Feasibility Study Into the Reporting of Research Information at a National Level Within the UK Higher Education Sector

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This article presents the key findings of feasibility and scoping study into the reporting of research information at a national level within the United Kingdom, based on Common European Research Information Format (CERIF). The study was carried out by the Jisc-funded UK Research Information Shared Service (UKRISS) project. The reporting of research information to funders and statutory bodies is a major burden on researchers and institutions. The landscape for research reporting in the UK Higher Education sector is complex and fragmented. There is limited harmonization in reporting requests made on institutions and researchers, resulting in duplication of effort and limiting the potential for reuse of the information. The paper describes the current landscape for research reporting in the United Kingdom. The methodology and findings from a study involving interviews with a cross-section of

major stakeholders is described. Recommendations for further work in the area are proposed.

INTRODUCTION

This paper presents the key findings of feasibility and scoping study into the reporting of research information at a national level within the United Kingdom, based on Common European Research Information Format (CERIF). The study was carried out by the Jisc-funded UK Research Information Shared Service (UKRISS) project (http://ukriss.cerch.kcl.ac.uk).

The reporting of research information is a complex and expensive activity for research organizations (ROs). The UK does not currently have a national reporting infrastructure. Instead institutions are responsible for collating and submitting the required information to funders. This inevitably results in duplication and increased costs across the higher education sector.

ROs across the United Kingdom are at different levels of maturity in managing research information, which needs to be taken into account in designing a national service. Some ROs, particularly large Higher Education Institutions (HEIs), have invested in commercial Current Research Information Systems (CRISs) (Russell 2012). Others have developed in-house systems to facilitate the gathering of information. Many ROs, particularly smaller organizations with limited resources, still rely on storing information in spreadsheets and preparing information by hand.

CERIF (2013) has emerged as the preferred format for expressing research information across Europe. CERIF has been piloted for specific applications, but not as a format for reporting requirements across all UK ROs.

A number of national systems already exist that are closely related such as Research Fish (2013) and the Research Outcomes System (ROS) (2013), whose aim is to collect information from institutions and Principal Investigators (PIs) on grant-funded research by Research Councils UK (RCUK) (2013) and other funders. Research reporting also requires information sharing across institutions. Many institutions subscribe to commercial services such as citation databases (e.g., Thomson-Reuters Web of Knowledge (Thomson-Reuters 2013), which creates additional costs.

The paper is organized as follows. We first describe the background to the project and related activities, particularly relating to CERIF and its implementation across the UK higher education sector. The section Research Information Landscape outlines the current research information reporting landscape within the United Kingdom. The Study Methodology section

describes the methodology and subjects for a major study carried out by the UKRISS team involving interviews with the main stakeholders in research information reporting across the sector. The structure of the questions and the techniques used to analyze the transcripts of the interviews are also outlined.

The following four sections cover the findings of the study. These sections cover the general findings of the study, the drivers for harmonization of research information reporting requirements, the detailed requirements gathered, and specific use cases that were identified. The Recommendations section summarizes three main recommended areas for further development to achieve the overall goals of increasing efficiency, productivity, and quality across the UK Higher Education (HE) sector. Finally, we summarize the main conclusions of the paper.

BACKGROUND

CERIF (2013) was developed with the support of the European Commission (EC) in two major phases: 1987–90 and 1997–99. It is a standard as well as a recommendation by the European Union to its member states. Since 2002, care and custody of CERIF has been handled by the European Commission to euroCRIS (2013), a nonprofit organization dedicated to the promotion of CRISs.

The Jisc-funded EXRI-UK study of 2009 conducted a review of available standards for representation and exchange of research information (Rogers 2009). It recommended the adoption and further development of CERIF in the UK HE sector. The recommendations included developing pilots to demonstrate the application of CERIF in specific use cases.

The EXRI-UK study was supported by a further study commissioned by Jisc in 2010 to examine the business case for CERIF adoption (Bolton 2010). It concluded that the overall cost of either deploying CERIF-compliant CRIS or writing CERIF wrappers around non-CERIF compliant institutional and funder systems was low in relation to the benefits that could be realized in terms of reduced complexity of information exchange, compared to exchanges in multiple *ad hoc* formats.

A further Jisc-funded report released in January 2012 examined the adoption of CERIF-compliant systems within UK HE institutions (Russell 2012). At that point, adoption was around 30% of UK HEIs. All but one of these Current Research Information Systems (CRISs) was supplied by a commercial vendor.

Jisc-funded projects in the United Kingdom have explored and prototyped the application of CERIF across many uses cases requiring exchange of research information. Standards and standards bodies that are involved in research information management in an international context include VIVO (2013) (USA) and CASRAI (2013) (Canada). A number of projects in the Jisc

Research Information Management (RIM) program are relevant to reporting at a national level:

- The RMAS project (2013) provides a connector between internal systems (e.g. HR, finance and CRIS as well as to external systems to facilitate exchange of information in CERIF format).
- The IRIOS (2011) and IRIOS2 (2011) projects developed a B2B platform linking Research Councils and Higher Education Institutions, as well as the linking of grants information to outputs generated by projects funded by awards.
- CERIF in Action (CiA 2011) was concerned with using CERIF in production environments, focusing on two specific use cases: exchanging data between partner institutions (e.g., when a researcher moves to a new institution) and uploading grant-level information to the RCUK ROS system.
- The BRUCE project (2012) developed a prototype tool, based on CERIF, that facilitated the analysis and reporting of research information from internal data sources. The tool enabled institutions to produce a range of reports for use both internally (e.g., for promotion panels, appraisal, equal opportunity monitoring) and externally (e.g., in preparation for the REF).
- Readiness for REF (R4R) (R4R 2011) developed a sub-schema of CERIF, termed CERIF4REF to enable institutions to make submissions to the 2014 REF in CERIF format.
- Several projects, including MICE (2011), have investigated impact measures for research and their representation in CERIF.

The repository area is closely related to the RIM area. The most relevant Jisc project in the infrastructure area is the (RiO Extension Project 2012), which aimed to provide guidelines to institutional repositories with regard to exposing metadata for reporting, tracking, and harvesting purposes.

The HESA-funded Information Landscape Study (Redesigning the Higher Education Data and Information Landscape 2012) looked at a wide range of information requests made to institutions, particularly focusing on students, to identify ways of reducing the data collection burden. The report evaluated several options for simplifying information requests, including use of a single information collection agency. The overall conclusion was that the solution should harness the collaborative culture that already exists to improve efficiency, rather than imposing a centralized governance model.

NAMES (2013) is a MIMAS project which is working to develop unique identifiers for all UK researchers in conjunction with the international ORCID (2013) activity, which is a key requirement for interoperability. RCUK now use the shared infrastructure Je-S (RCUK Je-S System 2013) for grant submission and the shared grants processing system for management of grant applications. For reporting of research outputs to research councils, two systems have emerged. Research Outputs System (ROS) (2013) is an in-house

system used by five of the seven RCUK members. The two remaining RCUK councils (MRC and STFC), as well as a number of medical charities and other organizations, use the Research Fish system (2013) (formerly known as e-VAL). Research Fish is a private company, which develops and runs outcomes systems. There are significant differences in the reporting procedures as well as technical differences between the two systems. The Wellcome Trust also uses a research outputs system run by Research Fish, also known as e-VAL, although this is completely separate from the MRC one.

Many larger institutions are now deploying CRISs. With a very few exceptions, these provided by vendors rather than being developed in-house. The most significant systems are Pure from Atira (2013), Converis from Avedas (2013), and Elements from Symplectic (2013). The ePrints repository system (2013) is also widely used as a CRIS in UK HEIs.

The Gateway to Research (GtR) project (2013) funded by the UK government Department for Business, Innovation and Skills (BIS), is developing a public portal that collates a subset of the research information from the research council systems into a single repository to provide a showcase for UK research outputs. GtR performs mappings to CERIF as part of the project. A number of other countries have well-developed national CRIS systems including CRISTin in Norway (2013), FRIS in Flanders (2013), SICRIS in Slovenia (2013), Star Metrics in USA (2013), and NARCIS in the Netherlands (2013), as well as METIS (2013).

The sector is highly dependent on commercial bibliographic metadata services for compiling lists of publication outputs for use in institutional repositories. Services used widely across the sector are Thomson-Reuters Web of Knowledge (Thomson-Reuters 2013) and Elsevier Scopus (2013).

RESEARCH INFORMATION LANDSCAPE

Figure 1 illustrates the complex nature of the current research information management processes within the UK HE sector. The landscape shows interaction between research activities and information between and within three broad environments: researcher, institutional, and external. At researcher level, most activities need to be reported many times to both the institution and externally; for example Knowledge Transfer (KT) activities need to inform both the institution and also be reported in the HESA Higher Education Business and Community Interaction (HE-BCI 2013) survey, and Postgraduate Research (PGR) activity has to be captured at many levels. There are also instances where single items need to be captured by multiple systems such as outputs that might need to be entered in institutional CRISs, into funders systems (Research Fish, ROS, etc.), institutional repositories, open repositories, the Research Excellence Framework (REF) submission system, and so forth. There is currently little effective sharing of this information
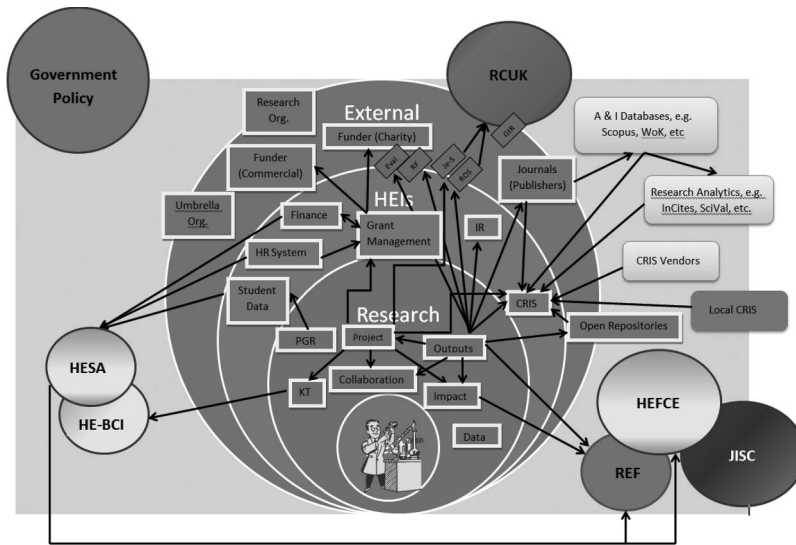
FIGURE 1 The UK research information landscape.

with the result that the same information may be sent to multiple systems in several different formats, causing unnecessary duplication of effort and increasing the potential for error.

STUDY METHODOLOGY

Stakeholder Analysis

Informed by the landscape study, a comprehensive list of relevant individuals, research organizations, funding bodies, and professional associations representing key stakeholders in the domain was generated. The emphasis for scoping down this long list to a feasible number of stakeholders to approach was based on who had deployed, funded, or was using a system to support research information management.

Thus identified, stakeholders were categorized into broad typologies based on role type in relation to the project. Stakeholders were then stratified within these broad typologies to ensure a representative sample of organizations across sectors of different sizes and maturity.

The categories and typologies and sample sizes for the interviewees are described in Table 1. Institutions were sampled according to their membership of mission groups (e.g., Guild HE, Alliance).

Interview Process

A comprehensive set of sixty-four interview questions was produced, mapped to typologies, as well as functional and non-functional requirements,

TABLE 1 Interview Sample Set by Category

Category	Typology	Description	Number of subjects
Funders	Funder	Government-backed funder (e.g., RCUK)	5
	Charity	Charity funder	4
HE Organizations	HE Organization	(e.g., HEFCE, HESA)	2
Institutions	GuildHE	Institutional grouping	2
	Alliance	Institutional grouping	2
	Million plus	Institutional grouping	2
	1994	Institutional grouping	2
	Russell	Institutional grouping	2
	Research Institutes	e.g., British Library,	2
Researchers	Researcher	Researcher at institution	2
Umbrella Organizations	Umbrella	Umbrella (e.g., ARMA, UCISA)	3
Vendors	Vendor	CRIS vendor	3

to maximise the utility of the qualitative information captured for translation into requirements across different types of stakeholder. These questions were tailored before each interview to fit the roles and responsibilities of the interviewee.

The questions covered a broad of areas including:

- The objectives and desired outcomes of UKRISS, including the potential for harmonization and simplification of processes and systems.
- Processes: IT solutions for managing research information at the interviewee's organization.
- Reuse of research information.
- Costs and issues associated with the current process and systems.
- Exchange of research information with external systems and stakeholders.
- Use of standards in existing systems.
- Technical areas including software and interfaces.
- Ease of use.

Face-to-face structured interviews were the default capture methodology, with telephone interviews as a standby option. In-person interviews also allowed the project team to capture tacit knowledge more effectively, probe on previously unidentified areas that became apparent during the interview, and build rapport with the interviewee.

Interviews lasted, on average, for 1 hour, and audio recordings were made. Transcripts were produced from these recordings via an approved professional agency and quality assurance carried out by the project team. The interviews generated around 900 pages of transcribed text which went through to analysis.

A post-interview personal email provided an opportunity for follow-up and/or clarifications and included an offer to share the transcription with the interviewee.

Interview Analysis

Transcripts were analyzed line-by-line, with statements being coded against requirement and driver categories as outlined in the following. Raw requirements extracted from each interview were clustered according to a two-level semantic hierarchy. The high-level categories are defined in Table 2.

The requirements were de-duplicated within each category. De-duplication was not carried out across categories, as source requirements could have multiple contexts. The requirements were linked to the typologies of the stakeholders that generated them. Thus, for example, it is possible to check that a given requirement was requested by three organizations, two of which were Russell group members. A list of eight high-level requirements was generated.

A set of 209 driver statements, motivations underlying the stakeholder interview responses, were identified during the interview analyses. Driver statements were coded according to the following categories in Table 3.

Drivers were filtered according to categories, analyzed for common themes, de-duplicated, and coalesced around a small number of overarching drivers sharing a common description format. Section 6 provides a summary of these overarching drivers, as well as an analysis on the different stakeholder perspectives in relation to these drivers.

Based on further analysis of the raw interviews and requirements, the full set of use cases relating to exchange of research information was identified. These use cases are summarized in the section Identified Use Cases.

GENERAL FINDINGS

Overview Summary

Our study revealed a research information management landscape in the UK that is currently fragmented. Intentions did not match realities. Stakeholders from across the sector that we interviewed—be it research funder, government agency, HE institution or software vendor—were, with good intention, implementing systems and processes to support their research information needs as best they could. All were aiming toward the same goal of improving the efficiency and quality of information management and reporting to enable more agile, evidence-based decision-making. However, because of differences in motivations for designing and implementing these systems and processes, a joined-up approach within and across organizations was often lacking. While perspectives and drivers differed across stakeholder groups, a number of shared themes, described in the following sections, emerged.

TABLE 2 Large Categories Subdivided into Multiple Subcategories

Category	Description	Occurrences
Automation	Automating processes and reducing or eliminating manual intervention	21
CERIF	Measures specifically aimed at use of CERIF	19
Compliance	Ensuring that researchers or institutions comply with reporting requirements	17
Confidentiality	Confidentiality of research information	22
Cost-benefit	Cost of implementing change versus benefits	5
Data dictionaries	Dictionaries for describing research information (c.f., identifiers, output types)	40
Data entry	Manual entry of research information into CRIS systems. Also includes any kind of user interaction (except providing open access).	70
Data protection	Data protection issues (e.g., personal data)	8
Data quality	Measures or processes concerned with the quality of research information	30
Duplication	Duplication of effort (e.g., entering the same information twice into different systems)	22
EC reporting	Reporting about EC projects	
Financial	Reporting or use of financial information	42
Governance	Governance of processes and systems. Includes retention policies for data.	23
Harvesting	Harvesting of information from repositories	24
Identifiers	Labels that uniquely identify resources (e.g., people, grants, funders, equipment)	37
Information exchange (external)	Exchange of information between IT systems located in different organizations (institution-institution, institution-funder, funder-funder), interoperability between systems	93
Information exchange (internal)	Exchange of information between IT systems within an organization, interoperability between internal systems	54
Information extraction	Extraction and retrieval of data and analytics, such as research quality metrics, from research information - funder or institutional systems, report generation	137
Information representation	Representation or format of research information	211
Internal reporting	Reporting of research information within an institution (or funder)	37
Intramural	Reporting carried out by centers directly funded by research councils	2
Open access	Public access to research information, FOI.	30
Output types	Classifiers and classification for research output types including those beyond publications	41
REF	Requirements specifically related to REF submission	7
Reporting frequency	The frequency with which research outputs should be reported	16
Research data	Requirements linked to management of research data	8

(*Continued*)

TABLE 2 (*Continued*)

Category	Description	Occurrences
Simplification	Reducing complexity of existing processes and harmonization, ease of use	60
Smaller organizations	Requirements that address the need of smaller funders or smaller institutions, which lack the resources to provide comprehensive RIM IT infrastructure	2
Student	Linking of information about students to RIM, also covers teaching activities of staff	12
Technical	Technical and performance requirements	34
Upload	Upload of information from institutions to funders	18

TABLE 3 Driver Statement Categories and Frequency of Occurrence

Category	Description	Occurrences
Strategic	Political, competitive, marketing, research drivers for business delivery	77
Operational	Day-to-day practical, workflow, management, implementation, efficiency drivers	133
Technical	Technology, functional, hardware, software, standards drivers	57
Economic	Cost, saving, resourcing drivers	28
Governance	Statutory, legal, ethical, contractual drivers	26
Reporting	Reporting, submission and similar transactional drivers	60
Social	User, engagement, adoption, transition drivers	44

Harmonization

Consortia from the different stakeholder groups had begun the drive toward harmonization to help reduce the reporting burden and enable cross-sector impact analysis and evaluation. There was a shared awareness among funders of the need to articulate the return on investment from the public purse through better evidence gathering and reporting. Harmonization was seen as a driver to support this. There was an inherent tension in this desire to harmonize. Funders and HE institutions wished to benchmark themselves against others but also wanted to converge on reporting standards and processes that represented them in the best light. An additional consideration was the level of granularity at which they were able to share information and data. This arose from a range of sensitivities relating to the corporate, commercial or personal confidentiality associated with some of their information and data assets. There was also a transition challenge to harmonization as existing funder and HE institutions systems were at different levels of maturity and adoption. Thus, adapting already tailored systems and processes to enable interoperation in the current landscape is as much a social as a technical challenge.

Costs

Prior to the stakeholder interviews, we had surmised that a major driver for greater harmonization would be economic. The shared goal of reducing the reporting burden on researchers and research administration by greater automation of information management was recognized as important but not described by stakeholders in the context of cost savings. Stakeholders were more interested in efficiency gains. However, on-going costs for the sustainability of such solutions were a consideration. Some stakeholders wanted their in-house systems to capture and track information on published outputs more efficiently to remove the need to purchase commercially-sourced bibliometric data.

Research Quality

Many stakeholders, particularly those responsible for overseeing research in HE institutions, indicated that improving the quality and impact of their institution's research was their key driver. All stakeholders recognized that better quality research information was essential to enabling this improvement. This research information underpinned their business intelligence, and its quality, presence or absence had a significant effect on their ability to plan and manage their research portfolio. Good business intelligence also allowed stakeholders to demonstrate value, exploit strategic gaps and opportunities, and remain competitive.

Solutions and Standards

It was clear that while HE institutions wanted to deploy solutions that helped them to deliver statutory and funder reporting as efficiently as possible, they also wanted these solutions to enable them to capture quality-assured information and re-use it in many different research strategy and planning contexts. The ease of integration, scalability, and flexibility to business needs were important considerations for solution acquisition and development. Information standards which might enable this were mentioned by those involved in deployment and management of research information systems, but CERIF had low visibility.

Information Flow

Information flow, or rather lack of it, was a recurrent theme. Many of those consulted wanted to improve information flow so that it became a two- rather than a one-way process, for both internal and external systems. Funders and research management teams in HE institutions saw this enabling richer, more agile reporting and analysis. Good information flow was seen as critical to

reducing reporting burdens, enabling feedback and supporting monitoring. In contrast, the researchers that we interviewed did not perceive any reduction in the requests they were receiving currently to provide information to colleagues or enter it themselves online.

User Adoption

Motivations for researchers to upload their information were mostly compliance-based, that is, they did it because their funder or institution required it. An emerging driver in this regard was observed where an institution's centralized system was the only place where information was sourced for performance reviews, promotion panels, REF submissions, and other reporting that impacted on an individual researcher's career. Benefits-based drivers for adoption included auto-generation of CVs and web profiles that were configurable, and the more general ability for researchers to extract and re-use the information they had submitted. Researcher adoption was closely linked to the ease of use of the system interface.

DRIVER ANALYSIS

The driver analysis aimed to understand the motivations underlying the responses of the stakeholders interviewed in the study. Overarching drivers are summarized in the following sections using a common format:

[**overall aim**] *through* [**improvement**].

A total of six main drivers were identified as described in the following subsections.

D1 Improve Business Intelligence, Management, and Due Diligence Through Better Information Quality and Reporting Utility

For both funders and HE institutions, improving business intelligence means better research portfolio management to inform strategy and planning. In effect, knowing at any point in time, what research they are managing, why, how much, and what it has/will deliver. Business intelligence is also about these stakeholders being able to capture and validate the whole range of activities, outputs and impacts of an individual researcher to enable informed decision-making and performance management. Reporting utility for research institutions goes beyond the REF and refers to an ability to collect information once and repurpose it for a wide range of different internal

and external reporting requirements. Possessing good business intelligence allows more effective communication of outputs and impacts to a wide range of stakeholders, including the general public. It enables easier compliance for due diligence purposes such as reporting use of research funds, IP and contract management, and responding to Freedom of Information (FOI) requests. All these aims were seen to be dependent on improving research information quality.

D2 Reduce the Reporting Burden and Increase the Efficiency or Response Agility of the Research Community Through Harmonization of Reporting Processes and/or Systems

Reducing the reporting burden on the research community was seen as an efficiency driver: reducing the administrative costs and effort and allowing researchers to spend more time engaged with research. Efficiency was also one of the drivers for cross-funder harmonization. Multiple stakeholders saw value in greater consistency for research information reporting—systems, software, standards—and interoperation with internal and external systems to reduce the need for manual effort.

HE institutions in particular recognized that standardization was not enough. Having a common language for describing the research information being collected, managed and shared was also seen as key to reducing the reporting burden. This common language (e.g., an agreed definition of 1 FTE research) needed to be easily digestible and acceptable to those undertaking the collection and management, as well as the evaluation of the research. Aligned to this, HE institutions were keen to see funders agree a standard core set of reporting requirements across the board; it was recognized that this would be supplemented by a smaller level of funder-specific reporting requirements.

D3 Enable Cross-Sector Impact Analysis, Evaluation, and Strategy Development Through Systemization and Harmonization of Reporting

In addition to the efficiency gains resulting from systemization and harmonization as previously outlined, other benefits were identified as drivers for change. Enabling cross-sector analysis was one of these. For funders, this helped them co-ordinate investment across the research landscape to maximize their impact and strategic positioning. Research institutions also identified these benefits but in the context of remaining competitive. Benchmarking was recognized as a specific approach that would be easier to undertake with greater harmonization. Consistency in the interpretation of the research information that was collected was also seen as important. This

was linked to agreeing a common framework for defining and evaluating research outputs and impacts.

D4 Increase Research Community Reporting Compliance Through Deploying Easy-to-Use Flexible Reporting Systems with User Benefits

A number of compliance-based motivations and functionality benefits for users that promote adoption of reporting systems have been previously summarized. For reporting systems reliant on researchers or research office staff inputting information, ease-of-use remained a key driver for adoption. System flexibility was also important as users wanted to tailor systems to different institution needs and run different types of reports at different points in time. Convergence of systems, to the extent of having a single interface for multiple funders reporting needs, cropped up several times. The tension here is that most research institutions and funders are already committed to deploying a range of different reporting systems.

Communication, or rather lack of it, was a barrier to compliance: funders were not always being explicit about how requested information would be used nor communicating back to institutions when reports had been submitted and approved. Better information flow between reporting systems, both in terms of ease of interoperation, and an ability to retrieve information for re-use in different contexts was a positive driver for adoption.

D5 Improve the Research, Strategy, and Planning Across UK Institutions Through Use of Better Quality Reporting Information

This driver was closely aligned with the benefits derived from improving business intelligence, some of which have been previously summarized. This included an ability to capture structured research information from different funding streams for monitoring, evaluation, benchmarking, forward planning, policy work, and strategy development. Research institutions mentioned a range of research portfolio analyses enabled by better quality reporting information that they perceived as beneficial. Pro-Vice Chancellors for Research and research office staff highlighted a need to identify areas of current and emerging strength to inform development of critical mass and responses to funding opportunities. This was aligned with a general ability to move research information management away from a sole focus on retrospective reporting towards evidence-based forward planning. Good business information was also seen as an enabler for developing new collaborations, joint activities and networking between organizations and individuals in different research sectors, both on a national and international scale.

D6 Improve Research Information Management Across the Sector Through Deploying Sustainable, Affordable Solutions That are Fit-for-Purpose

An overarching driver for deployment was ensuring that the investment in integrating and setting up new research information systems did not outweigh the benefits. Investment in this sense was more often identified as effort, time and human resource rather than cash expenditure. Another barrier to adoption was a general wariness among some institutional IT staff of the business need for deployment of new systems and the consequent need for on-going support in terms of costs and skills. Other concerns pertained to systems integration and future-proofing to ensure fitness for purpose. The focus in many institutions in the past had been on development of systems to meet transactional administration needs rather than portfolio management and analysis.

Obviously resource constraints across the different research institutions consulted varied in magnitude and nature. These constraints applied to funders as well, with an additional consideration of how they want to manage their relationship with their fundees. For example, smaller charity funders were concerned that a centralized system might present a barrier to the close relationship they currently have with their research community.

REQUIREMENTS ANALYSIS

In this section, we describe the eight main requirements R1-R8 extracted from the UKRISS study, using the techniques described in the Study Methodology section. Each requirement has a high-level description supplemented by a more detailed set of sub-requirements.

R1 Harmonize Dictionaries and Usage of CERIF Within the UK HE Sector

a. Produce a common set of definitions of data dictionaries, output types (including non-publications, identifiers (people, equipment, grants, and funders), institutional structures, research topics, and metrics.
b. Specify use of DOIs for linking outputs and equipment to grants and funders, outputs to researchers, and so forth.
c. Align more closely standards development and implementation with the practical requirements of a wide range of stakeholders.
d. Support international initiatives such as (ORCID 2013), (FundRef 2013), and (CrossRef 2013).

The study uncovered numerous issues regarding the usage and implementation of CERIF within both institutions and funders. CERIF is a powerful

and flexible schema for representing research information. It enables a wide range of information to be represented and complex relationships to be modeled. However, the precise mapping of information fields to CERIF entities often resulted in ambiguities, leading to lack of interoperability. There is a reliance on data dictionaries or standard terms. As these are not provided within the standard itself, there is currently no uniform set of definitions for the UK HE sector that can be applied.

There was recognition of the need for standard identifiers, both for people as well as other entities such as equipment and grants. There was an awareness of international initiatives such as ORCID and FundRef, and that there is a need for both national and international approaches. Increasing need is being made of DOIs, to enable automated processing and in particular association of research outputs with research grants. Areas such as organizational structures and research topics are recognized as complex areas that require further work. There was a clear wish to extend to range of available output types that can be represented in CERIF, both to include greater expressiveness for certain disciplines as to represent a wider range of non-publication outputs. Not all key stakeholders were directly engaged with CERIF standards development, and there was a clear need to collect a more exhaustive set of requirements that could be incorporated into the standard. There was also recognition that standards development is quite slow and costly, and not all stakeholders had the capacity to engage fully.

R2 Obtain Agreement Between All Key Stakeholders (e.g., Funders, Institutions, Charities, Statutory Bodies) on Closer Alignment of Reporting Requirements and Their Persistence, and Adoption

a. Define a minimum core dataset that is collected by all stakeholders to enable comparison, sharing and re-use.
b. Enable reporting information to be collected once and associated to multiple funders.
c. Develop agreed definitions of non-publication outputs and impact measures.
d. Align funder, institutional and charity reporting requirements with those of statutory reporting such as HESA returns and REF.
e. Ensure compliance with agreements to collect a minimum core dataset.

There was strong consensus on the need to provide a common set of information fields that could be collected by all funders. This would simplify the reporting process by reducing the duplicate reporting that is currently required by both researchers and institutions. Much research is now interdisciplinary resulting in an increase in co-funded projects, and there is a need

to simplify their reporting. There was also recognition that such a common set of fields would provide a basis for more effective benchmarking across the sector.

There is strong interest in collecting a wider range of non-publication outputs and agreement on common definitions of such outputs is required. In particular, similar outputs are often classified differently across different research disciplines. A standard set of information fields should take into account requirements of funders and charities, institutions and statutory bodies such as the (HEFCE 2013) and (HESA 2013).

Work on the 2014 Research Excellence Framework (REF) (REF 2013) is now well advanced. The timing or requirements for future REFs are unknown, so their requirements could not be integrated. However, there was a desire that future REFs should factor harmonization that is occurring across the sector into their planning. There were differing views on whether a common reporting profile could be achieved purely through consensus, or whether some degree of compulsion should be used where feasible. There was recognition of the need for both the education of researchers on the need to provide key information as well as measures to ensure compliance such as withdrawal of funding in certain circumstances.

R3 Provide Structures (Common APIs, Shared Services, or Connectors) to Support the Exchange of Research Information, But Not a Central Reporting System

a. Do not create a single national reporting system.
b. Provide common APIs to source, not transformed, research information.
c. Any technical solution for data exchange should be straightforward and have low integration costs.
d. Provide a single point of deposit for research outputs.

There was little enthusiasm for a single research reporting system across the sector. Considerable investment has been made by RCUK funders in systems such as ROS and Research Fish, which are now well-established. The UK Department for Business, Innovation and Science (BIS) is funding development of the Gateway to Research system. Also many larger institutions are making considerable and longer term investments in CRIS systems. Hence, any proposed solution should work within this framework. There was much stronger interest, both from institutions and funders on being able to harvest research information, in source rather than transformed format, and measures that could simplify this such as common API definitions. There was concern, particularly from institutions on the costs of integration with a national system, and a clear need for benefits for them. The solution should also be suitable for institutions with both large and small research budgets.

R4 Increase the Quality and Timeliness of Research Information Across the Sector

a. Improve quality control of research information.
b. Reduce human effort and increase automation in collection and processing of research information.
c. Implement administrator workflows to reduce possibility of human error.
d. Enable researchers to view and correct their own research information.
e. Use of shared services for validation and quality control.
f. Enable institutions to collect and validate research information prior to submission to funders.
g. Enable on-going reporting of research outputs to support *ad hoc* reporting by funders.

Data quality was seen as a major issue by most stakeholders. In particular, there was a desire for further automation of processes, and automated or semi-automated validation. Bulk upload from institutions was in most cases seen as preferable to manual entry of information by researchers or research office staff into funder systems. In particular, cross-system synchronization can be used to validate data. Enabling institutions to validate information prior to submission to funders will also result in an increase in data quality. An important caveat to this is that some funders value more qualitative information that researchers provide, particularly around the wider impact of their research. Hence, they are keen to maintain a relationship with researchers working on their grants.

Where manual entry is required, this should be supported by validation workflows. Researchers and administrators should be able to log in, review and correct their entries as appropriate. Information that is collected for a specific purpose is often of higher quality, so information collection should be reduced to essential pieces of information. There is a requirement both in institutions and funders for ad hoc reporting on a short term basis. Institutional research offices need to respond to reporting requests. Funders need to respond to information requests from BIS and other government bodies.

R5 Facilitate the Flow of Information Between Internal Institutional Systems and External Systems (e.g., Funder Systems) in CERIF Format

a. Integrate internal systems with CRIS to reduce re-keying and enable institutions to collate information for reporting.
b. Enable bulk upload of data from CRIS systems to funder systems.

Research information is currently spread across multiple systems. There is a strong requirement from institutions to improve the interoperability and

synchronization of internal systems related to research such as finance, human resources, institutional repositories, and CRIS systems. In order to compile reports for funders, there is often a large amount of re-keying of data, resulting in omissions and errors. This results in an inefficient and expensive process. There is wide acceptance that institutions should, where feasible, collect and upload research information from researchers to funders.

R6 Enable Institutions to More Effectively Consume and Re-Use Research Information (e.g., for Benchmarking and Management Information, Portfolio Management, Collaboration, Compliance Monitoring, Communications)

a. Support data harvesting of data from multiple funder systems.
b. Support for data harvesting from other institutions.
c. Provide benchmarking tools.
d. Provide ability to analyze data in different ways (e.g., according to department, collaborative network).
e. Provide support for communications and marketing.

There was strong demand from institutions for business intelligence tools to provide management information. Institutions with CRIS systems can already generate internal reports. However, institutions were keen to harvest data from external sources such as funders to be able to benchmark their performance against other institutions. There was a requirement to carry out this analysis in different ways such as by departmental or by research area. There was also strong interest in tools to support research portfolio analysis, strategic planning, analysis and promotion of collaboration, and compliance monitoring. There was demand to more easily generate full CVs for researchers, both for use for internal management purposes such as staff development, as well as to simplify the process of submitting grant proposals. There was an interest in automating the process of uploading and publishing research information to websites to support external communications and marketing.

R7 Support Benchmarking and Portfolio Analysis Across Research Funders

a. Enable funders to harvest research information from other funder systems.
b. Support benchmarking across funders.
c. Support research portfolio analysis across funders.
d. Support measure of long term impact of research.

Funders also had a strong interest in benchmarking their performance across other funding organizations. In order to support this analysis, agreed

definitions of research impact metrics are required. Charities also had an interest in measuring research quality but were more strongly motivated by qualitative information that could be used for raising awareness to support fundraising activities.

R8 Provide Appropriate Data Governance, Transparency, and Security When Collecting, Sharing, and Reusing Sensitive Research Information

a. Ensure compliance with data protection legislation.
b. Protect the confidentiality of commercially sensitive data.
c. Maintain trust of researchers in the use of the data.
d. Provide retention policies to support long-term monitoring.
e. Provide rigorous validation of data before release into the public domain.

Research information contains sensitive information relating to individuals as well as commercial organizations. Thus processes are required to protect confidential information. This can be supported by appropriate access management and security within systems. Use of data should be compliant with data protection legislation. Researchers were particularly concerned about how the data they provide might be used. Thus clear terms of use should be provided by institutions and funders requesting this information. Reporting on research information was generally based on aggregated or anonymized data, rather than on specific individuals. Rigorous workflows are required to support the publication of data, to ensure both that confidential data is not released, and also that the data is of high quality.

IDENTIFIED USE CASES

The subsections Institutional Use Cases and Funder Use Cases describe the use cases that were uncovered during the requirements gathering process that are dependent on exchanges of research information between institutions, funders, charities and government bodies. The use cases are described from the perspective of both institutions and funders (of all types). Each use case includes a brief description, the required data exchanges and how the use case is relevant to UKRISS.

Institutional Use Cases

This subsection describes use cases relating to data transfers to and from institutions, and describes opportunities for adding value that could be made to enhance that use case.

REPORTING TO FUNDERS

In order to report to funders, information has to be collated from multiple institutional systems (finance, HR, CRIS, repository) and a bulk upload must be done to the funder's system. The data can be complicated, and can include reporting on co-funded work. It would be of value for this use case to simplify the gathering of information from internal systems, and reduce the duplicate effort required to report to multiple funders, while increasing automation. Institutions are also interested in data validation prior to submission to the funder.

REF REPORTING

REF is a critical but infrequent activity for institutions. REF requires institutions to interact directly with HEFCE. It would be valuable to have a standard format in which the reporting could be done, and in which the reporting requirements were harmonized with other funder reporting activities.

STATUTORY REPORTING TO HESA

Institutions have to report regularly to HESA focusing on elements relating to research staff and students. It would be valuable if HESA reporting were in line with the reporting requirements of other external bodies (such as funders) and processes (such as REF) to reduce duplication of effort.

INTERNAL REPORTING, BENCHMARKING, AND OPERATIONAL MANAGEMENT (E.G., OPTIMIZING FACILITIES USAGE)

Management information requires reports to be generated based on research information and other operational data collected from within the organization. This requires many different types of system to talk to each other (e.g., CRIS, HR, finance), which indicates the need for alignment of representation of internal data, and possibly the support of benchmarking tools.

BENCHMARKING AGAINST OTHER INSTITUTIONS

Institutions want to be able to compare research information collected internally with information acquired from funders or directly from other institutions. There would be value in a core information profile across which comparisons could be made, and some standard metrics which could be extracted from the comparison. There is also a need for a tool-chain that can consume data in appropriate formats (e.g., CERIF) and provide an interface over the top.

PORTFOLIO ANALYSIS (INTERNAL) AND COLLABORATION (CROSS-INSTITUTION)

It is useful for management information purposes to be able to analyze an institution's current research activities, and from that to identify opportunities to collaborate with other institutions. This requires data to be grouped internally (by department, research field, or collaborative network), and then compared/contrasted with data obtained from other institutions.

SUBMISSION OF GRANT PROPOSALS TO FUNDERS

Institutions need to submit grant proposals to funders, and there are a variety of ways of doing this, often involving duplication of effort and re-keying information. It would be useful, for example, to be able to connect institutional systems directly to the RCUK Je-S grant submission system.

RESEARCHER CV GENERATION

Institutions, funders, and researchers themselves want to be able to generate a researcher CV based on their full working life (not just their employment within a single institution), which implies an exchange of data across institutional boundaries when researchers move, and a Researcher ID of some form (e.g., ORCID). There would be a lot of value in automating this process, and for the CVs themselves to be auto generated (which is already partially the case in many institutions). This data may then be submitted to a funder along with a grant application, so being able to automatically convert and submit the CV in the appropriate format would be useful.

EXTERNAL COMMUNICATIONS

Institutions want to be able to make publicly available a subset of their research information, typically via a website or an API. This raises issues of quality control and authority, as data travels out into the open, beyond the institutional firewall, and the workflows required to transform data into this state.

Staff performance management: Institutions need to collect and analyze research information pertinent to staff appraisals, which can be used either to inform staff development or promotion panels. Much of the data is available internally, but there could be value in acquiring some of this information from funders.

STRATEGIC PLANNING

Based on existing research information, institutions need to carry out analyses which allow them to plan for the future (e.g., identify new research

opportunities). This means gathering information from a variety of sources including funders, charities, and commercial data sources. Harmonized data formats could assist in analyzing across multiple data-sources and disciplines; the data needs to be timely and of high quality.

COMPLIANCE MONITORING

In order to ensure they qualify for future grants, institutions are concerned with monitoring reporting compliance, delivery of work, and financial targets. Improved communication between institution and funder could make it easier to be compliant and identify compliance issues, while automated aggregation of data from institutional systems could make the compliance monitoring easier.

Funder Use Cases

This section covers use cases relating to funders of all types (from government-backed to charities) that have the capability to accept research information from institutions and describes any value adds that could be made to enhance that use case. Use cases involving funders that also involve institutions are covered in the previous section and not included here.

PUBLICATION OF SOURCE DATA VIA COMMON APIS

Funders want to be able to clean and publish data collected from institutions, so that it is available via APIs (including making it available to Gateway to Research).

FUNDER-FUNDER BENCHMARKING

Funders wish to be able to compare their relative performance, and potentially HEFCE and BIS will want to do the same. This requires data to be available across funders, to enable benchmarking (across a core set of comparable data) with some defined metrics. Availability of benchmarking tools to aid this would be valuable.

PORTFOLIO ANALYSIS AND STRATEGIC PLANNING

Funders want to be able to analyze their current research activities and identify opportunities for future funding calls. This mostly requires funder-internal data (or that gathered from institutions), but also potentially data from other funders. Having access to such data in a harmonized format would therefore make these tasks much easier.

REPORTING TO GOVERNMENT (REGULAR AND AD HOC)

Funders are often required to report upward to government and are reporting on data which, in turn, has been reported to them via institutions. Access to timely and high quality data is essential to enable rapid and reliable report generation.

EXTERNAL COMMUNICATIONS

Funders want to be able to make publicly available a subset of research information, typically via a website or an API. This raises issues of quality control and authority, as data travels out into the open, beyond the funder's firewall, and the workflows required to transform data into this state.

GATHERING OF INFORMATION FROM RESEARCHERS

Researchers need to be able to directly enter research information via a web form or some other manual means. This data should be harmonized with the kind of data that is uploaded by researchers in bulk uploads and should have similar quality control measures in place.

PRODUCTION OF EVIDENCE OF IMPACT

Researchers need to be able to directly enter textual information describing the wider impact of research.

RECOMMENDATIONS

Based on an analysis of the drivers and requirements, as well as analysis of relevant technologies, the UKRISS project team identified three main recommendations for further investment and development:

1. Modeling: Specification, standardization, and adoption of a core CERIF profile for reporting of research information in UK HEIs. This recommendation addresses requirements R1 and R2 in the section Requirements Analysis.
2. Reporting infrastructure: Implementation of a national CERIF connector and associated shared services to facilitate the exchange of research information between IT systems within institutions, funders and statutory bodies. This recommendation addresses requirements R3, R4, R5, and R8.
3. Benchmarking: Provision of benchmarking tools that enable comparison and analysis of research information generated by multiple organizations for management information purposes. This recommendation addresses requirements R6 and R7.

There are clear dependencies between the recommendations. Recommendations 2 and 3 depend on recommendation. Recommendation 3 can be implemented without recommendation 2, although issues such as data quality and compliance with the core profile schema would need to be addressed in other ways.

In the following subsections Modeling, Reporting Infrastructure, and Benchmarking, we describe each of the three recommended areas of work in more detail. For each recommendation, we describe the objectives of the proposed work, the barriers, and the anticipated benefits for key groups of stakeholders.

Modeling

OBJECTIVES

The main objective is to define a core information profile for research reporting across the sector and a set of mappings to enable unambiguous generation of this profile in CERIF. The core information profile would contain a minimum set of fields to be collected by all funders and statutory bodies across the sector, to enable sector-wide comparison. It could be defined by examining the information that funders currently collect, and identifying commonalities across multiple organizations.

In order to ensure that the core information profile is unambiguous and would result in fully interoperability between CRIS systems, detailed work is required to define dictionaries and common terms. Such dictionaries of terms would in many cases be specific to the UK higher education sector, although there would also significant overlap with international initiatives such as (CASRAI 2013).

BARRIERS

The main barriers to adoption of such a core profile are the potential changes that would be required to existing reporting systems and the need for agreement between a potentially wide and diverse set of funding organizations. In particular, any changes to future reporting requirements may also result in a need to transform data collected in previous years to enable trend analysis to be performed, where this is feasible.

BENEFITS

The amount of duplicate reporting and reformatting will be decreased since a common set of information can be repurposed for multiple reporting requirements. Institutions can harvest data from multiple sources, including funders, statutory bodies and other institutions in the knowledge that it will contain a standard set of information fields, without the need for

additional processing. Given access to data from other institutions and suitable software tools, there is the potential to perform benchmarking, portfolio analysis and develop collaboration tools through analysis of a comparable set of information.

For researchers, reporting processes will be simplified. Regardless of whether researchers are reporting internally or directly to funders, a core set of the information fields requested will be the same, resulting in a reduction of complexity, time, and effort.

For funders adopting the core information profile, a subset of the information collected would be comparable, enabling funders to exchange information about their portfolios to reduce duplication, to perform benchmarking, and to generate standard reports (e.g., to government).

For vendors of institutional CRIS vendors have a strong interest in standardization of data formats to enhance the functionality of their existing products, while, at the same time, reducing the need for adapting to changes in core standards. Providing a persistent core information profile would give vendors much greater certainty when developing their products, while also providing the potential to develop additional reporting and benchmarking tools to exploit shared information.

National bodies, such as HEFCE and HESA, collect a wide range of information from institutions, which places a considerable administrative burden on institutions as well as the statutory bodies themselves. Aligning the statutory reporting requirements with a core information profile would greatly simplify collection of information, as it would reduce the need for bespoke information collection. Repurposing of the information is also likely to result in higher data quality, since each submission of the information would require validation.

Reporting Infrastructure

OBJECTIVES

The objective of a national reporting infrastructure would be to provide a robust mechanism for the exchange of research information in CERIF format between existing funder and institutional systems. This includes both reporting of research information to funders as well as other exchanges such as download of information from funders, as well as institution to institution and funder to funder exchanges. Example of such use cases are described in the Identified Use Cases section.

The national infrastructure would comprise a single central server farm to route information to one or more destinations together with a connector for interfacing with institutional and funder systems. This infrastructure would provide a supplier agnostic mechanism for information exchanges via a single API. All information exchanges would be in CERIF-XML format.

The precise implementation of such a connector will not be discussed in detail. We note however that the Jisc-funded RMAS project (2013) developed a CERIF connector as part of their activities that could provide a technical basis for such a system.

BARRIERS

The main barrier of the approach is that it requires deployment and adoption of a national infrastructure, which will result in costs for organizations that participate. The complexity of the information exchanges between participants, for instance for validation and resubmission of erroneous or incomplete data also poses a challenge. Data governance is an issue that would need to be addressed, for instance if the service were run by a third party. Clear terms and conditions for reuse of the data would need to be established and agreed by all stakeholders. A business model for running and maintaining the connector would need to be defined.

BENEFITS

For institutions, a national infrastructure would simplify the upload and harvesting of research information by providing a single interface for information transfer. Using a national infrastructure in conjunction with a CERIF connector (such as the RMAS connector) linking in-house systems would reduce significantly the need for re-keying of data. Institutions would need to collate reporting information only once.

   Implementing one or more templates at the end point of the CERIF connector in the institution would enable information to be and then filtered to provide reports to multiple recipient organizations. Such templates would also provide a robust mechanism to prevent unwanted disclosure of confidential information such as personal or commercial data. A national infrastructure would greatly simplify the infrastructure requirements on the institution in responding to information requests from multiple organizations.

   For funders, a national infrastructure would simplify the connections of funders to UK HEIs. Large funders potentially need to receive data from over 150 UK institutions. Additionally, funder-to-funder transfer of information would be greatly simplified. The (RMAS Benefits Analysis Report 2012) found that over 30% of research information stored within partner institutions was either incomplete or was erroneous. Thus, data validation services that compare data across multiple sources for inconsistency and incompleteness would be of great value.

   For *statutory bodies*, the benefits are analogous to those to funders. Statutory bodies in particular have strict compliance and quality controls, which results in rejection of incomplete or incorrect information. Such

communications could be carried out far more efficiently by shared services linked to the national infrastructure.

For *CRIS vendors*, institutional CRIS systems would provide the main endpoint for the national connector. Thus there is a potential for CRIS vendors to provide services to support research management, such as cross-organizational benchmarking based on timely and high quality data, as well as providing a gateway to external information resources for researchers.

As well as considering the technical aspects of the connection, data governance and data quality issues around sharing data via the national infrastructure should be addressed. Quality, compliance and data privacy issues could potentially be addressed by additional shared services. For example, a data quality service could cross-check data with publicly available data sources to provide additional validation that could not cost-effectively performed by individual institutions. A further option would be to provide a national data warehouse that captured all exchanges of research information.

Business models for the reporting infrastructure and for offering shared services would need to be developed and evaluated by conducting interviews with institutional and funder staff responsible for management of research information reporting activities.

Benchmarking

OBJECTIVES

Benchmarking tools are required to analyze research information harvested from multiple institutions. Preliminary work is required to define the core information profile in order to facilitate comparison of datasets from a wide range of sources. An examination of the quality of the data, the implications for the benchmarking metrics that can be produced (such as error ranges) and data governance issues, especially around the willingness of institutions to share their data and on what granularity are required.

BARRIERS

Providing only benchmarking tools does not address the requirement to provide a single point of contact for exchanging research information. Thus, all exchanges would need to be point-to-point using ad hoc interfaces. For information with larger bodies such as funder systems or statutory bodies, this does not present a huge burden. However, it does present a major barrier to cross-institutional information sharing or submissions to the very large number of smaller funders. There is no option for including quality control, standardized reporting (i.e., responses from the recipient), or compliance monitoring.

Harvesting information for benchmarking would also be complex. This could be done by harvesting public research information across multiple funder systems, by bilateral information exchanges or from institutional repositories. National systems such as Gateway to Research may also provide a subset of the information required. Timeliness of the research information may also be an issue. Published research information may relate to different time periods making it difficult to compare.

BENEFITS

The main beneficiaries of the benchmarking tools would be institutions, funders, and CRIS vendors.

Benefits for Institutions: The benchmarking tools would simplify the task of generating management reports for Research Office staff. Ideally, the benchmarking tools would be integrated with institutional CRIS systems to provide full access to internal data. The primary beneficiaries would be institutional research managers. The benchmarking tools would enable far more effective use of resources, monitoring of research activities, portfolio analysis, and collaboration.

Benefits for CRIS Vendors: Vendors would have considerable interest in proof-of-concept benchmarking tools, which could be enhanced and integrated with existing products to provide additional value for institutions and to enhance their product offerings.

Benefits for Funders: Demonstration of benchmarking over a core information profile would provide funders with a mechanism to carry out their own funder-funder benchmarking and portfolio analysis.

CONCLUSIONS

The UKRISS study performed a wide-ranging study on the reporting of research information from institutions to funders within the United Kingdom. The study comprised over thirty interviews with key stakeholders. A range of institutional staff were interviewed including senior research managers, researchers, and research office staff, sampled from the various institutional groupings. Representatives of funders, including research councils and charities, umbrella organizations (UCISA, ARMA), and national bodies (HEFCE, HESA) were consulted. Technical reviews of commercial CRIS systems and existing national research information systems were carried out. The findings of the paper are based on this dataset.

The goals of UKRISS were strongly aligned with the aims and aspirations of the stakeholders. There was a strong desire to simplify and harmonize reporting processes to increase efficiency, support the provision high quality management information, increase reporting compliance by improving

ease-of-use, and to provide cost-effective, sustainable reporting solutions. A key requirement was the need to further harmonize the information requests made by external organizations to funders (the exact definitions of the information fields), as well as providing a consistent and unambiguous representation of this information in CERIF (aligning usage and dictionaries).

Options for a national infrastructure for a national reporting infrastructure were considered. Any solution would have to interoperate with existing systems, such as institutional CRIS systems and funder systems (Research Outcomes System, Research Fish) in which considerable investment has already been made. A national system was therefore ruled out but there was a need to simplify the exchange of information in a lightweight and cost-effective manner.

There was a strong desire for tools to support reuse of research information such as benchmarking, which would demonstrate value of harmonization and information exchange. Data quality and data governance were identified as key issues that should be investigated in more depth.

Based on this analysis, we made three main recommendations for future work:

1. Specification, standardization, and adoption of a core CERIF profile for reporting of research information in UK HEIs.
2. Implementation of a national reporting infrastructure and associated shared services to facilitate the exchange of research information between IT systems within institutions, funders, and statutory bodies.
3. Provision of benchmarking tools that enable comparison and analysis of research information generated by multiple organizations for management information purposes.

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