sharing code (instead of data) or even registering prototype instantiations in different formats (e.g., pseudocode, data diagrams, or running code) at various stages of the research cycle (e.g., before and after initial or subsequent artefact evaluations). Several journals (such as Journal of Computing or Management Science) already encourage, if not require, the sharing of code or sharing of research materials. There appears to be no obvious disadvantage from enforcing such a practice more broadly. A strict mandate policy might be ill-advised, but perhaps a policy stipulating encouragement or alternatively a default opt-in (with possible opt-out scenarios) might be the way to go. Irrespective of the form of implementation, the challenge will be to identify those Open Science practices that actually yield benefits to the scientific community associated with a given research genre – we should abstain from mandating practices for the sake of doing so.

Third, we should then identify those genres or contexts where Open Science is not applicable or even detrimental to knowledge generation. For those genres and contexts where that is the case, we should then identify *alternative mechanisms* that could yield desired outcomes even if

Open Science principles themselves would be ill-advised. For example, some might argue that interpretive qualitative field research (Klein and Myers 1999) would not benefit from preregistration or data sharing. But this is not to say that such research would not be affected by publication bias or questionable research practices. For such situations, it will be important to find other ways to promote transparency, openness, and reproducibility (Nosek et al. 2015). A start into such a direction could draw on MIS Quarterly's transparency initiative (Burton-Jones et al. 2021), but a closer look into the present guidelines also reveals that much work remains to be done to identify specific and genre-appropriate guidelines for all the different flavors of research the information systems field has to offer.

Finally, aside from adjusting the Open Science model to the specific circumstances of our field, we also need to put more effort into educating the key stakeholders in our ecosystem. Such an effort will have to start in our doctoral education programs, but it must also include our institutional gatekeepers – reviewers and editors. One of the most important and early lessons we are learning in the current MIS Quarterly special issue is that authors as well as reviewers and editors need to change both their writing and reviewing practices to make the Open Science approach work. Our cognitive frames and our writing scripts are still very much stuck in a not-so-Open Science world. This, too, will have to change.

6 Disintermediation for More Open Science: A Worthy Goal for the Information Systems Community?

Ali Sunyaev and Benjamin Sturm

Unrestricted access to knowledge and education is one of the central pillars of functioning democracies and, therefore, one of society's core tasks in times of digital change (Sanborn and Thyne 2014). However, this access is about much more than free access to information. The goal of the open knowledge movement is to unlock access to knowledge and expand and share knowledge at all levels of society. The Open Knowledge Foundation defines knowledge as truly open only when "anyone is free to access, use, modify, and share it – subject, at most, to measures that preserve provenance and openness" (Open Knowledge Foundation 2015).

Freedom of knowledge is at the same time the breeding ground for new forms of open and shared knowledge creation, dissemination, and further development, which directly ties open knowledge to Open Science. Open Science is the movement that attempts to make scientific research processes and results accessible to all levels of society, amateur or professional (Parsons et al. 2022; Woelfle et al. 2011). The Open Science idea also includes that everyone interested in science can participate in knowledge-creation processes (Peters 2014). The roots of the Open Science idea can be traced back to the establishment of the first modern scientific journals in the seventeenth century (Nielsen 2012). Before this, a widespread aura of secrecy surrounded the work of researchers in the pursuit of nature's secrets to, in part, protect intellectual ownership. With the development of the journal publication system, the ethos of secrecy changed, as scientific journals allowed for appropriately crediting researchers for their accomplishments (Bartling and Friesike 2014). It is now generally believed that knowledge creation and its spread are two sides of the same coin – that when knowledge cannot be communicated, it will not influence society (Oster 1994).

While the modern journal system has led to a more Open Science culture, it has also become somewhat of a burden on free knowledge dissemination. Many knowledge processes, especially distribution, are currently dependent on intermediating third parties. Knowledge intermediaries, such as publishers or internet platforms, provide the necessary infrastructure and processes for the effective distribution of knowledge. On the other hand, knowledge intermediaries also have a variety of vested interests, ranging from monetary to political motivations, which can harm the openness of knowledge (van Rossum 2017).

For example, knowledge intermediaries are known to censor the content they provide or to completely block access to undesirable content, as examples from the recent past have shown (Hernández 2017). A similar pressing issue is the triple-pay system, the common practice in the publishing industry of making both authors and readers bear the costs of a knowledge publication, which has created one of the most lucrative industries in the world (van Rossum 2017). Furthermore, knowledge intermediaries often charge prices for access to knowledge far exceed their actual costs, which creates substantial financial barriers for individuals as well as institutions (Bergstrom et al. 2014), and, thus, they clearly work against the principles of open knowledge.

One way to reduce the financial barriers for knowledge consumers could be for researchers to use open-access publishing options, either by submitting directly to nonprofit open-access journals or using the open-access publication options offered by most commercial journals. Both options usually require a substantial fee from authors to offset publication costs or lost revenue. Hence, this fee of up to USD 11,000 (Grossmann and Brembs 2021) just shifts the financial barrier to knowledge dissemination from the reader to the author. Like in most other research discipline, this obstacle manifests itself in the information systems field. Table 1 provides an overview of the research articles published in 2023 journals from the senior scholar list (AIS 2023) and the BISE Journal. Less than 25% of all research articles are available to the public free of charge.

For these reasons, the fundamental question of whether central knowledge intermediaries can be replaced in the long term by independent, open, and decentralized approaches is becoming increasingly important. A more open knowledge culture requires a rethinking of how knowledge and technical information infrastructures are managed is required. In this context, the concept of blockchain is often discussed as a potential technical solution for many disintermediation endeavors (e.g., in finance, supply chain management, and Open Science) (Leible et al. 2019; Treiblmaier 2018; Xu et al. 2023).

Blockchains are a variant of distributed ledger technology (DLT) that enables a form of distributed data storage where the data is not stored centrally on a single server. DLT instead allows to manage an exact copy of a database (i.e., the distributed ledger) on many physically separate computers (so-called nodes) that operate without a central authority over a network (Kannengießer et al. 2020; Yeow et al. 2018). With centralized data storage, the availability of data is always tied to the availability of a single system. The decentralized approach of DLT means that each node provides its users with the same data and functionalities and, thus, the data can still be accessed from any node.

As the name already suggests, a blockchain aggregates data in the form of transactions into blocks which are linked together like a chain (Sunyaev 2020b). A new block is always appended to the end of the blockchain. In principle, transactions stored in a public blockchain can be read by anyone in the public domain. However, the ex-post modification or deletion of stored transactions is almost impossible thanks to the use of cryptographic procedures (Sunyaev 2020a). Figuratively speaking, each transaction represents a chain link that is firmly connected to its predecessor and successor transaction. If the content of a transaction is changed or deleted, the link breaks, and the chain is irrevocably split in two. This results in the key characteristic of the data immutability of blockchains, as retroactive manipulation of data that has already been stored becomes evident.

Since blockchains operate without a central controlling party, appending blocks to the end of the blockchain requires a coordination process between the nodes. The process ensures that all nodes add the same blocks in the same order and thus store an identical copy of the blockchain. An essential part of this process is the consensus mechanism, which synchronizes the various nodes in the blockchain (Yeow et al. 2018). One of the most common algorithms that consensus mechanisms employ is proof-of-work (PoW), in which nodes can fulfill a certain task (i.e., mine) that grants them the right to propose the next block to be added and gain a reward (Nakamoto 2008).

Thanks to such joint coordination mechanisms, a blockchain is highly resistant to the influence of individual interests. Data manipulation or censorship is only possible if the majority of nodes cooperate toward this end. A blockchain therefore becomes more secure as the number of independent nodes increases. In addition, the resources required to operate a blockchain are provided by the

Table 1 Overview of open access publications in the senior scholar list of premier journals and BISE journal

Senior scholars' list of premier journals (AIS 2023)	Publisher	Research articles published in 2023	Number of open access articles	Proportion of open-access articles
Decision Support Systems	Elsevier Ltd	92	9	9.78%
European journal of Information Systems	Taylor and Francis Ltd	54	17	31.48%
Information & Management	Elsevier Ltd	95	12	12.63%
Information and Organization	Elsevier Ltd	20	9	45.00%
Information Systems Journal	Wiley-Blackwell Publishing Ltd	37	27	72.97%
Information Systems Research	INFORMS	47	9	19.15%
Journal of the AIS	AIS	42	0	0.00%
Journal of Information Technology	Palgrave Macmillan Ltd	19	11	57.89%
Journal of MIS	M.E. Sharpe Inc	42	8	19.05%
Journal of Strategic Information Systems	Elsevier Ltd	16	9	56.25%
MIS Quarterly	MIS Research Center	46	3	6.52%
BISE Journal	Springer Gabler	22	17	77.27%
Total		532	131	24.62%

community of independent node operators. Anyone interested can participate in a public blockchain by setting up and operating a node. This means that a blockchain can also be operated without direct financial incentives, provided that enough nodes are motivated to participate. The use of blockchains is consequently particularly useful when several parties who do not necessarily know or trust each other want to share data, when it is of great interest that this data is not held centrally by one party, and when transmissions should be unalterable and traceable (Sunyaev 2020a). For more open knowledge creation, dissemination, and use, blockchains appear to be a suitable technological building block that could be used to support Open Science endeavors in the sense of open knowledge.

However, before this vision can become reality, several unresolved issues need to be tackled. While the technical aspects of the blockchain concept are becoming better understood and the first systems are in place (Sunyaev et al. 2022), sustainable decentralization requires a sociotechnical approach. If the IS community is to make a serious effort to promote Open Science through disintermediation, there are two main challenges a.

Firstly, from an institutional perspective, there needs to be an amendment of the indicators for measuring academic performance. The number of papers published in prestigious journals, the number of citations, or other citation-based scientometrics all influence academic career progression (Rawat and Meena 2014). This primarily originates from institutional and funding agency criteria, which create pressure for researchers to conform to established publication norms. The situation creates the well-known mindset of “publish or perish” (Rawat and Meena 2014). Researchers are incentivized to prioritize prestige over accessibility when publishing their research results, which means that new forms of knowledge dissemination are depreciated, and researchers are pushed toward traditional journals and knowledge intermediaries. To alleviate this problem, the IS community would need to restructure the way academic performance is evaluated in order to create a level playing field that would allow to establish new forms of open (decentralized) knowledge dissemination.

Secondly, from an individual IS researcher’s perspective, a decentralized approach would create costs. Besides the financial burden of upholding a common infrastructure, decentralization requires the active participation of individuals. Without a central party, all tasks must be performed by system participants, such as for instance system development, node operation, or content quality control. Looking at the current peer review system, the lack of individual incentives has created a clear imbalance, where a greater percentage of the peer reviews are done by a minority (Kovanis et al. 2016; Petchey et al. 2014). A decentralized system would require even more commitment and personal responsibility from each participant. While the research community should set the proper incentives to participate, it is the sum of all participants’ contributions that defines the system. If only a few are willing to perform a certain function in a decentralized system, then this function will be centralized around these few willing to perform it. For example, those who are willing to review manuscripts are the ones who define research quality expectations for everyone, and those who operate nodes define who can access them. To keep a system decentralized, it is necessary to mitigate such centralization tendencies through engagement.

In conclusion, to encourage disintermediation for more Open Science, it is essential to address the career concerns of academics, enhance the visibility and reputation of Open Science outlets, and educate researchers about the benefits of wider dissemination. Additionally, reevaluating promotion and funding criteria to recognize the value of any Open Science contributions and to create strong incentives for engagement is crucial for fostering a culture that allows IS researchers to embrace innovative forms of knowledge dissemination and, thus, utilize the value of openness.

7 Open Science in Energy Research – A Call for Attention and Action

Oliver Werth

The pursuit of sustainable and innovative solutions accelerated by Digital Transformation and Digitalization to meet the world’s growing energy demands is more critical than ever. Continuously transforming energy systems through the implementation of Information Technology (IT) leads to so-called cyber-physical systems (CPES) (Steinbrink et al. 2019). Requirements for CPES are increasing, but also non-technical functionalities of CPES like technology acceptance and societal aspects are emerging. Consequenty, interdisciplinary research is necessary among the various stakeholders involved in CPES. Open Science, characterized by the transparent and collaborative sharing of research methods, data, and findings, emerges as a catalyst for progress in this dynamic field (Pfenninger et al. 2017). This subsection of the opinion paper is devoted to why Open Science is crucial in the context of energy research and how it should gain more attention and action from the researchers involved, such as the members of the BISE community.

Open Science dismantles traditional barriers to information access, enabling researchers to build upon existing knowledge and accelerate research itself. In general, energy research and the simulation of energy systems are heavily driven by data, models, and software (Pfenninger et al. 2014). As a result, where research findings are needed to address CPES-related questions, leveraging shared data, software, and methodologies can significantly expedite the development of novel research results (Hirth et. al. 2018). Consequently, the scientific community in energy research can collectively propel advancements, ensuring that no valuable time is lost due to redundant efforts or information silos. Also, novice and established energy researchers can (re-)use existing software and code leading to quicker collaborations (Werth et al. 2022).

Open Science, with its commitment to open peer review and open access publishing, ensures that research findings, such as energy system models or source code, are not locked behind paywalls or restricted access. This democratization of information foster creativity and innovation by allowing a broader audience, including industry, policymakers, and educators, to engage with the latest developments in energy research (Morrison 2018). Ideas and results are more likely to reach those who can translate them into practical applications, accelerating the transition from lab discoveries to real-world solutions. The reliability of scientific findings depends on the ability to reproduce experiments and validate results. Open Science, with its emphasis on transparency and accessibility, plays a pivotal role in enhancing the reproducibility of research in energy science (Hülk et al. 2018). Through Open Science, researchers provide a clear roadmap for others to validate and build upon their work. This not only strengthens the robustness of scientific claims but also safeguards against erroneous or biased results, fostering a culture of rigor within the scientific community.

As mentioned, the complexity of CPES necessitates a multidisciplinary approach, drawing on insights from engineering, economics, sociology, and others (Lehnhoff et al. 2021). Open Science provides a collaborative platform for experts from different disciplines to converge, share expertise, and collectively tackle complex problems. The free exchange of ideas and data fosters innovation by allowing researchers to draw inspiration from intellectual sources that may not be well-known and integrate knowledge from various domains. As a result, Open Science is becoming a catalyst for holistic and transformative solutions to energy-related issues. Tackling global energy challenges requires a concerted effort on a global scale, and Open Science can provide the framework for such collaboration (Xu et al. 2016). By fostering international cooperation and information exchange, Open Science enables researchers to leverage the collective intelligence of the global scientific community.

Energy-related issues and problems impact society at large, and Open Science can provide a mechanism for engaging citizens in the scientific process (Pons-Seres de Brauwer and Cohen 2020). By making research findings accessible and understandable to the general public, Open Science fosters a sense of transparency and trust. Citizen scientists, armed with accessible data, can contribute valuable insights, participate in data collection efforts, and even propose innovative solutions. Involving the public in energy research through Open Science initiatives can enhance scientific dissemination but also promote a sense of shared responsibility for addressing energy-related challenges.

Currently, initiatives to foster Open Science on an EU-wide level like the European Open Science Cloud are gaining more and more attention from researchers in various disciplines (EOSC 2023). With a special focus on energy research, the German initiative National Research Data Infrastructure for the Interdisciplinary Energy System Research (NFDI4Energy) started its work in March 2023 (Werth et al. 2023). NFDI4Energy is dedicated to developing a research data infrastructure that specifically fits the needs of energy researchers (for the full working program, refer to Nieße et al. 2022). Requirements and conceptualizations of such platforms for energy research have been examined in the past by other initiatives (Ferenz et al. 2022; Werth et al. 2022). The NFDI4Energy consortium (re-) uses this existing knowledge, enriches it with a more multi-stakeholder perspective, and makes it sustainable for the future. While the idea of NFDI4Energy is promising, it needs some time to input the spirit and its ideas into the energy research community.

Those parts of the BISE research community that are concerned with CPES-related questions can foster this by actively living an Open Science culture. There are, of course, already good examples of Open Science and reusing publicly available datasets in an energy context (e.g., Wenninger and Wiethe 2021). Furthermore, journals like BISE provide useful guidelines and tips for publishing according to several Open Science activities mentioned before in this Opinion Paper (COS 2023). Regarding cooperation efforts, some guidelines exist to conduct Open Science and perform interdisciplinary research in the energy sector (Cohen et al. 2021; Cao et al. 2016). It can be summarized, that guidelines for Open Science (in energy research) already exist in order to provide proper support for "newbies" to Open Science.

However, there are research directions that need the community's attention f: BISE researchers should continuously explore Open Science in terms of its drawbacks and opportunities and discuss these within the community. Possible research inquiries under different theoretical lenses or research paradigms could explore crucial success factors for Open Science Infrastructures, e.g., open research data infrastructures and their (non-)use by energy researchers. How can we foster and accelerate interdisciplinary research among disciplines like energy research, Information Systems, or sociology? What are promising best practices for Open Science activities from third-party funded projects or initiatives? How can we motivate energy researchers and the BISE community to participate in Open Science and its infrastructures? What characterizes the stakeholders that participate in Open Science in energy research? How dosuch infrastructures need to be designed appropriately in terms of front- and back-ends for various stakeholders such as citizens, practitioners, and researchers in the energy sector? What are the needs for education and appropriate teaching materials regarding Open Science from the energy research and BISE community?

Much work remains to be done in the future, and this subsection could serve as a starting point for future discussions on the topic of Open Science with a focus on energy research. In conclusion, Open Science is a crucial force in the advancement of energy research. Its role in shaping the future of energy research is significant. As the world as we know it grapples with the urgent need for sustainable energy solutions, embracing the principles of Open Science becomes not only a scientific imperative, but a moral and societal one, ensuring that the benefits of research are shared among all stakeholders from research, industry, and society.

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