

Research Assessment Reform, Non-Traditional Research Outputs, and Digital Repositories: An Analysis of the Declaration on Research Assessment (DORA) Signatories in the United Kingdom

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Résumé de l'article

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Methods – The researcher developed a list of 77 universities in the UK who are signatories to DORA and have institutional repositories. Using this list, the researcher consulted the public websites of these institutions using a structured protocol and collected data to 1) characterize the types of outputs collected by research repositories at DORA-signatory institutions and their ability to provide measures of potential impact, and 2) assess whether university library websites promote repositories as a venue for hosting non-traditional research outputs. Finally, the researcher surveyed repository managers to understand the nature of their involvement with supporting the aims of DORA on their campuses.

Results – The analysis found that almost all (96%) of the 77 repositories reviewed contained a variety of non-traditional research outputs, although the proportion of these outputs was small compared to traditional outputs. Of these 77 repositories, 82% featured usage metrics of some kind. Most (67%) of the same repositories, however, were not minting persistent identifiers for items. Of the universities in this sample, 53% also maintained a standalone data repository. Of these data repositories, 90% featured persistent identifiers, and all of them featured metrics of some kind. In a review of university library websites promoting the use of repositories, 47% of websites mentioned non-traditional research outputs. In response to survey questions, repository managers reported that the library and the unit responsible for the repository were involved in implementing DORA, and managers perceived it to be influential on their campus.

Conclusion – Repositories in this sample are relatively well positioned to support the collection and promotion of non-traditional research outputs. However, despite this positioning, and repository managers' belief that realizing the goals of DORA is important, most libraries in this sample do not appear to be actively collecting non-traditional outputs, although they are active in other areas to promote research assessment reform.

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Research Article

Research Assessment Reform, Non-Traditional Research Outputs, and Digital Repositories: An Analysis of the Declaration on Research Assessment (DORA) Signatories in the United Kingdom

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Abstract

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Introduction

Universities, governments, and funders in many jurisdictions are increasingly investing time, resources, and energy into changing the way that researchers and the outputs of research are assessed for rewards such as grants, hiring, promotion, and tenure. Traditional means of assessing the outputs of research, and by proxy the researchers producing these outputs, have relied on a limited set of outputs (primarily peer-reviewed journal articles, books, and monographs) as well as a narrow range of metrics to measure those outputs (primarily quantitative bibliometrics in many fields, or factors such as the prestige of a press in others). Increasingly, it is being recognized that limiting the assessment of research to these outputs and metrics is inequitable and does not align with the stated mission and goals of many actors in the research ecosystem. An early and highly influential force in this shift is the Declaration on Research Assessment (DORA), which developed out of a scholarly conference held in 2012. Along with a suite of other recommendations, DORA pushes institutions and funders to consider a wider range of research outputs in research assessment (San Francisco Declaration on Research Assessment, 2012).

Widening what is considered a “research output” outside of the traditional paradigm of peer-reviewed journal articles, books, monographs, and conference publications presents challenges. Non-traditional research outputs can take a variety of forms, such as digital collections, GIS projects, audio-visual materials, datasets, or code. Due to their diversity, these outputs are unlikely to find a home with established scholarly publishers (Library Publishing Coalition Research Committee, 2020). As such, researchers who produce non-traditional research outputs may face barriers to showcasing these items to knowledge users, peers, or assessors in their institutions or beyond.

Digital repositories hosted by academic libraries are unlike traditional scholarly publishers in that they can typically host and preserve a wide variety of content and format types, and they are not constrained by the profit motive of most academic publishers. Additionally, many repositories have features to track a variety of usage metrics, such as permanent identifiers to help make outputs more discoverable. Staff in academic libraries can also advise researchers on topics including copyright, preservation, and impact

assessment. As such, institutional repositories may be well placed to help facilitate the recognition of non-traditional outputs in research assessment. However, it is unclear to what extent academic libraries are positioning research repositories as a solution to this challenge, particularly among institutions that have publicly committed to enacting the recommendations of DORA.

This study examined the digital repositories of universities in the United Kingdom that are signatories of DORA. The goals of this exploratory study were to 1) characterize the types of outputs collected by research repositories at DORA-signatory institutions and their ability to provide measures of potential impact, 2) assess whether university library websites promote repositories as a venue for hosting non-traditional research outputs, and 3) survey repository managers to understand the nature of their involvement with supporting the aims of DORA on their campuses.

Literature Review

Research Assessment and the Impetus for Reform

The push towards reforming the way research is assessed has been spurred on by policies of funders worldwide, by institutions, and by researchers themselves. These groups are reacting to a substantial body of research that demonstrates major limitations in the way research and researchers have traditionally been assessed. One of the major targets of this criticism has been the Journal Impact Factor (JIF), a metric that was originally created as a tool to help librarians make journal selection decisions by quantifying the frequency with which the “average article” in a journal has been cited in the past two years (Garfield, 2006). Over the years, its use has evolved, such that many in the research community use it as a simple proxy for journal quality, and by extension, for quality of individual journal articles and even individual researchers. This is despite well-documented limitations of this metric, including that citation distributions within journals are highly skewed, that impact factors can be manipulated by unethical editorial practices, and that the data used to calculate journal impact factors are neither transparent nor open to the public (Sugimoto & Larivière, 2017). Even when used appropriately, the journal impact factor only captures a narrow portion of potential research impact; namely, impact on scholarship in the form of citations.

The shortcomings of the Journal Impact Factor for research evaluation can be seen as the tip of an iceberg of well-documented biases that disproportionately impact scholars who are not English-speaking White men in all parts of the research ecosystem (see, e.g., Caplar et al., 2017; Chawla, 2016a; Fulvio et al., 2021; Mason et al., 2021). These biases influence the ability of scholars to enter academia, publish and disseminate scholarship, progress through tenure and promotion, receive funding, and be competitive for recognition and awards (Inefuku & Roh, 2016). Additionally, the profit-seeking paradigm of traditional scholarly publishers creates artificial scarcity and uses gatekeeping mechanisms to limit the formats, perspectives, and volume of scholarship that is published through their channels (Suber, 2012). This paradigm particularly disadvantages scholars whose most important contributions may come in formats such as software, code, datasets, or practice-based research outputs created with or for community partners (Chawla, 2016b; Parsons et al., 2019; Savan et al., 2009).

The Role of Non-Traditional Outputs and Impacts in Research Evaluation

Despite not being widely accepted in traditional research evaluation exercises, there is evidence that sharing research outputs such as datasets, code, and grey literature can be very important in a variety of ways, including contact and collaboration with a broader range of colleagues, an improvement in the

reproducibility of research, influence on policy and practice, and, as citation practices for these outputs mature, increased measures of impact in the form of citations or altmetrics (Lawrence et al., 2014; Piwowar et al., 2007; Van Noorden, 2013; Vandewalle, 2012). The emerging evidence around the potential benefits of making these outputs more visible and discoverable has led libraries to pursue means of hosting and preserving them, although this endeavor is not without challenges (Burpee et al., 2015).

In light of this evidence, and to align with current institutional initiatives around equity, diversity, and inclusion, most calls to reform the way research is assessed look to broaden both the methods used to evaluate research as well as the types of research activities evaluated. The most influential researcher-led initiative in this space, DORA explicitly rejects the use of metrics such as the Journal Impact Factor in research assessment, and provides specific recommendations to funding agencies, institutions, publishers, metrics-supplying organizations, and researchers themselves. One of DORA's recommendations is that a wider range of research outputs be considered in assessment exercises (reflecting its origin in the sciences, DORA specifically mentions datasets and software) as well as a broad range of impact measures (including influence on policy and practice). Alternative metrics (known as "altmetrics") such as mentions in news media, social media, or citations on Wikipedia have been offered as one method to attempt to quantify a broader range of impacts, although debate on how to interpret them, and discussion of their limitations, still exists in the research community. Some of the drawbacks of altmetrics include their ability to be "gamed," bias, data quality, and commercialization (Bornmann, 2014; Priem et al., 2010; Sud & Thelwall, 2014).

DORA now has over 20,000 signatories including publishers, institutions, and individuals from across more than 160 countries (Signers, n.d.). However, it is not the only influential document expressing dissatisfaction with the current state of research assessment and making recommendations for change, including broadening the range of activities that are included. In 2015, UK Research and Innovation published a report presenting the findings and recommendations of an independent review of the role of metrics in research assessment entitled *The Metric Tide: Review of Metrics in Research Assessment*. That report mentions a wide range of non-traditional outputs including blog posts, datasets, and software, and recommends that "the use of DOIs [Digital Object Identifiers] should be extended to cover all research outputs" in order to make them more discoverable and trackable (Wilsdon et al., 2015, p. 145). This recommendation was expanded in a 2022 update of the report to acknowledge the utility of a wide variety of persistent identifiers (PIDs) for a variety of outputs (Curry et al., 2022). The same report summarizes the recommendations of 19 documents published by a variety of organizations in the research ecosystem and notes that most of them "include at least one recommendation on widening the range of research activities considered by research assessment" (Curry et al., 2022, p. 68). The most commonly mentioned non-traditional outputs in these documents are datasets and code as well as activities such as peer review and mentorship.

A consistent definition of non-traditional outputs is not present in all of these documents. The Australian Research Council defines them as research outputs that "do not take the form of published books, book chapters, journal articles or conference publications" and names several specific output types including original creative works, public exhibitions and events, research reports for an external body, and portfolios (Australian Research Council, 2019, para. 1). A study examining the research, promotion, and tenure documents from over 100 North American universities found mention of 127 different types of scholarly outputs, which the researchers grouped into 12 diverse categories (Alperin et al., 2022). These

examples make it clear that researchers are producing a wide variety of items outside of the traditional paradigm, and that these outputs may be valued—or at least considered—by research assessors.

Funding agencies in a wide variety of contexts are also increasingly adjusting their practices to align with the recommendations of DORA and other research assessment reforms. A survey completed by 55 funding agencies from around the world in 2020 found that 34% of them had endorsed DORA, and 73% had “adapted their research assessment systems and processes for different research disciplines and fields, or where different research outputs are intended” (Curry et al., 2020, p. 32). Additionally, 76% of respondents were currently assessing non-publication outputs, with software, code, and algorithms the most commonly mentioned. The Open Research Funders, a group of philanthropic funders worldwide, published an “Incentivization Blueprint” that urges funders to “provide demonstrable evidence that, while journal articles are important, [they] value and reward all types of research outputs” and promotes research repositories as a way for researchers to disseminate outputs (Open Research Funders Group, n.d., p. 1). The global charitable foundation Wellcome Trust developed guidance for organizations they fund that draws heavily on DORA’s recommendations and suggests that candidates for recruitment and promotion be encouraged to “highlight a broad range of research outputs and other contributions, in addition to publications” (Wellcome Trust, n.d., para. 20).

The Role of Academic Libraries

Simultaneously with this broad movement to shift the way research is assessed, academic libraries have been developing and expanding services and roles around scholarly communication and the research lifecycle. To support what Lorcan Dempsey (2017) terms the “inside-out library,” libraries have increasingly developed infrastructure and staff to support outputs at all stages of the research lifecycle, including non-traditional outputs such as datasets, preprints, digital collections, audiovisual materials, and more. As part of this shift, libraries have introduced infrastructure such as institutional repositories and research data repositories, as well as roles including scholarly communications librarians, repository technicians, research data management librarians, and digital preservation specialists. Digital repositories managed by academic libraries are typically quite flexible in terms of the file formats they can host and maintain and may have advanced technological features both to promote discoverability of their contents and to track and communicate indicators around usage and potential impact of outputs. Additionally, librarians and other staff supporting these services often bring with them skills in publishing best practices, digital preservation, copyright, and impact evaluation that can provide added value to users of repositories and other library-hosted infrastructure. This has led to calls for more discussion of how libraries can support the publication of a variety of non-traditional research outputs that may not align with the activities of traditional academic publishers (Library Publishing Coalition Research Committee, 2020). Other researchers have pointed out that libraries may need to invest in training to better prepare staff to support research evaluation and impact assessment activities (Nicholson & Howard, 2018).

Some academic libraries have recognized an opportunity to get more involved with hosting—and helping to demonstrate the impact of—non-traditional research outputs in their repositories. In an article published in 2003, when repositories were a relatively new feature in the academic library environment, Lynch noted that repositories’ ability to host these new forms had potential to challenge scholarship’s status quo:

preservability is an essential prerequisite to any claims to scholarly legitimacy for authoring in [a] new medium; without being able to claim such works are a permanent part of the scholarly record,

it's very hard to argue that they not only deserve but demand full consideration as contributions to scholarship. (p. 330)

Early analyses of the deployment of institutional repositories at academic libraries focused primarily on the United States, where assessments showed that repositories did contain a variety of non-traditional outputs, although the most commonly included types of materials were versions of articles, along with student work including electronic theses and dissertations (Bailey et al., 2006; Lynch & Lippincott, 2005; McDowell, 2007; Rieh et al., 2007). One 2005 study to assess repositories in 13 countries found more variation in content types, with European repositories being more focused on textual content types than U.S. repositories and also more likely to collect metadata-only records than their North American counterparts. The study showed that repositories in the United Kingdom were comprised of 74% articles, 16% theses and books, and 9% other materials, including data and multimedia (van Westrienen & Lynch, 2005).

In the decades since these early analyses, some academic libraries have prioritized the collection of a diverse range of research outputs in their repositories to respond to different institutional priorities. For example, the University of San Diego built on their university's commitment to community engagement to prioritize the collection of items created in collaboration with community groups (Makula, 2019). Similarly, Moore et al. (2020) provide examples from the University of Minnesota demonstrating how the university's institutional repository can support community engagement by hosting and preserving outputs such as newsletters, reports, and other community-focused publications. A study tracking access to non-traditional research outputs in one institutional repository found that four diverse types of outputs were all accessed frequently in the year after they were deposited, garnering on average between 16–25 page views per month (Kroth et al., 2010).

Libraries have also begun to see repositories as central not only to hosting non-traditional outputs, but to demonstrating their impact, due to the variety of metrics available in many repositories. Kingsley (2020) characterizes this as the "impact opportunity" for academic libraries and notes that they can build on their experiences and strengths with research data management and open access to develop infrastructure and processes to capture non-traditional outputs in their repositories. However, she also points out that repositories might need to widen their collections policies to include a broad range of outputs, metadata-only records, or different content types.

The concurrent rise in interest in reforming the way research is assessed, along with academic libraries' shift towards supporting the outputs of their researchers through the whole research lifecycle, presents potential synergies. For example, if universities are moving towards a more inclusive definition of what constitutes a research output, as well as broadening the ways in which the impacts of research outputs might be measured, then digital repositories may be able to assist with this endeavor.

Methods

Data to inform the research questions of this study were gathered using two methods: analysis of publicly available website content and a survey of institutional repository managers. To gather the data, a sample of relevant institutions was developed using information found on the DORA website. By using the website's filters, the researcher was able to develop a list of institutions located within the United Kingdom that had signed onto DORA. From this list, a subset of 77 universities was generated (non-

university organizations such as scholarly associations, subject-specific research groups, and publishers were excluded).

Website Analysis

From this list of universities, the researcher gathered URLs for each institution's repository using OpenDOAR, a global directory of open access repositories. Using this list, the researcher performed an analysis of three information sources for each university on the list: an analysis of the university's institutional repository, an analysis of the university's data repository, and an analysis of university websites describing or promoting the use of these repositories.

The researcher visited the public-facing websites of these institutions to analyze the content and selected features of both institutional and data repositories. The analysis was conducted in 2022 and followed a structured protocol to collect information on variables including:

- the types of outputs collected by repositories
- the proportion of various output types contained in repositories
- whether or not repositories accepted metadata-only records
- the types of persistent identifiers (PIDs) created for items deposited into repositories
- the types of impact metrics available within repositories

The full data collection protocol can be found in Hurrell (2022).

The researcher also examined webpages (such as repository policy documents, library guides, and institutional websites) that provided information about the repositories as well as guidance and instruction to faculty who might use the repositories to deposit their work. The researcher scanned these web pages looking for specific mention of non-traditional research outputs, defined as anything other than peer-reviewed journal articles, book chapters, monographs, or conference proceedings. Where specific non-traditional outputs were mentioned, the researcher kept a tally of which specific outputs were named.

Survey of Repository Personnel

Using the same list of 77 universities mentioned above, and during the content analysis process already described, the researcher collected contact information associated with institutional repositories at each institution. An online survey, administered via the Qualtrics platform, was distributed twice during an 8-week period in 2022, resulting in a 29% response rate (n=22). The research was approved by the University of Calgary's Conjoint Human Research Ethics Board. A list of all survey questions is available in Hurrell (2022).

The survey consisted of eight questions designed to elicit additional data about how academic libraries, and more specifically digital repositories and the staff who support them, have been involved (or not) in implementing the recommendations of DORA on their campuses; whether or not their repository policies have changed since becoming a signatory to DORA; and information about other factors affecting research assessment practices at their institution. Most questions were in multiple choice format, with additional data gathered through open-ended options and questions.

Results

Website Analysis

All 77 of the universities in the sample were maintaining a publicly accessible open access institutional repository at the time of data collection. As is evident from Figure 1, all the institutional repositories contained peer-reviewed outputs, while 96% of repositories contained non-traditional outputs of various types, with grey literature (including white papers and reports), and art or creative performances being the most common. Most repositories (76%) contained metadata-only records as well as full-text items.

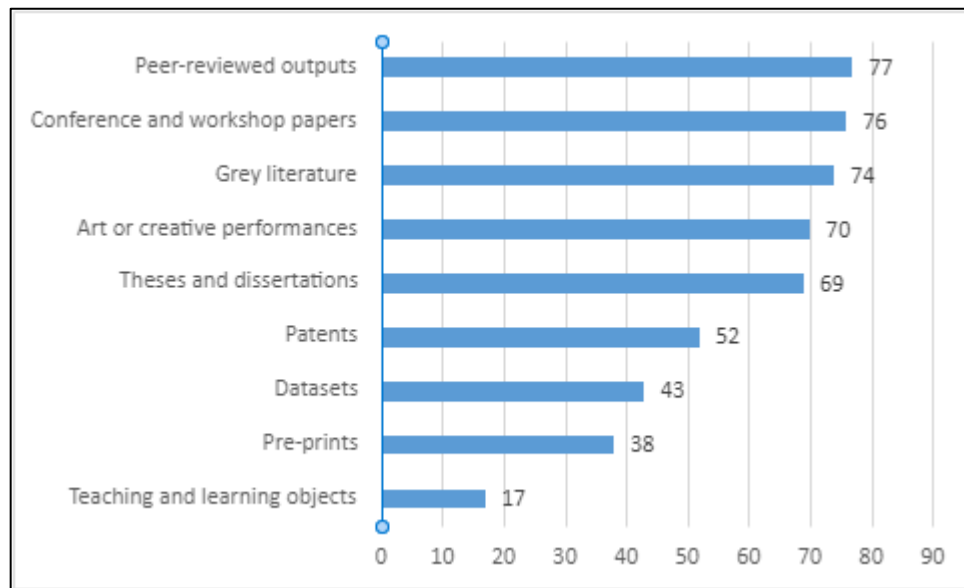


Figure 1
Item types contained in institutional repositories (n=77).

The researcher also attempted to characterize the proportion of these item types in the repository data set. These data were difficult to collect accurately, because different repositories used different schemas for categorizing item types, and many repositories did not have clear item type categories for outputs such as grey literature, pre-prints, or teaching and learning objects. Additionally, nine of the repositories in the dataset could not be searched or browsed by item type. However, it was clear from the available data that peer-reviewed items made up the majority of content available in the repositories under study, even though most repositories contained a wide variety of content types overall. As shown in Figure 2, peer-reviewed outputs comprised 74% of items, with conference and workshop papers comprising 9%, “other” items comprising 9%, and theses and dissertations comprising 5%. Other item types were represented in very small numbers, although it is likely that many item types were miscategorized as “other.”

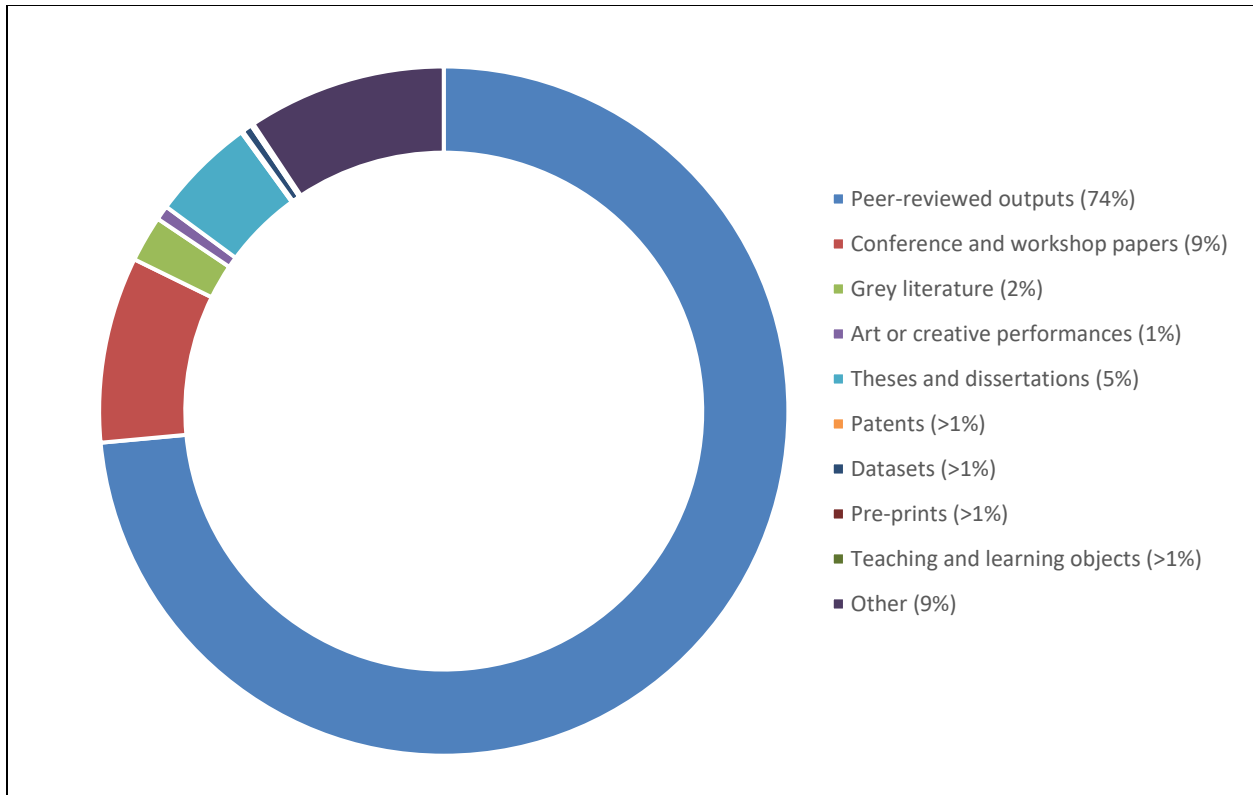


Figure 2
Proportion of item types contained in institutional repositories (n=68).

Persistent identifiers were not minted by the majority of the institutional repositories in this sample. Most institutional repositories (67%) did not assign any type of persistent identifier to items, while 24% of repositories minted Handles, and 10% assigned Digital Object Identifiers (DOIs).

A variety of metrics were available from most institutional repositories, with download statistics being the most common type. Where commercial altmetrics (e.g., Altmetric.com or PlumX Metrics) were integrated into repositories, these were counted separately. A full list of available metrics is shown in Figure 3.

The researcher also ran searches for known items from each institutional repository in Google Scholar to test whether the repository's content was being indexed. Four known items were searched from each institutional repository using title searches. Due to documented issues with Google Scholar's indexing of grey literature (Haddaway et al., 2015), the researcher chose to search for grey literature item types in this test. This simple test revealed that 96% of tested items were discoverable by Google Scholar.

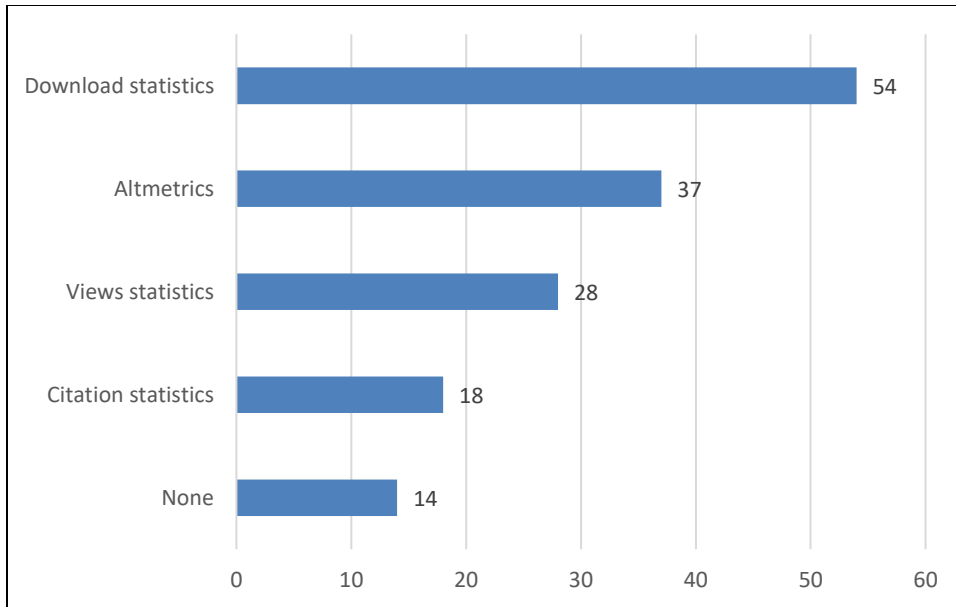


Figure 3
Metrics available in institutional repositories (n=77).

In the analysis of institutional websites to learn whether repositories were promoted as a place to deposit non-traditional outputs, the researcher found an approximately even split between websites naming specific non-traditional outputs as items that could be deposited into institutional repositories (47%, n=36) and websites that did not mention non-traditional outputs at all (49%, n=38). Three web pages (4%) could not be assessed because they were not public (i.e., links went to a password-protected intranet). Of the 36 web pages that named non-traditional research outputs, a total of 55 unique output types were noted, with datasets, reports, working papers, images, exhibitions, and software being the most commonly named output types. A complete list of outputs mentioned, along with their frequency, can be downloaded from Hurrell (2022).

Because research data represent an important type of non-traditional research output, and due to the growing practice to collect datasets in repositories specifically designed for this purpose, the researcher also examined institutional websites to ascertain whether the university had a separate research data repository. Within the larger sample of 77 universities, 53% (n=41) had a separate data repository. Almost half of these repositories (49%) contained metadata-only records as well as records with all data files, while the remaining 51% contained full records with files only.

Of the subsample of data repositories, the vast majority (88%) were assigning DOIs to records, with 5% assigning Handles and only 10% not issuing any sort of persistent identifier. Similarly, most data repositories offered at least some metrics, with download statistics again being the most common. A full list of available metrics is shown in Figure 4.

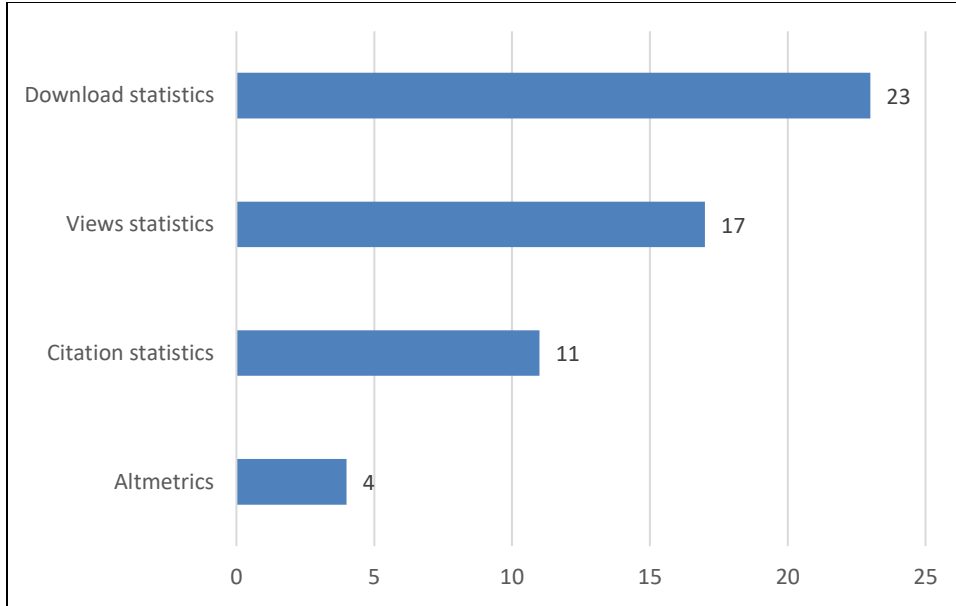


Figure 4
Metrics available in data repositories (n=41).

Similar to the test run for institutional repositories, the researcher searched for known items contained in the data repositories by searching for specific dataset titles in Google Dataset Search. Only 34% of data repositories in this sample were discoverable by Google Dataset Search.

Survey of Repository Personnel

Survey results provided additional details from institutional repository managers about how DORA was implemented on their university campuses as well as some context on DORA's influence on how scholarship is produced and evaluated at their university. The 22 participants who responded represented institutions that had signed onto DORA at a variety of points in time, the earliest being 2014 and the most recent being 2021.

In their responses, repository managers cited the library as being most often responsible for implementing DORA, along with their institution's research office. Human resources departments and "other" (described most commonly as committees of academic staff) were less commonly mentioned, as well as other campus units, as shown in Figure 5.

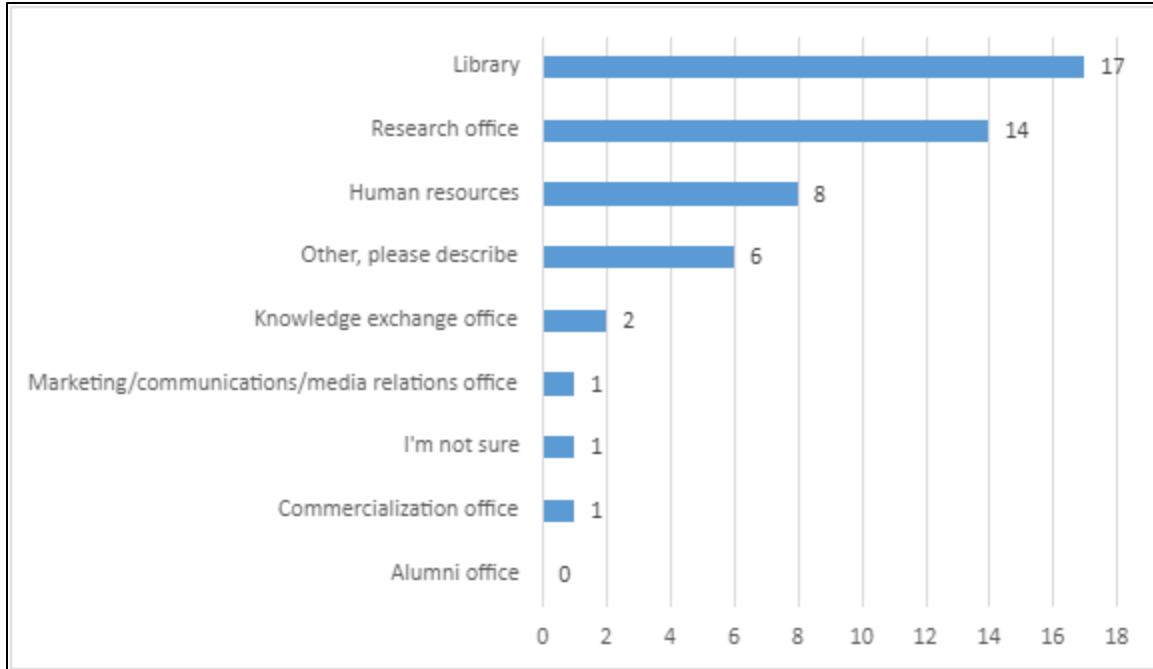


Figure 5
Campus units involved in DORA implementation.

When asked more specifically if the unit responsible for the institutional repository had been involved in implementing DORA, 75% of respondents indicated that their unit had been involved in some fashion, primarily through outreach and engagement; development of policies, guidelines, or information resources; or through participation in working groups or committees. A smaller number (10%) indicated having delivered workshops or instructional modules. Of respondents, 20% indicated that the institutional repository had expanded its inclusion criteria to include non-traditional research outputs since signing on to DORA.

When asked to rank DORA’s influence on the production and assessment of research as compared to other forces, repository managers ranked it as being quite influential, second only to policies of funding agencies. Overall, as shown in Figure 6, DORA was ranked as having a higher influence than other manifestos and reports aiming to change research assessment, and higher also than the UK’s national research assessment exercise, the Research Excellence Framework (REF).

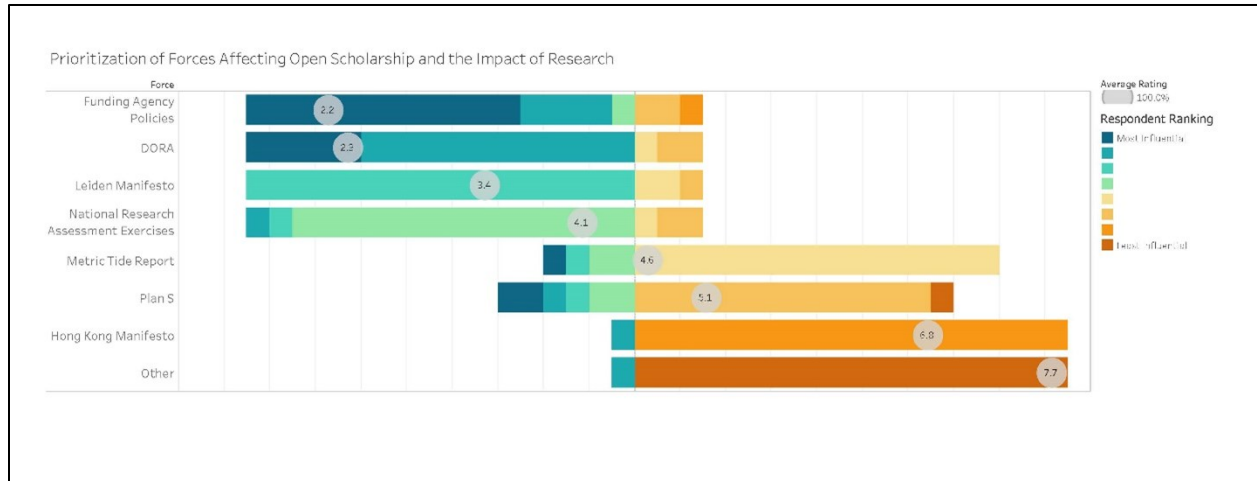


Figure 6
Perceived influence of various factors on the production and assessment of research.

Discussion

This analysis of repository websites, institutional websites, and repository managers at universities in the United Kingdom who are signatories to DORA found that although most repositories do contain a variety of non-traditional outputs, the active collection of these materials does not appear to be a strong priority for most repositories, given the volume of these items compared to traditional research outputs. This is despite the fact that repository managers perceive DORA to be an influential factor in research assessment, and that libraries are given significant responsibilities for implementing DORA on their campuses.

Repositories have a number of characteristics that make them ideal locations for the preservation and discoverability of academic outputs, and these characteristics were present in many of the repositories included in this sample. For example, almost all repositories were well indexed in Google Scholar, making their contents more discoverable, and most incorporated one or more usage metric. These features may not exist in other online locations such as faculty, lab, or community-based research unit websites, and certainly represent a benefit of repositories.

However, past research has shown that researchers are often not aware of these benefits, or they do not value them. Even early research interrogating the utility of repositories suggested that the difficulties faculty associated with using repositories (such as time, concerns about copyright, unintuitive software, and inflexible features) vastly outweighed the legitimate yet unappealing benefits such as preservation and the open access citation advantage (Salo, 2008).

This analysis also showed that less than half of institutional repositories in the sample were providing a persistent identifier (PID) to deposited items. PIDs, and particularly DOIs, are well recognized by researchers and provide benefits beyond a persistent URL, including assistance in tracking usage and potential impact (Haak et al., 2018; Macgregor et al., 2023). Perhaps because of their more recent

deployment, software tools used as data repositories in this sample were much more likely to integrate DOIs, although they were less likely to be indexed by Google Data Search.

Some institutions have marketed PIDs, and the metrics they can help drive, to positive effect. For example, Imperial College London noted a 206% increase in the deposit of reports in the year following a targeted outreach campaign promoting the features of their repository, including persistent identifiers and metrics (Price & Murtagh, 2020). Imperial College London is a signatory to DORA and thus was included in the present study's sample; their website was by far the most detailed and thorough in promoting the repository for non-traditional outputs.

However, even those institutions that have found success in promoting their repository for non-traditional outputs note significant challenges: first, faculty members often prefer the flexibility, customizability, and perceived ease of using commercial hosting sites or personal websites for depositing outputs; second, repository managers acknowledge the resource and time commitments required to complete other research assessment exercises, especially the UK's Research Excellence Framework (REF; Price & Murtagh, 2020). The requirements of the REF—namely that all journal articles and conference papers be deposited in a repository—have vastly increased the volume of content in UK repositories but have also shifted perceptions of the repository from an optional and potentially exciting tool to a compliance requirement. As one repository manager noted in an interview, “all the interesting stuff, talking about all the benefits, or the potential benefits, it's reduced to ... it's just compliance, compliance, compliance” (as reported in Ten Holter, 2020, p. 7). The respondents in the Ten Holter study note that the emphasis on depositing traditional outputs as a requirement has left less time, energy, and interest amongst repository managers and researchers for using repositories in other ways. This observation was borne out in the website analysis portion of the current study: All websites and guides promoting repositories contained information about how to comply with the REF's open access requirement and provided guidance on how to comply with publisher requirements around green open access and self-archiving of journal articles.

Collecting non-traditional outputs in repositories requires targeted outreach, engagement, possible investment in infrastructure changes (such as DOI registration), and potential changes to policies and workflows. An analysis of over 100 academic repositories in North America discovered that while 95% of them contained outputs such as technical reports and working papers, only 63% of repositories appeared to be making an active effort to collect those items (Marsolek et al., 2018). The authors suggest that changes to repository collection policies and scope statements might be required, as well as targeted outreach and metadata enhancement to make deposited items more discoverable. The present study reinforces these findings by gathering data from a different jurisdiction to find similar results.

There are several limitations to the current study. First, the researcher relied on information found on institutions' public websites to gather data about the contents, features, and functionality of repositories and information used to promote them. It is possible that this analysis missed important information, and it is uninformed by the workflows and procedures that underlie the public interface. The number of repository managers that responded to the survey part of the study was small, and because participants responded anonymously, links between the survey results and the website analysis results cannot be drawn. Future research would benefit from more in-depth engagement with repository managers, perhaps in the form of interviews. Additionally, further engagement with researchers in the form of

interviews and user experience testing may surface additional opportunities for developing effective partnerships to showcase non-traditional research outputs in repositories.

Conclusion

This study demonstrates that repositories are well equipped to accept non-traditional research outputs, both from a technical and a policy perspective. Most repositories already contain a wide variety of non-traditional outputs, but the volume of these outputs is dwarfed in comparison to traditional, peer-reviewed outputs. This suggests that repository staff and researchers both put a higher priority on ensuring that traditional outputs are reflected in institutional repositories. This is likely influenced by the requirements of existing research assessment exercises and cultures.

This research suggests that if repositories are to make a concerted effort to collect and showcase non-traditional research outputs, they may have to expand beyond the current focus of ensuring that researchers comply with requirements set out by funding agencies, governments, and publishers. The UK's higher education funding bodies are making changes to the next REF, which will assess research and impact between 2021 and 2027, including to "recognise and reward a broader range of research outputs" (Research England et al., 2023, p. 2). The report goes on to state:

Supporting and rewarding a diversity of research outputs is important for the progress of research and its dissemination to diverse audiences. There are important output types that contribute to the wider infrastructure of research fields that, as well as being important contributions in their own right, enable the research of others. Examples include review articles (including systematic reviews), meta-analyses, replication studies, datasets, software tools, reagents, translations and critical editions. Reaching businesses, policymakers and citizens also requires outputs in different formats, such as policy summaries or video or audio content. (p. 8)

It is too soon to tell whether these changes, coupled with the incremental yet growing culture shifts in the research ecosystem towards more holistic and equitable forms of research assessment, will result in repositories gaining a more central role in collecting, disseminating, and showcasing non-traditional research outputs.

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