

Research data management and libraries: Current activities and future priorities

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Abstract

This paper reports research carried out at the end of 2012 to survey UK universities to understand in detail the ways in which libraries are currently involved in research data management and the extent to which the development of research data management services is a strategic priority for them. The research shows that libraries were offering limited research data management services, with highest levels of activity in large research-intensive institutions. There were major challenges associated with skills gaps, resourcing and cultural change. However, libraries are currently involved in developing new institutional research data management policies and services, and see this as an important part of their future role. Priorities such as provision of research data management advisory and training services are emerging. A systematic comparison between these results and other recent studies is made in order to create a full picture of activities and trends. An innovation hype-cycle framework is deployed to understand possible futures and Abbott's theory of professions is used to gain an insight into how libraries are competing to extend their jurisdiction whilst at the same time working collaboratively with other stakeholders.

Keywords

Abbott's system of professions, academic libraries, data curation, hype cycle, library roles, research data management, research support, United Kingdom

Introduction

The management of research data has recently emerged as a strategic priority for universities (Pryor, 2012; Whyte and Tedds, 2011). The pervasive use of powerful computing technology across disciplines now means that an increasing number of researchers generate and use large datasets as part of the research process. This applies to large-scale collaborative e-Science programmes but also to a wide range of research activities in various subject areas. Simply storing these data in a form that can be easily accessed, processed and analysed is challenging. The datasets are potentially fragile, being vulnerable to storage failures and technological obsolescence. Data may also be sensitive, containing personal information for example, and so needs to be managed with appropriate security measures in place. A whole range of other activities commonly associated with datasets, such as reformatting them for analysis in various software packages, shipping them between sites, processing them for potential reuse, and carrying out

various preservation actions upon them, all create challenges. At the same time, the fact that most data are produced or gathered as part of publicly funded research gives rise to the need for accountability. In the UK (as in a number of other countries) many major research funders now mandate that applicants produce a data management plan as part of their research proposal and this is expected to design-in data sharing and reuse wherever possible (RCUK, 2012). However, whilst there may be a strong case for open data (Fry et al., 2009; Royal Society, 2012), there is only patchy coverage of subject-specific data repositories and other data services (including national services) (Simmonds et al., 2011). Therefore, the responsibility for addressing

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these challenges (in both the short and long term) is likely to fall on institutions. As a result, higher education institutions (HEIs) in many countries are beginning to develop infrastructures to support researchers to manage their data more effectively, with services ranging from advice to storage repositories (Jones et al., 2013).

Data produced as part of research take a wide range of forms, from statistics and experimental results to interview recordings and transcripts (Borgman, 2012). Data could exist as physical records or files on a researcher's computer or terabytes of data on shared servers. Research data management (RDM) is about 'the organisation of data, from its entry to the research cycle through to the dissemination and archiving of valuable results' (Whyte and Tedds, 2011: 1). It consists of a number of different activities and processes associated with the data lifecycle, involving the design and creation of data, storage, security, preservation, retrieval, sharing, and reuse, all taking into account technical capabilities, ethical considerations, legal issues and governance frameworks. Precisely what these are could be radically different in different contexts.

In a context of a powerful agenda for RDM at the institutional level, universities are beginning to try and work out how the management of research data should be supported, be that in terms of advice and training or an infrastructure for storage, sharing and curation. A number of professional services, including the research administration and computing services, have an important part to play. Libraries, it has also been suggested could play a large part in supporting RDM. This paper analyses how UK institutions were exploring this role at the end of 2012. After providing a review of previous research in the area, the paper presents data gathered from a survey of UK HEIs detailing the ways in which libraries are involved in RDM and the extent to which the development of RDM services is a strategic priority for them. Key issues and challenges are also highlighted. In addition, factors affecting the potential trajectory of developments are discussed.

Previous research

The growth of data management potentially creates a number of specialist roles in data curation or analysis (DCC, 2011; Hyams, 2008; Pryor and Donnelly, 2009; Swan and Brown, 2008), but it could also be supported by library services. Several commentators have proposed that academic library services are well positioned to play an important role in RDM (for example, Alvaro et al., 2011; Corral, 2012; Gabridge, 2009; Henty, 2008a, 2008b; Lyon, 2012; Monastersky, 2013). The understanding of the need for standards-based information organisation and the generic information management skills that librarians have (such as in practical information housekeeping and in organising resources) could be extended to data management. In particular, expertise around metadata is likely to play a key

part in both retrieval and curation aspects of the management of data. Similarly, there is an argument that providing RDM advice and training could be seen as a natural extension of existing library work in advice services and information literacy training. There is also a potential connection between RDM and the open-access agenda that libraries have been so active in promoting, although the argument for RDM is not simply or necessarily related to openness. In addition, librarians within organisations have certain strengths that could make them key players. Arguably, unlike some other professional services, they have extensive networks within academic departments, though these might usually be activated around teaching rather than research. The strong inter-organisational professional networks of librarians also make them good at sharing practice between institutions.

The role in RDM is one among a number of possible enhanced roles in which libraries may provide research support. Auckland (2012) identifies various ways in which librarians could have a role in supporting research (see also Brewerton, 2011; Garritano and Carlson, 2009):

- offering advice on funding sources;
- embedded or support roles conducting literature reviews or current awareness alerts for research projects or groups;
- bibliometrics and impact measurement;
- support for the Research Excellence Framework;
- bibliographic software training;
- advocacy for open access/ institutional repository;
- data analysis advice;
- advice on copyright issues;
- advice on archiving of research records (such as correspondence).

This emphasis on expanding the library's role to support research is partly in response to evidence that researchers often do not engage with the library (Auckland, 2012). Yet such an expansion creates major challenges. For example, it implies significant demands on staff time in a context where library services are already over-stretched. Existing roles are demanding and to support RDM implies downgrading other priorities. Equally, resources for RDM, including infrastructure, policy and management and governance development at all levels are still in flux, so it remains unclear exactly where the library should best position itself.

While librarians' information management skills may be relevant, it could be challenging translating them to research data contexts (including metadata creation or good data housekeeping). The authors' own reflection on the domain is that it is, like any area of specialist activity, complex and jargon ridden; there is a whole social world of organisations, projects, thought-leaders and key influencers, technologies, discourses, concepts and terminology that have to

be mastered in order to be ‘taken seriously’. Much of the existing thinking in the field, as articulated, for example, in the DCC Curation Lifecycle Model (Higgins, 2008), is perhaps more obviously tied to archival and records management thinking, than librarianship. The IT technical knowledge required could also be significant. Librarians may not currently have this technical knowledge, may lack domain-specific expertise and may also have limited personal experience of research, all of which may make it difficult for them to position themselves as key players in this area. This is particularly the case since researchers may not see the library as the natural place to turn for their RDM requirements. Carlson and Garritano (2010) emphasise the challenge by stressing the need for risk taking, flexibility and creativity in taking on such new roles.

A further type of challenge is in the complexity and scale of RDM issues in institutions. Given the fragmentation, hybridisation and fluidity of academic disciplines (Klein, 1996) and corresponding differences in information and data practices, the nature of data and how they are created and used, and what constitutes good research data management will vary widely within a single institution, even within a single faculty or department. Furthermore, some fields are well advanced in their understanding of the issues (such as health sciences or engineering), others not. In still others, it may not yet be an issue (for example, some humanities scholarship). Which particular drivers for RDM – storage and security, preservation, replication of research, data sharing, compliance with funders’ requirements – seem most compelling will also vary within and between HEIs.

Despite all of these challenges, a number of authors have argued persuasively for the need for library services to foreground the RDM agenda. Lewis (2010) proposed a pyramid model of nine areas of RDM activity for libraries. At the apex of the pyramid is influencing national policy; at the second level, leading on institutional policy, developing local curation capacity and working with LIS schools to identify required skills; and at the third tier, developing LIS workforce confidence with data, teaching undergraduate and postgraduate students, and advice services and data awareness raising among researchers. Corral (2012) added a new foundational layer to the pyramid: a data collection development and access management role, reflecting an extension of the library collection concept to data, and mirroring part of the data lifecycle. It is unclear, however, how this relates to the concept of ‘developing data curation capacity’ that was already in the Lewis model. Nevertheless, the revised model covers much of the essential ground. Significantly, it does not focus just on institutional-level roles, it also comments on involvement in national policy and partnership with educational providers.

That having been said, the importance of intra-organisational collaboration, for example through joint services, could perhaps be given further emphasis in the model.

Furthermore, the extent to which libraries are in a position to lead institutional policy is, of course, a moot point. Indeed, all the roles could be seen to require a multi-professional approach. At a more detailed level, it may be useful to differentiate between training of postgraduate taught students and postgraduate research students; and also to differentiate between support to early career researchers and principal investigators. Implicitly, the top of the pyramid is more strategic, but some of the ordering below this is less clear.

Whereas the Lewis-Corral model focuses on different types of functional activity, such as policy making and training, with an underlying hierarchical conception, Lyon (2012) maps potential roles of the library to a research lifecycle model, in 10 stages (at several points identifying potential partner services):

1. RDM requirements gathering – through auditing (with academic departments);
2. RDM planning – advocacy and guidance to researchers at all levels including PGR (with doctoral training centres);
3. RDM informatics – technical advice on data formats and metadata;
4. research data citation;
5. RDM training – training to researchers including PGR (with doctoral training centres);
6. research data licensing;
7. research data appraisal – guidance on which data to keep;
8. research data storage (with IT services);
9. research data access;
10. research data impact (with research support offices).

This is self-consciously an institutional perspective. It is recognised that differences between institutions and library services would mean this might look different in different contexts, but the focus remains on functions within the institution. It is also a library-centric model which although it stresses partnership, perhaps under-represents firstly, the extent to which other services would contribute or even lead on many aspects of RDM, and secondly, the independent activities of departments or faculties. Lyon does, however, usefully differentiate a number of roles by library organisational level and organisational unit, suggesting skills and relationships required in each case.

Focusing specifically on local institutional roles, Table 1 (further adapted from Cox et al., 2012) lists the main roles that have been proposed, and points to links in existing library practices (Auckland, 2012; Brewerton, 2011) that would define whether the roles would appear to be appropriate (both to practitioners themselves and to their users/customers).

As Table 1 suggests, the different roles in RDM imply different types of knowledge, but many align with existing

Table 1. Roles in research data management mapped to existing library roles and required competencies (adapted from Cox et al., 2012).

Role	Alignment with existing library roles	Competencies required
Policy and advocacy		
Lead on institutional data policy	Advocacy role e.g. in the area of open access	Strategic understanding and influencing skills
Support and training		
Bring data into undergraduate research-based learning, promoting data information literacy	Information literacy training	Understanding of RDM best practices as they apply to relevant disciplines; pedagogic skills
Teach data literacy to postgraduate students		
Develop researcher data awareness		
Provide an advice service to researchers (and research administrators), e.g. advice on writing data management plans, RDM within a project, licensing data, on data citation and on measurement of impact of data sharing.	Reference and enquiry roles; producing print and web-based guides; copyright advice	Reference interview, knowledge of RDM principles
Provide advice as above through a web portal	Library web site	Knowledge of institutional and extra-institutional resources
Signpost who in the institution should be consulted in relation to a particular question	Role of library as point of enquiry and the reference interview	Knowledge of institution
Promote data reuse by making known what is available internally and externally; explaining data citation	Marketing of library resources	Knowledge of researchers' needs, knowledge of available material
Auditing and data repository		
Audit to identify data sets for archiving, create a catalogue of materials or to identify RDM needs	Cataloguing and metadata creation	Metadata skills
Develop and manage access to data collections	Collection development, digital library management and metadata management	Audit interviews, knowledge of RDM principles, metadata, licensing
Develop local data curation capacity	Open access role Preservation role	Knowledge of RDM principles, relevant technologies and processes, metadata

roles (and the corresponding professional knowledge base). Any one individual may take on a number of these roles or part of them. While all RDM activities align in some way to existing roles of librarians, some do not, at least not in a simple way. Effort may be needed to 'sell' services based on such roles. Implicit in all the roles is the need to keep up to date on latest developments, in itself a significant challenge. To address this, it might be suggested that within LIS teams one person might play a maven and connector role, trend spotting and sharing information (Gladwell, 2002), keeping others abreast of wider developments.

Evidence about how far these potential roles have been realised in practice is beginning to emerge. Auckland (2012) surveyed subject librarians and managers in the 22 Research Libraries UK (RLUK) libraries, asking about the priority of different roles in supporting research and current ability to perform them. This pointed to significant skills gaps in the RDM area amongst others (see Table 2).

Auckland (2012) also identifies a skills shortage in the area of data analysis. Although the wider picture beyond subject librarians and research intensive institutions could be different, her work nevertheless highlights a number of major challenges.

The most relevant previous research in this area is Corral et al.'s (2013) survey of UK, Australian, New Zealand and Irish institutions, conducted in January 2012, which had 88 institutions respond. Corral sees existing and planned provision in the UK as weaker compared with Australia, New Zealand and Ireland.

While the percentage of UK libraries currently offering RDM support through assistance with technology infrastructure and tools (53.8 percent), and finding external datasets (41.3 percent) is relatively high, these areas form only a small part of the portfolio of support services thought to be needed, and even when we add their planned services to their current offerings, the plans of the UK libraries look disappointingly modest alongside those of their peers in other countries. (Corral et al., 2013: 639)

Only about 10% said that they were offering support to the technical aspects of digital curation (see also Table 5). Corral et al. found that the main constraints perceived were skills and confidence. RDM was also more commonly seen as lacking priority in the UK compared to other countries surveyed (40%). Levels of demand from users for RDM

Table 2. Top research data management skill gaps (adapted from Auckland, 2012: 3).

	Skills exist now	Essential in 2–5 years
Advising on preserving research outputs	10%	49%
Advising on data management and curation	16%	48%
Support complying with the various mandates of funders	16%	40%
Metadata advice and advocacy	10%	29%
Assisting locating sources of research funding	8%	21%
Developing metadata schema	2%	16%

services were also an issue. An additional constraint was that developing research data management services was not seen as part of their own role by libraries in the case of 33% of respondents. Resourcing was only mentioned by 25% of respondents.

A skills deficit was seen to be most likely addressed through on-the-job training or self-training. The specific skills needed were data curation skills (mentioned by nearly 90%), technical IT skills and knowledge of research methods. About 40% also recognised the need for disciplinary knowledge.

In a similar survey conducted for the US Association of College and Research Libraries in late 2011, 221 institutions responded (Tenopir et al., 2012; see also Table 5). Again, provision was currently quite low. In terms of 'informational and consulting services' providing advice on finding and citing data was the commonest current activity, with about 44% of institutions providing such a service. Of the institutions 20% were supporting data management planning, web guides or directly participating with researchers in projects. About 15% supplied a technical service. Libraries had relatively little engagement with policy, but there was a strong sense of collaboration with other campus services in relation to RDM. The stress was on reassigning staff rather than new appointments in order to develop capacity.

In the context of the debate about the role of libraries in RDM and limited data about the perspectives of practising librarians, the current paper reports research aimed at investigating current provision and readiness in the UK university sector. The specific research questions that the research sought to address were:

1. What current services do libraries in UK HEIs offer to support RDM?
2. What services are seen as a priority for the future?
3. What are the key issues and attitudes to RDM across the sector?

Research design

The research approach was designed to elicit detailed information to address these research questions. The main

instrument was a questionnaire the design of which was informed by the existing literature (particularly Auckland, 2012; Corral, 2012 and Lyon, 2012) and also the findings of research previously carried out at the University of Sheffield as part of the RDMRose project. RDMRose was funded by the UK's Joint Information Systems Committee (JISC) to produce an open-access educational resource to assist library staff in developing the skills and confidence necessary to take on roles in RDM (Cox et al., 2012). As part of its requirements gathering, the project carried out a series of focus groups of library and information professionals from partner institutions, members of the White Rose consortium of universities (Leeds, Sheffield and York). This activity helped to identify a number of key issues that were then designed into the questionnaire.

The questionnaire consisted of 27 questions, with a mixture of multiple-choice responses and free-text comments. It was arranged as follows:

- Introduction: Questions on the participants themselves, including their institution, role, and personal experience of research.
- Institutional RDM policy: Questions on whether the institution had a formal RDM policy (or one was planned) and the extent to which the library was involved in developing it.
- Library support for RDM: Questions on a range of possible RDM-related services and activities and the extent to which they are currently offered by the library and are strategic priorities for future development.
- Other questions: Questions on a variety of issues including cultural change, major challenges, skills and training requirements, charging for RDM services, and advocacy.

The survey questionnaire was made available online using the University of Sheffield Information School survey system (based on the LimeSurvey software) from 12 November 2012 to 12 December 2012. The research approach had been approved through the University of Sheffield ethics approval process. Prior to release, the questionnaire had been piloted by three senior managers in the UK academic

library sector with knowledge of RDM. Changes were made to the questionnaire in response to their comments before its general circulation. Piloting confirmed that the questionnaire took between 10 and 20 minutes to complete, depending on the extent to which free-text comments were added. It was specifically designed not to be onerous and therefore to encourage responses.

The survey was targeted at, but not limited to, library staff in UK HE and Research Institutions. Invitations to participate in the survey were sent to various professional email discussion lists. These included the closed lists for Library Directors in RLUK (Research Libraries UK) and SCONUL (Society of College, National and University Libraries). Open discussion lists were also targeted, including RESEARCH-DATAMAN, an international discussion list focused on RDM, JISC-REPOSITORIES, an international discussion list on repository management, and LIS-LINK, a general library discussion list with membership drawn largely from the UK academic library sector. At the beginning of December 2012, an assessment was made of the number of responses received to date and a message was sent to all UK HE Library Directors at institutions which had not yet submitted a response by that time requesting that they consider doing so. This prompted further responses before the survey was closed.

Data

A total of 116 full responses were received. For the purpose of analysis, it was decided to remove responses from non-UK institutions, since they did not constitute a systematic sample of institutions and there were only a few from any one country. Duplicates for some UK universities were also removed, leaving responses from the most senior member of staff, to ensure that the most authoritative data were being used. There were 76 de-duplicated responses from UK HEI libraries. In addition, five survey responses from the UK in which everything but the final page of questions had been completed were included in the analysis, making a total of 81 UK responses. This represents a response rate of approximately half of the target population (estimates differ but there are usually said to be between 160 and 175 higher education and other research institutions in the UK).

Of the 81 UK responses, 22 (27%) were from institutions in the Russell Group (large research-intensive institutions), 19 (23%) were from 'Pre-92' institutions (other research-led institutions), 30 (37%) were from 'Post-92' universities (teaching-led institutions) and 10 (12%) from other higher education and research establishments. Whilst this is ostensibly a good sample of institutions, it is reasonable to assume that it under-represents institutions which have not engaged with the challenge of RDM, and therefore to some extent exaggerates the sector's RDM activities. The sample in particular includes a very high proportion of Russell Group institutions (22 out of a total 24), although

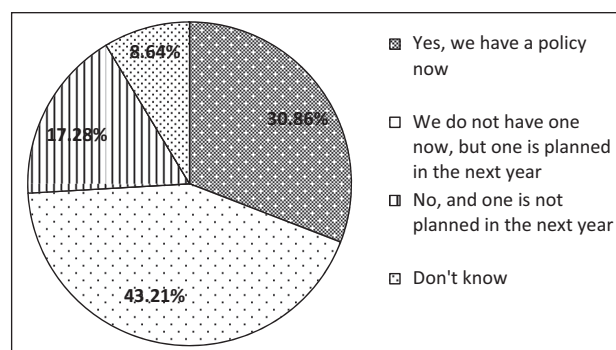


Figure 1. Research data management policies: 'Does your institution have a formal research data management (RDM) policy in place?'

this has the benefit of enabling comparisons between them and the rest of the sector.

Of the analysed responses 61 (75%) were on the library senior management team, most commonly the Library Director, making their responses on strategy and policy issues authoritative. Other respondents were most commonly specialist research support staff from libraries. Of the respondents 21 (26%) were from 'converged' library and IT services; 55 (68%) of the respondents had personal experience of research at Masters level but only 10 (12%) at PhD level. Their perspective on the researcher's viewpoint is not therefore usually based on direct personal experience of high-level research, an issue which may have implications for credibility (Lyon, 2012).

Results

Institutional policy

An affirmative response was made by 25 (31%) of institutions to the question: 'Does your institution have a formal research data management (RDM) policy in place?' (see Figure 1). This compares with 17% reported by Corral et al. (2013) from earlier in 2012. An additional 35 (43%) in the current survey stated that they expected to have a formal policy in place within the next year. Several of the latter commented that drafts had already been produced and were at various stages of approval. Of the remaining respondents, 14 (17%) stated that there was no formal RDM policy currently in place nor was one planned in the next year; seven (9%) responded: 'Don't know'. This means that the large majority of responding institutions (75%) either already had an RDM policy in place or expected to have one within 12 months, with approaching one-third with a policy already in place. Around 40% of Russell Group universities had a policy in place, in comparison to 25% of other institutions.

The majority of respondents (58 or 72%) reported that the library had been involved in institutional RDM policy

development. Only 13 (16%) said the library had not been involved and 10 (12%) answered: 'Don't know'. Thus, where there is a policy in place or where one is planned, the library is normally involved. A number of respondents provided further detail on the extent of library involvement. Some stated that the library had led (or was leading) the development of an RDM policy, in some cases with formal responsibility for RDM having been handed to the Director of Library Services:

The library took the lead by initially conducting a DAF [Data Asset Framework] study, taking the results to University Research Committee and then chairing the subsequent working group which developed the research data policy.

The Library is leading the University's project to define a policy for research data and sharing.

The Director of the Library is the 'process owner' for RDM and will therefore take the lead in policy development.

In a number of cases, the library reported to an institutional committee or senior institutional officer overseeing developments:

Library provided lead in the development of policy as charged by our Research Committee.

The Library drove the RDM policy, however RDM is now the responsibility of a Univ-wide group including the Library.

In the majority of cases, the library was represented on a university-level committee developing an RDM policy:

Small working group chaired by PVC [Pro-Vice-Chancellor] Research including Librarian, Director of [IT services], Head of Research Support, and Head of Compliance.

[The Director of Library Services is a] member of working group asked to develop a policy.

A number of respondents commented that at least some RDM development work was being carried out through a time-limited project in the institution which was raising the profile of RDM and coordinating some policy development. Several respondents mentioned projects funded by JISC which has sponsored various projects in UK HEIs as part of its 2011–2013 Management Research Data development programme (JISC, 2013):

The Board that is overseeing research data management and storage has a representative from the Library and the current JISC RDM project involves a member of Library Staff. Both of these groups have been instrumental in developing the University Policy on research data that is moving towards adoption.

Amongst the comments, the most commonly mentioned unit also to be involved in RDM policy development was the research support office, although other units were mentioned

as well, including IT services. As a general point, the importance of collaboration between different units in the University was a common theme running through a large number of the responses:

Library working closely with DVC [Deputy Vice-Chancellor] Research and Research and Innovation unit to joint author policy.

Library Services and Research Management & Administration staff have worked together on this. We are also involved in ... [a] JISC-funded ... Project.

We all work together – Research Strategy and Innovation, IT Services, Library, DCC [Digital Curation Centre] reps.

Only one respondent commented that the research support office was *leading* developments:

This is being taken forward by the Research and Enterprise dept, working in close collaboration with the Library.

A number of responses indicated that RDM policy development was not yet underway or at very early stages in their institution:

At very early stages, we would anticipate being involved at some level.

Cultural change

Most of the respondents (53 or 70% of the 76 who answered this question) stated that the 'culture of RDM' had in their view changed in their institution in the last year. Another 15 (20%) stated that it had not, with the remaining eight respondents (12%) uncertain. A number of respondents described the changing culture in more detail with the majority of those who commented on this issue clearly believing the changes to be important:

RDM is on the institutional agenda, is being discussed, and while there are differences of opinion and emphasis there is agreement that something needs to be done and around the direction the institution needs to move in.

There is increasing recognition that this is an important area and support is required for it.

In some cases, the changes were regarded as patchy within the institution:

[Cultural change is evident] amongst some, but it needs to change at a more widespread level across the institution. I predict that this will happen as a result of the work that we are currently undertaking.

RDM is being taken seriously by the University Senior Team. There are still areas of the University that are not culturally tuned to RDM and in particular sharing of research data.

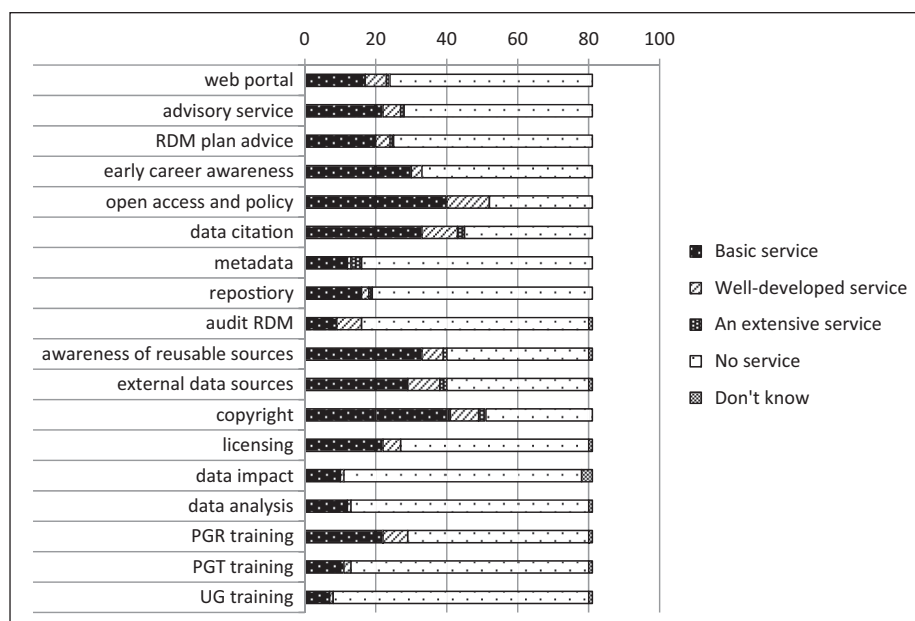


Figure 2. Current research data management services (N= 81).

Outside the Faculty of Science and Technology, there is as yet relatively little awareness of RDM and what it might involve.

Some respondents observed that different strands of RDM activity were receiving greater attention than others:

RDM is gaining more importance – albeit fairly slowly. There is currently activity on data security and storage, and a growing awareness of the issues around curation and preservation.

With REF [Research Excellence Framework] and importance of research ethics, the Uni is taking a more considered approach to RDM.

The UK's Research Excellence Framework (the UK-wide research quality assessment exercise) was one of a number of drivers within and outside the institution referred to by respondents:

There is more engagement due to a combination of awareness raising, requirements of funders and the recognition (by some) that data management supports 'good science'. There is also high level commitment as demonstrated by the funding of the project manager post.

Several other respondents referred in particular to policies recently introduced by research funders requiring greater research data management planning and data sharing. The Engineering and Physical Sciences Research Council (EPSRC) was specifically mentioned by a number of respondents following its initiative to require each institution receiving its grants to produce 'Data Management Roadmap' in 2012:

EPSRC requirements have brought this to the fore.

Research Council mandates have effectively energised the University Research Committee.

Other UK national bodies were also cited as being important including JISC in funding a number of RDM projects and the DCC (Digital Curation Centre) in providing guidance and advocacy material on RDM and related issues. In addition, specific institutional projects (some JISC-funded) were again mentioned this time for their perceived contribution to cultural change in the institution.

Current research data management services and future priorities

Two of the longest questions in the survey related to the different roles librarians might take in RDM. Eighteen distinct roles were identified from the literature and respondents were asked to identify from the list what sort of service they had currently (Figure 2) and what was seen as the priority for the next three years (Figure 3). Details of the roles as described in the questionnaire are given in the appendix. In the Figures a wide range of possible roles in RDM are represented. The level of current of activity can be read off from the bar chart. Different levels of service are differentiated but a clear pattern emerges from the shaded section of the bar. Unshaded areas represent the proportion of respondents where no service was offered. The tiny fraction of answers where the respondent did not know the answer are represented at the right-hand end of each bar.

Looking at the unshaded parts of the bar, it is immediately clear that many institutions have no current service in

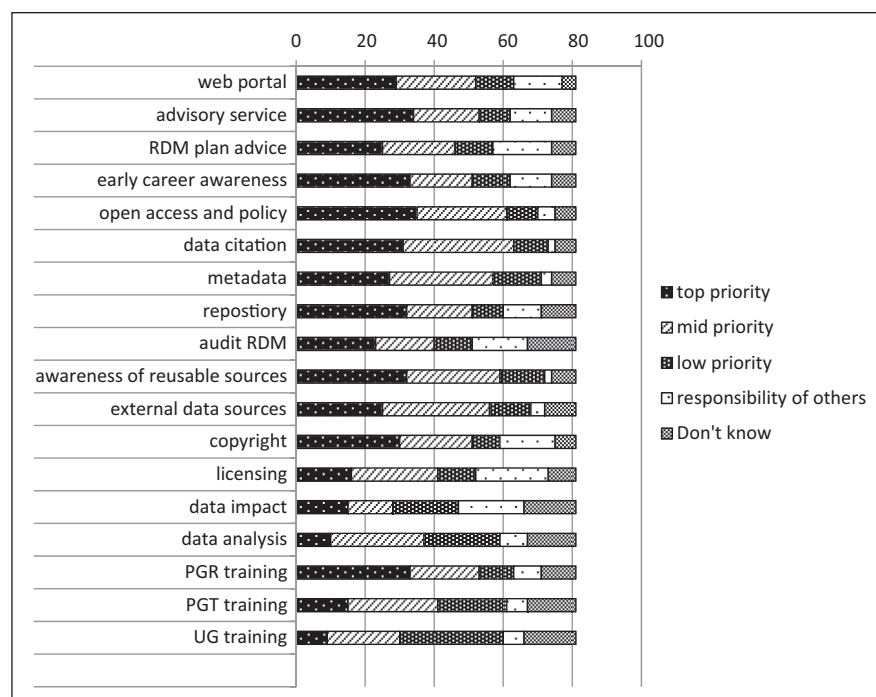


Figure 3. Research data management priorities for the next three years ($N = 81$).

many areas. Looking at the shaded sections of the bar, there were few well-developed or extensive services in any area. Taking together responses that indicated that *any* sort of level of service existed (all the shaded areas), two types of role had significantly more than half of institutions already offering provision: 'raising open access to data and RDM policy issues' (64%) and 'advice on copyright and IPR issues relating to RDM' (63%). Presumably, these link to existing open-access advocacy and to copyright advice activities of the libraries. Other services that existed were nearly always seen as 'basic' services. Around 50% of institutions said they offered some level of service in terms of how to cite data (56%), and awareness of reusable data sources (50%). It is also easy to see how these relate to existing roles. Similarly, libraries have traditionally undertaken awareness-raising and training activities in various areas, and with regard to RDM, this is evident to some extent with a focus on early career researchers and postgraduate research students. Of the institutions 41% reported they were undertaking early career researcher awareness-raising activities and 36% postgraduate research student training. These activities were much more apparent than any support for postgraduate taught or undergraduate students. In Corral et al.'s survey from the beginning of 2012, 'Guidance on the handling and management of unpublished research data, for example data literacy education and/or training' was only around 14%, so there seemed to be evidence of a significant growth of activity here.

Other activities were relatively rare. These included data analysis or support in assessing the impact of sharing data.

More technical services in the area of auditing, metadata or a repository were also quite infrequently found to be in existence, with only around 20% of institutions providing any service. Interestingly a smaller proportion of institutions (under 20%) claimed to have a data repository in our survey than in Corral et al.'s (2013) survey (37.5%) conducted at the beginning of 2012, although this may be an issue of definition.

Figure 3 represents stated priorities among the same set of roles. Shaded areas represent roles that were considered any sort of library responsibility, from high to low priority. The darker shading represents the number of respondents identifying a particular activity as a top priority. The proportion of the bars that identify roles as high or medium priority is over 50% in most cases and often much greater, indicating that RDM is a significant concern for librarians. Surprisingly perhaps, relatively few of the roles were seen as primarily the responsibility of another unit in the university, as indicated by the part of the bar that is unshaded. Thus, RDM is an agenda libraries are seeing as highly relevant.

Comparing the ranking of roles by current activity to what is considered top priority (Table 3), open-access and policy advocacy is the most common current activity and also the top priority. After this, alignment between current activities and future priorities is much less obvious. Priorities appear to lie in policy activity, providing an advisory service and raising awareness among early career researchers and PhD students. Running a data repository is also commonly seen as a priority; here the gap between aspiration and current activity is greatest.

Table 3. Comparison of top current services with top priorities.

	Rank by current activity	Rank by top future priority
Open access and policy	1	1
Copyright	2	8
Data citation	3	7
Awareness of reusable sources	4	5
External data sources	5	11
Early career awareness	6	3
PGR training	7	3
Advisory service	8	2
Licensing	9	14
RDM plan advice	10	11
Web portal	11	9
Data repository	12	5
Metadata	13	10
Audit RDM	14	13
Data analysis	15	17
PGT training	16	15
Data impact	17	15
UG training	18	18

There were distinct differences between Russell Group institutions and others, with Russell Group libraries having more services in many areas, especially web portal, advisory services, early career awareness, awareness of reusable resources and PGR (postgraduate research student) training (Table 4).

Challenges

Respondents were asked: 'What are the major challenges for libraries with RDM?' Of the 52 who answered the question, many named multiple challenges. Categorising these responses, of the 123 different items, the most common answers were connected with the issues of skills gaps (20) or resourcing (18):

The skill set of the library workforce, the costs of RDM and the difficult economic climate.

Capacity and workload in a context of shrinking resources.

Taking the rest of the institution with us!

As well as skills, lack of confidence was identified in some responses. Skills and confidence were the main constraints identified by Corral et al. (2013). However, only five people mentioned clarifying the library role as a challenge as such, implying that skills and capacity are the problems rather than ambiguities about what the role of the library should be. Nevertheless, the issue of the ambiguity of the role of the library does seem to be one implicit in a number of responses to the survey in general. Other common

responses to this question also have a bearing on this issue, often touching on the library's relationships with other parts of the institution. These include encouraging others to recognise RDM as a priority (10), working with other professional services (9), supporting the wide range of data management practices across different disciplines (7), and getting the library to be taken seriously (7).

Disparate views on where responsibility should be (often viewed as an IT Storage issue). Library needs to take a view and articulate it loudly and clearly (what it will and won't do).

Understanding how different researchers work with/gather/store data. Applying skills around organising information to a very wide spread of practices and in relation to data that researchers often have a personal attachment too. Persuading researchers that our information organising/handling skills are relevant to data management!

Being seen as a key player ...

Several respondents also mentioned challenges associated with infrastructure provision:

the need to provide a generic infrastructure that also interfaces with disciplinary tools.

However, the complexity and scale of the issues in general (as opposed to specifically in the nature of data) was, surprisingly, only mentioned by two.

Skills and training needs

Responses about skills suggested that libraries had patches of the relevant skills but that they were not seen as widely enough spread. About a third of respondents who replied to the question, said that they thought the library did have the 'right skills to play a significant role in RDM':

There is a wide range of skills required for research data management, and where the library is very strong in is: cataloguing including metadata, digital preservation, curation, training, academic engagement, copyright, publication process.

Yet this confidence was often qualified:

A few library staff have some of the right skills.

Librarians have core skills regarding the organisation of information but these need extending to fully encompass the requirements of data management.

They may not be aware that the skills they have are transferable however.

Over 50% said the library staff did not have the right skills, but these replies were qualified too, acknowledging that they had some of the skills needed.

Table 4. Comparison between Russell Group institutions and other respondents.

	Russell Group institution with any service (N=22)		Non-Russell Group with any service (N=59)	
Web portal	11	46%	13	22%
Advisory service	11	46%	17	29%
RDM plan advice	8	33%	17	29%
Early career awareness	13	54%	20	34%
Open access and policy	16	67%	36	61%
Data citation	9	38%	36	61%
Metadata	4	17%	12	20%
Data repository	7	29%	12	20%
RDM audit	6	25%	10	17%
Awareness of reusable sources	14	58%	26	44%
External data sources	11	46%	29	49%
Copyright	14	58%	37	63%
Licensing	9	38%	18	31%
Data impact	3	13%	8	14%
Data analysis	4	17%	9	15%
PGR training	10	42%	19	32%
PGT training	5	21%	8	14%
UG training	2	8%	6	10%

Some were looking to fill the gap through recruitment. Others stressed development of existing staff. It was seen as a gradual process that would build as service demand grew. Often institutional JISC projects had a training element that was seen as part of a solution.

Charging

The questionnaire also explored a number of specific implementation issues that seemed potentially interesting, namely views on charging for services and about whether support should be offered at an institutional or departmental level.

Respondents were asked: “Which, if any, RDM services should be charged for?” Most chose not to answer this question, which presumably can be taken as a response that charging cannot currently be confidently said to be appropriate for any services. This was stated explicitly by 16 respondents; for example:

There must be central funding and service to [the] end user should be free.

I would say that the service should be provided to researchers as part of the routine provision at the University.

Others stated that RDM activity was too immature in their institution to provide an informed answer to this question. Of those who did answer the question, 20 suggested that data storage costs might be chargeable, particularly if storage requirements were unusually large:

Data storage above a certain agreed capacity.

A basic level of RDM storage should be provided free at point of delivery and additional storage/HPC should be re-charged to funding bodies where possible or provided at school level. We know there will be some valuable assets which need to be kept which have no funding stream and are grappling with the whole institutional issue of funding for retention and archiving.

On site storage of data/any costs for hosting data elsewhere. There is scope for researchers to include this in grant applications but they need to be more aware of this. We would be reluctant to charge for advice/support/developing guidance as this would dissuade researchers from using a central service.

Other areas for possible charging were suggested by small numbers of respondents, including specialised services, metadata production, long-term preservation, discovery services, copyright advice or other value-added services. However, in all cases these were expressed as provisional suggestions rather than settled views and certainly not established policies.

A number of respondents commented specifically on the issue of internal funding streams and the relationship with research income from external sources, either direct funding for research or indirect funding for overheads (also known as fEC, full economic costing). Some suggested that more work needs to be done to ensure that appropriate levels of external income of various kinds is channelled to support institution-level services, including RDM:

Possibly too early to answer this question: fEC issues still to be resolved. Charging for data storage (not a library responsibility) seems reasonable.

Table 5. A comparison of findings between recent surveys.

Role as defined by Corrall et al., with Tenopir et al. wording in brackets	Current UK – Corral N=82	Planned UK – Corral	Total UK – Corral	Current US – Tenopir N=221	Planned in next 2 years US – Tenopir	Total US – Tenopir	Questions in current survey N=81	Currently any service	Top/ mid priority for next 3 years
1. Assistance to use available technology, infrastructure and tools	53.8	31.3	85.1	–	–	–	–	–	–
2. Guidance on the handling and management of unpublished research data, for example data literacy education and/or training [Training co-workers in your library, or across campus, on research data services]	14.3	42.9	57.2	11.4	27.3	38.7	Data management training to PhD students PGT students UG students Raise early career researchers' RDM awareness Offer an RDM advisory service to researchers Run a data repository	35.8	65 51 37 63 65
3. Support for data deposit in an institutional repository [Providing technical support for research data services systems]	37.5	37.5	75	14.5	27.2	41.7	–	23.5	70
4. Support for data deposit in external repositories or data archives	15.4	37.2	52.6	–	–	–	–	–	–
5. Finding relevant external data sets [in Tenopir and citing data sets]	41.3	20.0	61.3	44.1	21.9	66	Promote awareness of reusable data sources, such as data archives Provide support for research and retrieval of external data sources Offer advice on how to cite data	49.4 49.4 55.6	73 69 78
6. Technical aspects of digital curation	10.3	39.7	50	–	–	–	–	–	–
7. [Deaccessioning/ deselection of data/data sets for removal from a repository]	–	–	–	5.5	17.3	22.8	–	–	–
8. [Preparing data/data sets for deposit into a repository]	–	–	–	9.5	26.3	35.8	–	–	–
9. [Creating or transforming metadata for data or data sets]	–	–	–	11.9	22.1	34	–	–	–
10. Developing data management plans	8.8	48.8	57.6	20.5	22.2	42.7	Offer advice specifically on RDM plans	30.9	57
11. Developing tools to assist researchers manage their data	7.8	41.6	49.4	–	–	–	–	–	–
12. Development of institutional policy to manage data	17.3	60.5	77.8	*	*	*	Raise open access to data and RDM policy issues	64	75

Table 5. (Continued)

	Role as defined by Corraill et al., with Tenopir et al. wording in brackets	Current UK – Corraill N=82	Planned UK – Corraill	Total UK – Corraill	Current US – Tenopir N=221	Planned in next 2 years US – Tenopir	Total US – Tenopir	Questions in current survey N=81	Currently any service	Top/ mid priority for next 3 years
13.	[Creating web guides and finding aids for data/data sets/data repositories]	–	–	–	22.3	33.6	55.9	Maintain a web page portal of links for local advice and useful resources on RDM	29.6	64
14.	[Consulting with faculty, staff, or students on data and metadata standards]	–	–	–	17.9	23.9	41.8	Offer metadata services for a local catalogue of research data assets	19.8	70
15.	[Directly participating with researchers on a project as a team member]	–	–	–	21	19.7	40.7	–	–	–
16.	[Identifying data/data sets that could be candidates for repositories on or off campus]	–	–	–	11	33.6	44.6	Undertake an audit of the institution's RDM resources	19.8	49
17.								Offer advice on copyright/Intellectual Property Rights issues relating to RDM	63	63
18.								Offer advice on licensing of data	33	51
19.								Carry out any activities relating to data impact issues	13.6	35
20.								Offer advice on data analysis/mining	16.1	46

*Tenopir found that only 4.6% of respondents were engaged with the development of policies and procedures.

Pragmatically, what can be built into funder grants should be charged, at least nominally, as it is clear that sustainability is generally an institutional responsibility. However, there is a 'cost of being in business' question for the institution and an issue around internal recirculation of institutional funds. Reconfiguring central service charges may be a better way to manage this than direct costs.

Advocacy

Although 28 respondents (37% of the 76 answering this question) stated that in their view RDM was 'best approached through institutional advocacy and support rather than subject-community advocacy and support' and 12 (16%) disagreed, a large number of respondents (36 or 47%) were reluctant to choose between institutional or subject-community approaches. The vast majority of comments made by respondents mentioned the importance of both, albeit with different emphases:

I think both approaches will be needed, and both are equally important.

Researchers are more likely to be interested in information that has a direct bearing on their work and where the key benefits to them are clear. Tailored training and advocacy for specific disciplines is therefore more likely to see a greater uptake than generic information. This would work alongside a certain amount of generic institutional-level advocacy.

It seems to me that it should be a combination of both. The University should champion the RDM agenda and should provide an infrastructure of resources (people, systems, funds) whilst the subject community will provide discipline specific support and networks.

One respondent commented that institution-wide advocacy and support could in fact be informed by subject-community developments:

I'd like to say a combination of the two. Some of the best RDM practice in my institution is in subjects where the community have advocated for and supported it over a number of years. Engaging researchers in these areas in institutional advocacy and harnessing their knowledge, enthusiasm and experience has been critical in engaging areas where there isn't the same commitment to RDM.

Several respondents commented that subject-based support is likely to be variable across different disciplines with institutional approaches filling gaps and providing consistency for reasons such as regulatory compliance:

I would argue that both have a role to play and it very much depends upon the academic and the subject.

Subject communities knowingly doing research data will already be engaged; however, those not recognising that they produce it won't, so institutional approaches/support is needed.

For both, institutions have a growing externally imposed responsibility for RDM; subject communities will have no interest in this so institutional advocacy is an imperative to meet compliance, regulatory requirements, etc., even if for no other reason.

Discussion

The research reported here shows that UK academic libraries offered limited RDM services of any sort at the end of 2012. Many offered none, even in areas they regarded as a priority. However, the evidence also suggests that this is a time of change. For example, in most institutions formal RDM policies had recently been put in place by the end of 2012 or were expected to be put in place during 2013. The organisational culture is reported to be changing. Funders' mandates and JISC projects seem to be key drivers for change.

Libraries see RDM as relevant. It is seen as a core activity for institutions for the future and one in which the library should play a major role. Libraries are being involved in current policy making. They do not see RDM as of limited importance, nor do they see it as something somebody else should do, although the need for work to be collaborative is clear. This seems to have shifted even in the short time since Corral et al. (2013) conducted their survey when more institutional libraries seemed to regard RDM as irrelevant to their role. In the short term, the priority for most is to develop an RDM policy. In the medium term, the focus is likely to be in advice and training, but also some involvement in an institutional repository. Currently, libraries in research-intensive institutions tend to be ahead of others both in terms of policy development and service delivery. This is not surprising since it is in these institutions that the data management imperative is perhaps felt most keenly and also where libraries have more capacity to resource new areas of activity. There are, however, clearly examples of good practice outside these institutions.

The survey provides a picture of late 2012 priorities for the various roles proposed in the literature. Table 5 seeks to map the findings of the current survey to those of Corral et al. (2013) and Tenopir et al. (2012). Comparison is hard because the scope of the surveys is different and wording of questions is significantly different in several cases (for example, question area 2, 'Guidance'). Our survey asked more differentiated questions about types of training and advice (area 2) and copyright and licensing (17–20). It had fewer on technical data curation areas, which assume the existence of a data repository, a stronger focus in the Tenopir study (7–9). Comparison is also being made across different countries where it is possible priorities may be different.

It is apparent that support for data management plans has grown. There are indications here that a range of services in terms of training and advice to various groups, on

data management but also on external archives, citation, copyright and licensing are beginning to emerge as priorities at least in the UK. There may be more acknowledgment that starting with advice and training requires considerable work in applying current skills to a new type of problem, but is an appropriate role for the library to lead on. Whilst a data repository is an important part of an infrastructure that needs to be in place in order for researchers to operate, yet the importance of simple signposting, advice and training of users apart from the technical infrastructure seem to have gained ground as priorities for libraries. This might mean that the emphasis on training library staff in the specialised areas of curation and IT skills that emerged as a priority from Corral et al.'s (2013) survey at the beginning of 2012 are now seen as less important. Yet there are clearly issues around resourcing and skills. There are patches of the appropriate skills; others need to be developed. In general, there are also major challenges associated with the scale and complexity of the issues, and in developing partnerships with other stakeholders in the institution.

Future library roles?

The current situation seems to correspond to the early stages of an RDM 'hype cycle'. Fenn and Raskino (2008) describe the hype cycle as a framework for understanding innovation, such as new products or management techniques, plotting expectations against time. The cycle goes through several phases. Initially, 'positive hype' on the launch of a new product or introduction of a new idea leads to a 'peak of inflated expectations', only to be followed by 'negative hype' where 'problems with performance, or slower-than-expected adoption, or failure to deliver financial returns in the time anticipated all lead to missed expectations'. Despite this prompting a significant decline in expectations (labelled 'the trough of disillusionment'), many innovations may subsequently begin to demonstrate their value through further implementation. 'Drawing on the experience of early adopters, understanding grows about where the innovation can be used to good effect' and this leads to 'the slope of enlightenment' phase. Finally, with the 'real-world benefits of innovation demonstrated and accepted, growing numbers of organizations feel comfortable with the now greatly reduced levels of risk' associated with the innovation and achieve a 'plateau of productivity' (Fenn and Raskino, 2008: 8–9). The hype cycle model grew out of the IT industry and was developed and popularised by the Gartner consultancy. Nevertheless, the logic of hype cycles does also seem to apply in specific sectoral situations, such as in use of technologies and management techniques in education. It would not be unreasonable to anticipate that the RDM agenda follows the same pattern.

Amongst library and information professionals, there now seems to be a significant amount of positive hype

associated with RDM. This is evidenced in professional discussions at conferences and meetings, and in various online fora. Significantly, the hype itself becomes a *driver* for change with librarians being encouraged to implement change in line with current trends in the profession. However, the hype cycle model predicts that at some point this positive hype will turn negative as the scale and complexity of the challenge, resourcing implications and technical constraints become more apparent. Disillusion is usually linked to a loss of faith in the potential return on investment particularly associated with slower-than-expected adoption. Perhaps the slip into negativity for RDM will occur in 2014. This can often be triggered by a small number of influential actors coming out debunking the 'bandwagon', something that could be impactful in a professional community, such as academic librarianship, characterised by strong networks. The attack is likely to focus on the difficulties of providing an infrastructure for diverse data at the institutional level.

While this is likely to happen, it is also probable that the current powerful drivers for RDM will remain. These include funders' mandates, security concerns, open-access arguments, as well as the ever-increasing need for data storage. All of these are currently converging in a flow of forces for an RDM strategy. It is possible this will continue to be the case for the foreseeable future. It is also possible that the streams will diverge over time with different drivers carrying different RDM currents (such as data storage, security, preservation and sharing) forward at different rates and in different directions. Also, it is possible that as immediate imperatives (such as storage problems and security concerns) are addressed, energy may dissipate from the whole RDM agenda. It remains to be seen how the situation will mature and further research will be needed to review developments.

One key issue will be the roles of different stakeholders in institutions including libraries. An Abbotonian perspective (Abbott, 1988) on professional roles sees work as a competitive space where professions compete for 'jurisdiction' over different types of work (Cox and Corral, 2013). It could be argued that librarianship as an internally well-organised profession (for example, with strong professional identity and knowledge networks) has the ability to outmanoeuvre less-organised professions (such as research administration) or smaller professions (particularly archives and records management), however relevant their professional knowledge. Arguably, records managers already practise many of the disciplines relevant to research data management, yet because they tend to be a small group on campus, the library may more successfully portray itself as a more important player. In innovating librarians manage risk by sharing experience of what works (and what does not) formally and informally across the profession: this is a very powerful approach, not available to smaller professional groups. Yet the will to seek jurisdiction may be seen

to reflect broader pressures on librarianship's core traditional 'access' jurisdiction (Abbott, 1988), with the diminishing importance of the book-filled library, so long the cornerstone of librarianship. Librarians are actively seeking to reinvent their role; support of RDM and of research more generally is one area into which they seek to expand to compensate for the loss of ground elsewhere. Also to be considered is the relationship to computing services. Although poorly organised formally as a profession, the power of IT service providers' solutions and the IT departments' size mean that it will also be a powerful player in RDM. The relationship between the library and the IT service will be crucial in this area as in others. A further important consideration is how researchers and research disciplines as social entities respond to the 'support' professional services wish to offer. RDM could be seen as a managerialist discourse, a further attempt to discipline academics and curtail academic freedom. 'Kick back' against this could disrupt the easy realisation of RDM strategies, creating the type of intractable problems that critics of the hype will seize on. The common statement in RDM policies that the institution owns researchers' data could be the point of conflict where the positive hype bubble bursts.

As well as there being a competitive dimension to the relationship, libraries clearly need to collaborate with IT services and researchers along with other key players such as research support offices. Abbott's view that professional discourses around collaboration often actually disguise competition for jurisdiction may have some merit, but might be said to over-emphasise competition. His work does, however, recognise the possibility that jurisdiction of work may be divided between two professions (Cox and Corral, 2013). Nalebuff and Brandenburger's (1997) account of cooperation alongside competition captures an important dimension of the reality. They refer to 'co-opetition', a term that could certainly be used to characterise the competitive-cooperative tension currently at play in the RDM area. The extent to which this tension can be managed will be a critical part of success in this area for libraries. As part of this, libraries need to identify where they can develop their role in RDM and what that means for skills, policies and services, and also crucially, how these fit into the overall institutional provision. What is clear is that UK libraries are now beginning to think about doing so. It will be a fruitful area of research to continue to track changes across the sector and make international comparisons.

Conclusion

RDM is a fascinating area of academic library activity which at the time of writing in 2013 is the centre of many complex and changing expectations. The current study, especially when coupled with the work of others such as Corral et al. (2013) and Tenopir et al. (2012), begins to capture a picture of current activity and planning. Such

snapshots have a practical value in helping librarians, other professional services and policy makers benchmark the development of library services, nationally and internationally. The current paper has contributed a depth to the discussion by linking RDM developments to both the hype-cycle model and to Abbott's work on professional jurisdiction. These theoretical lenses offer deeper forms of analysis of the complex pattern of activity and a means to anticipate if not predict future paths of development. As the 'next big thing' the pattern of RDM service development will have its unique features, but is also likely to echo previous shifts in academic library practice.

Given the changing context, inevitably further research will be needed, both to repeat such survey work over the next few years to see how services and priorities change and to capture a sense of the pattern in different countries. There is also a need for more detailed qualitative studies. In particular, the focus of such qualitative work might be to explore how the network of agendas around RDM, such as compliance, openness, storage, security and preservation play themselves out at a local institutional level and how this shapes the process both of policy creation and then of subsequent service development. There is also a great deal more to explore in terms of precisely what skills library and information professionals need, how the workforce will be developed to support new roles in RDM and the implications for the identity of the academic librarian.

Acknowledgements

Thanks to Barbara Sen and Eddy Verbaan for their comments on the survey design.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

- Abbott A (1988) *The System of Professions*. Chicago, IL: University of Chicago Press.
- Alvaro E, Brooks H, Ham M et al. (2011) E-science librarianship: Field undefined. *Issues in Science and Technology Librarianship* 66. Available at: <http://www.istl.org/11-summer/index.html> (accessed 10 April 2013).
- Auckland M (2012) *Re-Skilling for Research: An Investigation into the Role and Skills of Subject and Liaison Librarians Required to Effectively Support the Evolving Information Needs of Researchers*. London: Research Libraries UK. Available at: <http://www.rluk.ac.uk/content/re-skilling-research/> (accessed 10 April 2013).
- Borgman CL (2012) The conundrum of sharing research data. *Journal of the American Society for Information Science and Technology* 63(6): 1059–1078.
- Brewerton A (2011) '... and any other duties deemed necessary.' An analysis of subject librarian job descriptions. *SCONUL Focus* 51: 60–67.

- Carlson JR and Garritano JR (2010) *E-science, Cyberinfrastructure and the Changing Face of Scholarship: Organizing for New Models of Research Support at the Purdue University Libraries*. Libraries Research Publications. Paper 137. Available at: http://docs.lib.purdue.edu/lib_research/137 (accessed 10 April 2013).
- Corrall S (2012) Roles and responsibilities: Libraries, librarians and data. In: Pryor G (ed.) *Managing Research Data*. London: Facet, pp. 105–133.
- Corrall S, Kennan MA and Afzal W (2013) Bibliometrics and research data management: Emerging trends in library research support services. *Library Trends* 61(3): 620–658.
- Cox AM and Corrall S (2013) Evolving academic library specialities. *Journal of the American Society of Information Science and Technology*. In press.
- Cox AM, Verbaan E and Sen B (2012) Upskilling liaison librarians for research data management. *Ariadne* 70. Available at: <http://www.ariadne.ac.uk/issue70/cox-et-al> (accessed 10 April 2013).
- DCC (2011) Data management in perspective: The career profile of data managers. Edinburgh: Digital Curation Centre. Available at: http://www.dcc.ac.uk/webfm_send/526 (accessed 10 April 2013).
- Fenn J and Raskino M (2008) *Mastering the Hype Cycle: How to Choose the Right Innovation at the Right Time*. Boston, MA: Harvard Business Press.
- Fry J, Lockyer S, Oppenheim C et al. (2009). *Identifying Benefits Arising from the Curation and Open Sharing of Research Data Produced by UK Higher Education and Research Institutes*. Project Report. JISC. Available at: <http://www.jisc.ac.uk/publications/reports/2008/databenefitsfinalreport.aspx> (accessed 10 April 2012).
- Gabridge T (2009) The last mile: Liaison roles in curating science and engineering research data. *Research Library Issues* 265: 15–21.
- Garritano JR and Carlson JR (2009) A subject librarian's guide to collaborating on e-Science projects. *Issues in Science and Technology Librarianship* 57. Available at: <http://www.isl.org/09-spring/refereed2.html> (accessed 10 April 2013).
- Gladwell M (2002) *The Tipping Point*. London: Abacus.
- Henty M (2008a) Developing the capability and skills to support eResearch. *Ariadne* 55. Available at: <http://www.ariadne.ac.uk/issue55/henty/> (accessed 10 April 2013).
- Henty M (2008b) Dreaming of data: The library's role in supporting e-research and data management. In: *Australian Library and Information Association biennial conference*, Alice Springs, Australia, 2–5 September 2008. Available at: http://apsr.anu.edu.au/presentations/henty_alia_08.pdf (accessed 10 April 2013).
- Higgins S (2008) The DCC curation lifecycle model. *International Journal of Digital Curation* 3(1): 134–140. DOI: 10.2218/ijdc.v3i1.48.
- Hyams E (2008) Data librarianship: A gap in the market: Stuart Macdonald and Luis Martinez-Urbe. *Update Magazine* (June). Available at: <http://www.era.lib.ed.ac.uk/handle/1842/2499> (accessed 10 April 2013).
- Joint Information Systems Committee (2013) *Managing Research Data Management*. Available at: http://www.jisc.ac.uk/whatwedo/programmes/di_researchmanagement/managingresearchdata.aspx (accessed 10 April 2013).
- Jones S, Pryor G and Whyte A (2013). *How to Develop Research Data Management Services - A Guide for HEIs*. DCC How-to Guides. Edinburgh: Digital Curation Centre. Available at: <http://www.dcc.ac.uk/resources/how-guides> (accessed 21 May 2013).
- Klein JT (1996) *Crossing Boundaries: Knowledge, Disciplinarity, and Interdisciplinarity*. Charlottesville, VA: University Press of Virginia.
- Lewis M (2010) Libraries and the management of research data. In: McKnight S (ed.) *Envisioning Future Academic Library Services: Initiatives, Ideas and Challenges*. London: Facet, pp. 145–168.
- Lyon L (2012) The informatics transform: Re-engineering libraries of the data decade. *International Journal of Digital Curation* 7(1): 126–138. DOI: 10.2218/ijdc.v7i1.220.
- Monastersky R (2013). Publishing frontiers: The library reboot. *Nature* 495(7442): 430–432.
- Nalebuff BJ and Brandenburger AM (1997) Co-opetition: Competitive and cooperative business strategies for the digital economy. *Strategy and Leadership* 25(6): 28–35.
- Pryor G (ed.) (2012) *Managing Research Data*. London: Facet.
- Pryor G and Donnelly M (2009) Skilling up to do data: Whose role, whose responsibility, whose career? *International Journal of Digital Curation* 4(2): 158–170. DOI: 10.2218/ijdc.v4i2.105.
- Research Councils UK (2013) *Common Principles on Data Policy*. Available at: <http://www.rcuk.ac.uk/research/Pages/Data-Policy.aspx> (accessed 10 April 2013).
- Royal Society (2012) *Science as an Open Enterprise*. Available at: <http://royalsociety.org/policy/projects/science-public-enterprise/report/> (accessed 10 April 2013).
- Simmonds P, Stroyan J, Brown N et al. (2011) *Data Centres: Their Use, Value and Impact. A Research Information Network Report*. September 2011. Available at: <http://www.rin.ac.uk/our-work/data-management-and-curation/benefits-research-data-centres> (accessed 10 April 2013).
- Swan A and Brown S (2008) The skills, role and career structure of data scientists and curators: An assessment of current practice and future needs. Bristol: JISC. Available at: <http://www.jisc.ac.uk/publications/reports/2008/dataskillscareersfinalreport.aspx> (accessed 10 April 2013).
- Tenopir C, Birch B and Allard S (2012) *Academic Libraries and Research Data Services*. Association of College & Research Libraries. Available at: http://www.ala.org/acrl/sites/ala.org.acrl/files/content/publications/whitepapers/Tenopir_Birch_Allard.pdf (accessed 10 April 2013).
- Whyte A and Tedds J (2011) *Making the Case for Research Data Management*. DCC Briefing Papers. Edinburgh: Digital Curation Centre. Available at: http://www.dcc.ac.uk/webfm_send/487 (accessed 21 May 2013).

Author biographies

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Appendix

Current RDM services and future priorities: Survey Question Details

Respondents were asked to comment on the following detailed roles:

- a. Maintain a web page portal of links for local advice and useful resources on RDM?
- b. Offer an RDM advisory service to researchers?
- c. Offer advice specifically on Research Data Management Plans?
- d. Raise early career researchers' RDM awareness?
- e. Raise open access to data and RDM policy issues?
- f. Offer advice on how to cite data?
- g. Offer metadata services for a local catalogue of research data assets?
- h. Run a data repository?
- i. Undertake an audit of the institution's RDM resources?
- j. Promote awareness of reusable data sources, such as data archives?
- k. Provide support for research and retrieval of external data sources?
- l. Offer advice on copyright/Intellectual Property Rights issues relating to RDM?
- m. Offer advice on licensing of data?
- n. Carry out any activities relating to data impact issues?
- o. Offer advice on data analysis/mining?
- p. Offer data management training to Postgraduate Research (PhD) students?
- q. Offer data management training to Postgraduate Taught students?
- r. Offer data management training to Undergraduate students?

In the first place, respondents were asked to comment on current library provision in these areas on a scale comprising:

- No service currently
- Basic service
- A well-developed service
- An extensive service
- Don't know

Secondly, they were asked to sign a priority to future development in these areas:

- A low priority for the the library in the next three years
- A mid level priority for the library in the next three years
- Top priority for the library in the next three years
- Primarily the responsibility of another unit in the University
- Don't know