OCLC RESEARCH REPORT

Convenience and Compliance:

Case Studies on Persistent Identifiers in European Research Information Management

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OCLC

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A note on interests

The authors have strived to be balanced and impartial in their research efforts. To this end, we want to offer transparency to our readers about author interests. OCLC is the service provider for ISNI, supporting technical operations through the OCLC EMEA offices in Leiden, Netherlands. OCLC also holds a seat on the ISNI board. OCLC is an ORCID member organization, and it has previously held a seat on the ORCID board of directors. Senior Program Officer Rebecca Bryant is a former ORCID employee.

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INTRODUCTION

The goal of this report is to provide university and research library leaders with useful insights on emerging practices and infrastructures in European research information management (RIM), on the current and future role of persistent person and organization identifiers, and, more specifically, on incentives and barriers to adoption in three different national settings—Finland, Germany, and the Netherlands—in order to better understand the decision-making dynamics in this space.

Background

Research was conducted by OCLC Research in conjunction with LIBER (Ligue des Bibliothèques Européennes de Recherche—Association of European Research Libraries), a leading professional organization for national and university libraries throughout Europe. OCLC Research is one of the world's leading centers devoted exclusively to the challenges facing libraries and archives in a rapidly changing information technology environment. For LIBER, the project is part of its 2013–2017 strategic priority of enabling Open Science.[1]

Broadly defined, research information management, or RIM, is the aggregation, curation, and utilization of metadata about research activities. Research information management systems collect and store metadata on research activities and outputs such as researchers and their affiliations; publications, datasets, and patents; grants and projects; academic service and honors; media reports; and statements of impact. Depending upon institutional requirements, the RIM registry may also capture additional internal information such as courses taught, students advised, and academic committee service.

RIM is distinct from research data management (RDM), a similar-sounding term that is used to describe the processes researchers and institutions use for organizing, securing, archiving, and sharing research data throughout the research lifecycle. Find more information about RIM in general, and, more specifically, about the value that libraries can bring to RIM in the OCLC Research position paper *Research Information Management: Defining RIM and the Library's Role*.[2]

In Europe, RIM activities are often described under the label of "CRIS" or some local language equivalent such as FIS (ForschungsInformationsSystem) in Germany. The term CRIS, an acronym for Current Research Information System, indicates a software system or solution to manage research information. Elsevier's Pure and Clarivate Analytics's Converis are examples of proprietary CRIS software solutions supporting RIM activities, both widely used in continental Europe, in addition to several country-specific and in-house built solutions. euroCRIS, the International Organisation for Research Information, based in the Netherlands, is an organization that promotes cooperation, knowledge sharing, and standards within the RIM community.[3]

Universities and research institutes throughout Europe are engaged in RIM adoption, and have been for a while; the first locally developed systems such as METIS appeared as early as the 1990s, most of which have now been replaced by proprietary or other second- (or even third-) generation systems, making the European RIM landscape a very mature one. However, practices vary widely by institution, nation, and region, in response to local requirements. In some geographies, RIM efforts are also scaling nationally—such as in the Netherlands—and discussions have begun about transnational scaling efforts.[4]

The European Commission has taken a long view toward future interoperability and data exchange in the RIM space. It provided and continues to provide funding for numerous initiatives that support standards and identifiers, to ultimately develop infrastructures for European Open Science. To name just a few:

- The Common European Research Information Format (CERIF) has been developed as a standard to facilitate interoperability of CRIS systems within Europe. Today CERIF is being maintained by euroCRIS, its use is recommended across the EU, and both Pure and Converis are considered to be CERIF-compliant.[5]

- THOR (Technical and Human infrastructure for Open Research), an EU funded project under Horizon 2020, forms part of more recent European strategic efforts at building e-infrastructures for research. It leverages emerging infrastructures such as ORCID and DataCite (see below) to enhance interoperability between platforms by way of persistent identifier linking and services integration.[6]

- HIRMEOS (High Integration of Research Monographs in the European Open Science infrastructure), another project funded under Horizon 2020, aims at technologically enhancing a selection of major publishing platforms for open-access (OA) monographs, "rendering technologies and content interoperable and embedding them fully into the European Open Science Cloud." One part of this effort is the implementation of persistent object, person, and funder identifiers (DOI or digital object identifier), ORCID, CrossRef Funder Registry).[7]

Persistent identifiers (PIDs) are long-lasting references to a resource. PIDs for objects, such as the DOI, have been around since the 1990s and are widely adopted today. Popular content-sharing platforms used by researchers, such as figshare or ResearchGate, can automatically mint DOIs for documents uploaded by users, via membership with DataCite, a provider of DOIs for research data and other research objects[8].

Persistent identifiers for researchers are a more recent development but gaining traction. Libraries have long sought to disambiguate person names and support discovery through name authority files. More recently, there have been several efforts to support author name disambiguation in scholarly communications based on identifiers, notably non-proprietary, global efforts like ISNI (or International Standard Name Identifier) and ORCID, as well as proprietary efforts like the author-claimed ResearcherID (Clarivate Analytics) and the algorithmically created Scopus Author ID (Elsevier). Author identifiers play an increasing role in European research infrastructures, with a number of local and national efforts promoting ORCID adoption by researchers and integrating researcher identifiers into local and sometimes national CRIS infrastructures[9].

Use of PIDs for organizations is emerging. Organizational identifiers are potentially relevant for a number of use cases in an academic environment, such as publication management or research performance and impact assessment, from the perspectives of researchers or research institutions, as well as for funders and publishers. However, disambiguating organizational identities is a complex challenge: organizations merge and split, acquire or get acquired, change names, hierarchies or locations, and so on. Identifying and managing organization names can be a nightmare.[10]

Today several organizational identifier schemas are available, offered by both proprietary and not-for-profit entities. ORCID currently makes use of Ringgold identifiers to register researcher institutional affiliations. To address remaining issues, a working group led by CrossRef, DataCite, and ORCID began work in January 2017, considering new ways of solving the organizational identifier problem within the scholarly communications ecosystem. ISNI, mostly known as a person identifier, also registers organizational identities, with more than 650,000 organization identifiers assigned to date. In August 2017 it announced plans for expanded services in this area to better serve the needs of the scholarly communications community. GRID (Global Research Identifier Database), a service launched by Digital Science in 2015, is focused on registering research organizations worldwide. Another example is the CrossRef Funder Registry, a taxonomy of grant-giving organizations.[11]

Other entities relevant in the RIM context, such as projects, equipment, or infrastructures, may warrant PID development, but this is still in an experimental stage and was not addressed in this investigation. However, emerging use cases for PIDs have become a standing topic at PIDapalooza, the persistent identifier festival first organized in 2016, and is a space worth watching.[12]

The following report consists of four main sections. The Key Findings section describes the results of our study, distilled from all three different national landscapes. The in-depth country profiles provide additional detail on each of those landscapes, supplementing the Key Findings. The Glossary lists country- and industry-specific terms and acronyms used throughout the report that might not be familiar to the average reader.

This report is part of a growing body of work by OCLC Research on issues related to research support by libraries, particularly ways in which the library is promoting and engaging with broader research support initiatives on campus and nationally.[13]

Methodology

Given the wide variety of research management practices and systems across Europe, and the dearth of literature on the specific topic in question, the research presented in this report was undertaken to provide a carefully scoped evidence base in the form of case studies comparing RIM infrastructures in three European countries.

The work was scoped by investigating RIM practices in three national settings: Finland, Germany, and the Netherlands. The choice of settings was made because research infrastructures in these three countries exhibit useful parallels as well as instructive differences that represent a host of emerging practices in research information management in Europe. In each of these countries, there is evidence of concerted efforts to develop shared research information management

infrastructure operationalized at a group, regional, or national level. These group-scale efforts, however different in kind, promised to provide a window into emerging interoperability trends and concerns, as well as provide insights into the incentives to adopt persistent identifiers for researchers, publications, institutions, and funders.

Research was based on a combination of desk research and a series of semi-structured interviews with practitioners and stakeholders within universities, national libraries, and collaborative information and communications technology (ICT) organizations. In selecting institutions for additional study through interviews, we sought to include institutions that use a diversity of CRIS systems, have mature implementations, and are participating in national- or regional-scale efforts.

All interviewees received identical information before the interviews: a project description, the preliminary country profile for their own national setting prepared from a comprehensive literature review, and the list of discussion topics (appendix A). Standardized information about the project was provided at the beginning of each interview, to set the scene in comparable ways.

All interviews were conducted via videoconference technology with at least two researchers participating, and were also recorded—with prior consent by the interviewees—for later review exclusively by the research team. The discussion topic list in a modified version also served as a data collection template (appendix B). Interviews were conducted in a conversational style, covering all topics, but not in a fixed sequence. This allowed us to flexibly react to what our interview partners had to share, but also to include specific questions or aspects we wanted to see covered at this particular stage in the research cycle.

Key Findings

In this study of RIM infrastructures in Finland, Germany, and the Netherlands, we were curious to explore local institutional RIM practices and to examine the role—perhaps even the necessity—of persistent identifiers for the facilitation of group-scale RIM activity and data aggregation.

A central component of research information management practice at all of the institutions studied was the collection of a university bibliography: the publications metadata representing the scholarly output of the institution. External reporting requirements appeared as the strongest driver of CRIS adoption and usage in our research study. More recently, open-access mandates are also beginning to directly influence research output and publication management priorities. In this context, Germany is the exception with few external incentives driving adoption of CRIS systems.

Local institutional needs are also drivers of CRIS adoption and RIM practice in all three national settings within our investigation, whether serving as the primary driver at German institutions or as additional incentives in the Finnish and Dutch landscapes. Institutions particularly sought information to support internal reporting and decision support activities, such as support for strategic planning, analysis of research activities, identification of institutional participation in specific programs or collaborations, and collection and analysis of a broad array of research outputs, not just publications.

Stakeholders are eager to improve workflow efficiencies and see potential for persistent identifiers, in particular person (author or researcher) identifiers, to support this need. Adoption of persistent person identifiers to support name disambiguation and improved publications metadata harvesting is underway in all three national environments, and ORCID is widely perceived as becoming a de facto standard. Universities and ICT organizations are following international developments around organizational identifiers with interest, but we found no activities to integrate standardized organizational identifiers into CRIS systems.

Libraries are a fairly new but increasingly important partner in this space, with responsibilities in publication management and user support, particularly as CRIS systems are increasingly used to monitor, track, and report on open-access activities.

This report documents a rapidly changing RIM landscape, as CRIS systems aggregate more types of data, harvest publications from a growing number of external sources, and serve as an important node interoperating within a large, complex scholarly communications landscape.

External policies are the strongest driver of CRIS adoption

External reporting requirements appeared as the strongest driver of CRIS adoption and usage in our study. Following the implementation of national assessment regimes in the Netherlands and Finland, beginning in the 1990s in the Netherlands, research universities developed local software solutions like METIS to reduce administrative burden and improve data quality and transparency. In the intervening years, all research universities in the Netherlands and Finland have implemented CRIS systems, and we have also seen significant efforts to aggregate university research outputs in national publication portals like NARCIS (the National Academic Research and Collaborations Information System) and Juuli.[14]

A central component of research information management practice at all of the institutions studied was the collection of a university bibliography: the publications metadata representing the tangible scholarly output of the institution. Typically, these bibliographies are compiled to support national reporting requirements associated with public university evaluation and research funding. In our review of the three national settings, we found Finland had the strongest incentive to collect each and every publication in the country, as 13% of the institutional support from the Ministry of Education and Culture is directly linked to publication output. Finnish institutions have dedicated considerable resources into software, systems, and personnel in order to identify, validate, and report on all locally produced publications. For instance, the University of Helsinki now reports annually on about 11,000 research publications, about 40% more than the 6,000 publications identified annually in 2009.[15]

While national research assessment requirements are the strongest and most mature driver of CRIS adoption, we observed that national open-access mandates, where taken seriously, are also beginning to directly influence research output and publication management priorities. The Netherlands has outlined an ambitious national open science initiative,[16] with the bold goal of achieving 100% open-access publication by 2020. This national agenda, applauded by librarians, will require additional record keeping at institutions across the Netherlands, in part because

progress toward open science goals will become part of the national standard evaluation protocol (SEP) with the next SEP mid-term review in 2018. While the Finnish Open Science Initiative (2014–2017) did not establish discrete targets for the proportion of open-access publications within the larger overall national research output, it has similarly galvanized institutions to establish local policies, targets, and workflows.[17]

Germany in this context is the exception that proves the rule, largely lacking external incentives to adoption of CRIS systems. OA publication is supported and recommended by many parties but is not mandatory, and existing voluntary standards such as CERIF or the German KDSF (Kerndatensatz Forschung — Research Core Dataset) serve as blueprints for implementation—"a kind of incentive," in the words of one of our informants—but not as a strong inducement driving CRIS adoption. As a result of this lack of external incentives, Germany's CRIS system landscape has developed later and differently than the national landscapes in Finland and the Netherlands. CRIS systems have been implemented in only a small number of institutions, and implementation rates are rising rather slowly. "It needs some kind of external pressure," as one of our German informants phrased it, and we expect that CRIS adoption in Germany will continue slowly in the absence of external mandates.[18]

Institutional needs also drive research information management practices

While top-down mandates have the most widespread impact, local institutional needs are also drivers of CRIS adoption and RIM practice, helping universities to address institutional problems. This is congruent with findings in other research underway by OCLC Research, including The Realities of Research Data Management report series, where we also find that institutional efforts to acquire capacity to support research data management are driven primarily by institutional needs, not researcher needs.[19]

We observed institutional needs as a driver in all three national settings within our investigation, whether serving as the primary driver at German institutions or as additional incentives in the Finnish and Dutch landscapes. Institutions particularly sought information to support internal reporting and decision support activities, such as:

- Support for strategic decisions with business intelligence data representing all institutional research programs
- Analysis of research activities across academic units
- Identification of institutional participation in specific EU programs, national and international collaborations, and knowledge transfer activities
- Assessment of institutional strengths, such as by identifying areas of highest grant awards
- Collection and analysis of a broad array of research outputs—not just publications—such as datasets, invited presentations, and research awards

German assessment and funding practices, such as those by the Deutsche Forschungsgemeinschaft (DFG), have traditionally emphasized qualitative reviews by scholarly experts, and each institution has exercised considerable autonomy with high expectations for self-evaluation. However, the 2007 German Excellence Initiative, which sought to increase German research competitiveness, led to a situation in which many German institutions recognized that it was difficult to assemble institution-wide indicators about research activities—information that could be demonstrably beneficial for institutional strategic analysis and planning and also improve transparency. Institutions such as Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) and Münster sought improved research information in addition to existing qualitative evaluations when implementing their CRIS systems.

Where CRIS systems are implemented primarily for local reasons, as in Germany, we observed a greater concern with cost benefit analysis. The absence of external reporting mandates leaves room for discussions of pros and cons of CRIS implementation and maintenance, such as the return on investment (ROI) of such systems. ROI as understood by middle managers, such as gaining strategic intelligence, saving time, or increasing confidence of results, is difficult to translate into something quantifiable and more meaningful to executive-level decision makers, who are typically looking for strategic impact, over and above any operational efficiency gains.

Finnish and Dutch institutions also reported additional local benefits and uses of CRIS data, such as:

- Data to support annual academic progress reviews
- Researcher profiles (either public or locally restricted) to support reputation management and expertise discovery
- Reuse in researcher web pages and curricula vitae
- Support for open access through repository integration, or, in some cases, by using the CRIS for full-text deposits[20]

Adoption of persistent person identifiers

Persistent person identifiers are growing in importance, and the need for improved workflows was consistently named as the principal driver for person identifier adoption and integration in CRIS systems in the three national settings we investigated. In particular, publication management at scale (for example, managing the university bibliography) was frequently mentioned as an important new field of activity relying on name disambiguation and improved metadata quality.

Another driver of person PID adoption is a conscious effort at internationalizing university research activity, in response to the increasingly global and mobile research community. This is certainly true for the Dutch, who are in the process of replacing a well-established, well-functioning, and well-integrated national researcher identifier, Digital Author Identifier (DAI; see below), partly because of a perceived need to internationalize their RIM infrastructure, in context and analogy with their recent work on updating their cataloguing infrastructure from a national to an international one.[21]

The increased practice of publishing in the English language, and outside of the country, is also worth mentioning, as these publications would not always be captured by the national library as related to the national culture but still need to be managed as the nation's scholarly output. The need to reliably identify relevant researchers and their affiliations, even in such cases where the link to their national affiliation may be "obscured," is additionally driving recommendations of ORCID adoption, particularly in Finland.

"Good practice" or standards, including open science (covered more below), while recognized and even applauded, do not in themselves drive PID adoption at the local institutional level. Faced with scarce resources and conflicting priorities, following good practice was not identified as a priority for our informants unless it solved an urgent problem.

Through our interviews, we identified the following person identifiers in use in CRIS systems: DAI, ResearcherID, Scopus Author ID, ISNI, and ORCID. A brief description of their use follows:

DAI

The Digital Author Identifier (DAI) is the oldest of these identifiers, being established for use across CRIS and library infrastructures in the Netherlands in 2005. DAIs are minted by institutions, and minting DAIs within the CRIS has been the standard workflow until recently, when most universities replaced their METIS system with a proprietary solution and thus lost the benefit of a fully integrated workflow. The DAI has limitations in that it exists only within the closed Dutch library and research information infrastructure, and fails to reflect the increasingly mobile and global scientific community. While still currently in use in the Dutch RIM ecosystem, including all local CRIS systems, it is gradually being replaced by a joint ISNI-ORCID person identifier solution. During this period of transition, many DAIs have been converted to ISNIs, but DAIs are still being minted while workflows are optimized. In time, the DAI is expected to be retired.

RESEARCHERID AND SCOPUS AUTHOR ID

The author-claimed ResearcherID (Clarivate Analytics) and the algorithmically generated Scopus Author ID (Elsevier) are proprietary identifiers that are used to support disambiguation in Web of Science and Scopus, respectively. Use of these identifiers has increased in importance as more institutions now rely upon metadata harvesting from Web of Science and/or Scopus to populate CRIS systems. Identifying and validating the appropriate person identifier(s) for each researcher can help to improve harvesting quality, and we found some institutions investing library effort into this process; however, these tools were also sometimes described as stopgap solutions, as they did not resolve disambiguation problems at scale, only within their respective proprietary indexes.

ISNI

ISNI, the International Standard Name Identifier, is a certified ISO standard covering the public identities of people and organizations across fields of creative activity worldwide. ISNI seeks to act as a bridge identifier across domains—including academic institutions, libraries, trade sources, publishers, rights agencies, funding agencies, and more.[22] ISNI is governed by the non-profit ISNI-IA (international agency) and technical operations are supported by the OCLC Leiden office on behalf of ISNI. Launched in 2012, the ISNI registry contained 8.75 million individual person records and 654,000 organizational records as of August 2017 (more on this below). Unlike ORCID or ResearcherID identifiers, but similar to DAI identifiers, ISNIs are not self-claimed by authors. Instead,

ISNI identifiers provide a type of authority control, with identifiers assigned by authorized organizations that work to validate information from multiple sources and with centralized quality control by the British Library and the Bibliothèque nationale de France.[23]

We found ISNI person identifiers in use in CRIS systems only in the Netherlands, as the Dutch are currently transitioning from using the DAI as the person identifier in their national infrastructures to using both ISNI and ORCID. In this context, ISNIs will be used to capture additional content—such as deceased authors—to serve libraries, archives, and museums with a quality controlled identifier, and to link to other creative communities. As ISNI adoption requires the establishment of a national infrastructure for minting ISNIs, a Dutch registration agency for ISNI has been established at the National Library, the Koninklijke Bibliotheek (KB), and the community is working to develop workflows to replace the previously well-developed infrastructure for minting DAIs within CRIS infrastructures. As described above, the creation and validation of each ISNI identifier requires consultation with multiple authoritative sources, and the current processes in local institutions are described as still being very labor intensive.

We did not find ISNI person identifiers in use in any of the CRIS infrastructures we examined in Finland or Germany. There is also no integration between ISNI and proprietary CRIS systems like Pure and Converis, and ISNI identifiers are not collected from researchers in publishing workflows. Consequently, ISNI identifiers have relatively low visibility among researchers and authors; according to one of our Dutch informants, researchers perceive ISNI identifiers as an "abracadabra library thing."

ORCID

ORCID, the Open Research and Contributor ID, is a unique, persistent identifier for researchers in all scientific and scholarly disciplines. ORCID is a not-for-profit organization, sustained by fees by membership organizations, and the ORCID registry launched in 2012. As of 5 September 2017, there were nearly 3.8 million ORCID identifiers and 712 organizational members worldwide. ORCID identifiers are free to researchers, who must self-register and who always maintain privacy and control over their own records. ORCID seeks to resolve the name ambiguity problem in scholarly communications, and it particularly describes itself as the "plumbing in research infrastructure." In this metaphor, ORCID identifiers and services are the pipes that support effective interoperability and communications between research information systems. ORCID works with publishers, funders, universities, research institutes, and scholarly communications technology providers (like figshare or Pure), as well as with researchers themselves. ORCID is now included (and often required) in publication workflows by many leading journals. Funding organizations are also incorporating ORCID identifiers into their workflows. ORCID additionally offers "auto-update" functionality to researchers, in which ORCID record holders can configure their account to automatically update their ORCID record when newly published content is available from CrossRef and DataCite.[24]

ORCID is widely seen as the emerging de facto standard, especially in CRIS infrastructures. This is supported by that fact that there are ORCID consortia in all three national settings. These initiatives were in all cases initiated and led by organizations that are by definition interested in scale and strategic developments at the national and international level, such as SURF in the Netherlands; CSC in Finland; and DFG, the Bielefeld Academic Search Engine (BASE), and the National Library in

Germany. At the institutional level, support for those initiatives varies. While many Finnish universities are in principle participating in the ORCID consortium preparations, relatively few are actually members because they do not yet see a concrete return on investment.

In our interviews, institutions reported significant interest in ORCID as a source of automatically updated publications metadata in their CRIS system. ORCID integration is now delivered in proprietary CRIS products like Pure and Converis, supporting the final stage of a "metadata round trip" in which ORCID IDs are collected in publication (or funder) workflows, continue through DOI minting into publications metadata, are automatically updated in the author's ORCID record, and used to interoperably update any system, including a CRIS, that the researcher has linked to their ORCID.[25] Identity management integration is also emerging as a powerful use case, offering the potential for improved researcher convenience by a single institutional integration. For example, Dutch researchers can now log into ORCID by using the same credentials they use to log into their university, functionality available to any institution that is an eduGAIN-enabled identity provider.[26]

This workflow is seen as very valuable to institutions, but our informants also identified many formidable challenges. For instance, ORCID is perceived primarily as an identifier for use in scientific journal content, and significant weaknesses exist for arts and humanities scholars, particularly in the collection of monograph content.[27] Other informants pointed to the challenge of collecting ORCID identifiers for secondary authors. Right now most publishers request (and sometimes require) ORCID identifiers from corresponding authors, meaning that only one contributor's ORCID record can be automatically updated. Finally, ORCID is researcher driven, and requires action by each researcher (or researcher-designated trusted party) to enable. As institutions move toward incorporation of the researcher-managed ORCID identifier into their workflows, as is happening in all three national environments, they also find that they have to motivate researchers to sign up for an ORCID, so that they—the universities—can benefit from the workflow. Research libraries, in particular, are beginning to reach out to and educate researchers, to encourage ORCID adoption, use, linking, and auto-updating.

While our informants expressed appreciation of the current benefits and potential value of ORCID, a few lamented the absence of a "killer app" (their term) that would make ORCID indispensable to researchers, thereby increasing uptake for self-registration and claiming of identifiers. Interview subjects observed that local researchers value the feature-rich networking environments provided by ResearchGate or Academia.edu which aggregate publications as well as metadata and provide authors with ready-made research profile pages and networking opportunities. While ORCID has not positioned itself as a profile provider or networking site, our informants reported that it is perceived as a less full-featured profiling system by their users, competing for researcher attention.

ORCID identifiers are required by a growing number of scholarly publishers, funders, and even national agencies, but there are no national ORCID mandates requiring researcher adoption in the Netherlands, Finland, or Germany.[28]

NEED FOR INCREASED CONVENIENCE AND INTEROPERABILITY

The development of person identifiers, workflows, and enhanced CRIS infrastructures is taking place in a rapidly evolving landscape in which researchers are also interacting with external platforms such as ResearchGate and Google Scholar that support reputation management and

academic social networking through a convenient user interface. Researchers often dedicate considerable effort in profile maintenance in these platforms and resent having to rekey the same information in multiple places. However, most proprietary platforms like ResearchGate offer limited support for any kind of metadata harvesting at scale. At best, institutions are working to train researchers to export their publications from platforms like Google Scholar into a format (such as BibTex) that can more easily be imported into the CRIS. ORCID auto-update is perceived by librarians as a longer-term, scalable solution that will also be convenient for researchers.

Some of our informants expressed a desire for improved interoperability between person identifiers. In the Netherlands, where both ORCID and ISNI identifiers will soon be used to replace the national DAI, organizations are particularly eager for improved interoperability between ORCID and ISNI. ORCID now offers "search and link" functionality to enable researchers to link their ORCID identifier with their ResearcherID and Scopus Author ID. An ISNI2ORCID linking tool for researchers has been available in beta since 2013, and a new, enhanced linking tool is expected in late 2017. The development of this feature was requested by the British Library as part of the European Commission-funded THOR project.[29]

Adoption of organizational persistent identifiers

There is significantly less activity related to organizational identifiers in the CRIS landscapes in Finland, the Netherlands, and Germany than for person identifiers. While the value of organizational identifiers, like other types of PIDs, is widely acknowledged, we found little activity, with more than one informant stating categorically, "we do nothing with organizational identifiers."

We found the CRIS administrators at research universities were focused primarily on pressing local needs, and they were able to accomplish their day-to-day research information management activities without national or international organizational identifiers. Each institution has its own local or system identifiers for organizing internal units and hierarchies that have been incorporated into the CRIS, and these identifiers are adequate for institutional business needs. For some institutions, the Scopus organizational identifiers used within Pure, which also includes country information, were useful for reporting related to international collaborations. We also observed some individual cases of institutions collecting ISNIs or the Erasmus student exchange program organizational IDs in the CRIS for external and/or international organizations, although this did not address a current workflow or reporting need but was perceived as potentially offering future benefit.

National ICT organizations like CSC, SURF, and DANS expressed the greatest interest in organizational identifiers, as they represent a group-scale perspective and perceive PIDs as essential infrastructure for scaling RIM activity, which is covered in greater detail below.

While persistent organizational identifiers may indeed be essential for interoperability, their lack of adoption in the Netherlands and Finland has not prevented some national-scale efforts, such as the creation and population of the NARCIS and Juuli portals, respectively.

Through our conversations, we observed three elements that may be curtailing organizational identifier adoption in the European RIM landscape:

1. The lack of a widely accepted, authoritative standard impedes adoption of organizational identifiers. Many of our informants felt that the problem should be solved internationally, and they particularly require that the identifier work interoperably within scholarly communications workflows. There is considerable reluctance to invest in the adoption of an identifier that is not cost-effective or open and may not be of longer term value. Many stakeholders described themselves as "watching the space," and several particularly expressed interest in the current Organizational Identifier Working Group being led by CrossRef, ORCID, and DataCite.[30] While ISNI is an ISO standard and has received industry support for adoption within library systems and as multi-use bridge identifier, we found little recognition of ISNI as an organizational identifier in our conversations with CRIS administrators.[31]
2. Addressing the problem of organizational identifiers is hard. For example, organizations may change names, merge and split, and change locales. They may be known as abbreviations that are not unique, and they may be called different things in different languages. Large academic institutions also have many sub-divisions that are in constant flux. Existing organizational identifiers are perceived as not managing this complexity very well yet.
3. Local business needs and workflow challenges within institutional CRIS systems are not presenting a strong driver for organizational identifiers. Local institutions—and even some national-scale activities—are operating today without a global organizational identifier. And while local institutions could benefit from one if it were easily available, the need is not felt severely enough to drive action, certainly not in view of conflicting priorities.

While research universities universally were reluctant to do anything with organizational identifiers in their CRIS systems, we did observe interest. For instance, one Dutch informant was eager to see a widespread adoption of organizational identifiers in scholarly communications workflows because more accurate affiliations tied to researchers in publications records could improve the results of harvested publications metadata into CRIS systems. In Finland, another informant described the increasing need to understand and report on international research collaborations as a problem that organizational identifiers could help to solve. Informants from all national landscapes perceived organizational identifiers as of value in collecting and managing research information about increasingly international and mobile collaborations.

Several of our informants also suggested that the future reporting requirements of funders (that seek to better connect grants to outputs, persons, and organizations) may create greater incentives for organizational identifiers within CRIS systems.

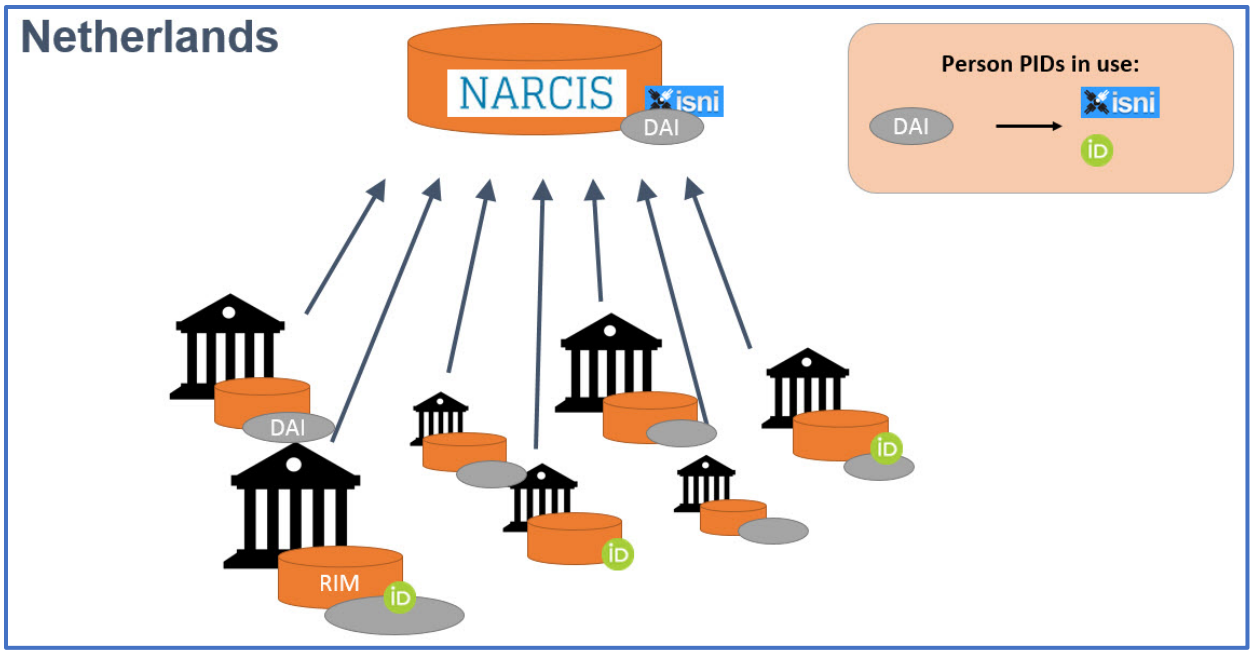

FIGURE 1. Research Information Management at Scale in the Netherlands. Research information is collected through institutional-scale CRIS systems and, from there, aggregated into the single NARCIS portal. DAIs are in the process of being replaced by a combined solution of ISNI and ORCID person identifiers.

Research information management infrastructures at scale

We initiated this work expecting to find national or transnational scaling efforts facilitated by persistent identifiers. Instead, we found a landscape that is still highly local, although additional levels of aggregation may take place at the national level. Only in the Netherlands is national scaling facilitated by persistent identifiers, a practice not observed in Finland or Germany.

Today, the Dutch have a system in which information from the institutional CRIS systems, along with institutional repositories and data archives, is aggregated into the single NARCIS portal. This infrastructure was facilitated—and scaled—through Dutch creation and adoption of the DAI, the national researcher identifier, soon to be replaced by a combined ISNI/ORCID solution, as described above. For the Dutch, identifiers are understood as a necessary component of aggregating and scaling research information management.

We also observed a smaller group-scale effort in the Netherlands, the "New Amsterdam CRIS," a cooperative of five Amsterdam-based institutions sharing responsibility for a new CRIS infrastructure to support consortial-level reporting about researchers affiliated with multiple Amsterdam institutions. Each institution has its own CRIS system, with workflows to support data sharing into a sixth instance that aggregates content and supports joint reporting. Our informants from the University of Amsterdam and VU Amsterdam acknowledged the importance of persistent identifiers like the DAI for name disambiguation and records management in this group-scale environment.[32]

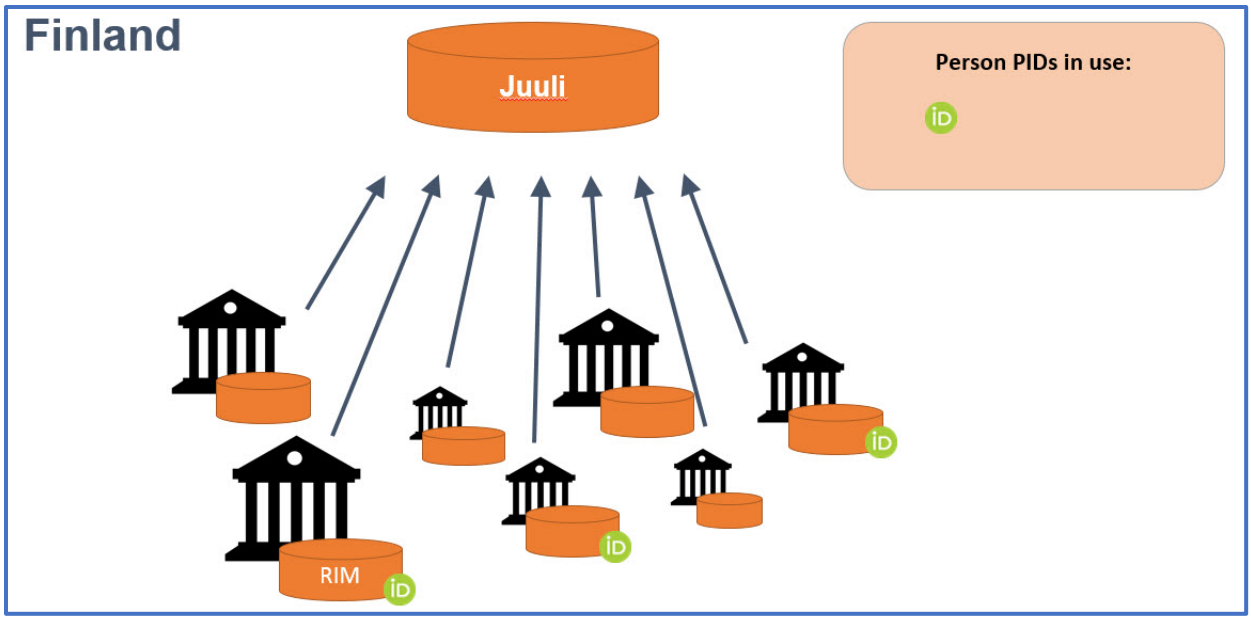

FIGURE 2. Research Information Management at Scale in Finland. Research publications metadata are collected through institutional-scale CRIS systems and, from there, aggregated into the single Juuli portal. ORCID identifiers are in the process of adoption at several Finnish institutions.

Similar to the Dutch landscape, the implementation of institution-scale CRIS systems is ubiquitous in Finnish universities. Publication metadata for university research outputs is aggregated in the national Juuli portal. While Juuli represents a national-scale aggregation, it is narrower in focus than NARCIS, as it collects only CRIS publications metadata, without additional aggregation from open-access repositories and data archives.[33]

In contrast to the Netherlands, Finland's national-scale aggregation into Juuli has occurred in the absence of national or international person or organizational identifiers. Local identifiers exist in Finnish institutions, as everywhere, and these have been adequate to manage institutional reporting and modest Juuli scaling to date. However, the need for improved interoperability and reporting compliance to multiple agencies are creating stronger incentives for identifiers and standardization in Finland. A national ORCID consortium was established in 2016 to encourage ORCID adoption by researchers and integration into Finnish research infrastructures, including CRIS systems.[34] The National Library of Finland is partnering with ISNI to improve coverage of Finnish organizational names in the ISNI database.[35]

Discussions are now under way in Finland regarding a new national RIM infrastructure to be implemented in the near future (2020), a development which some of our respondents perceived as a potentially unwelcome disruption of institution-scale activity and self-governance, and an impediment to local decision making, particularly with respect to local RIM implementation choices. It remains to be seen what influence national scale aggregation of RIM data will have on the PID landscape in Finland, as PIDs are generally recognized to be important for data flow at all levels.

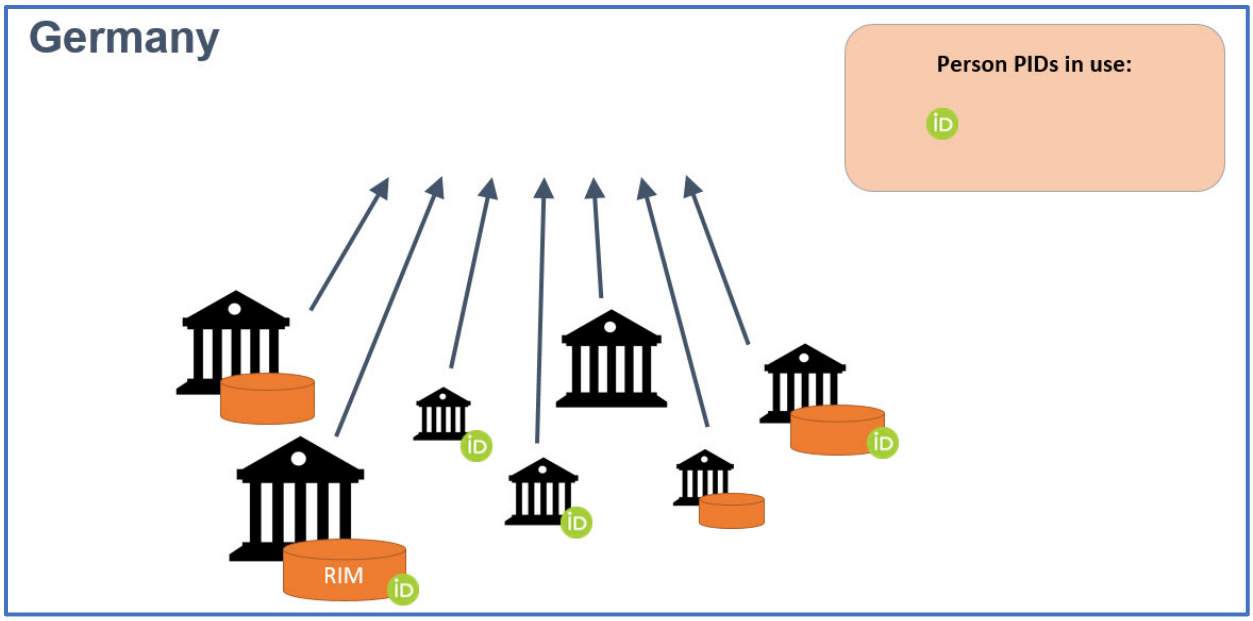

FIGURE 3. Research Information Management at Scale in Germany. Some German institutions have adopted CRIS infrastructures. Unlike Finland and the Netherlands, there is no national aggregation of local CRIS metadata. ORCID identifiers are being adopted by some institutions.

Where scaling efforts do not exist and are not supported by federal structures and science policies, as in Germany, this is seen as a barrier to adoption of both standards and identifiers. In sharp contrast with the Dutch and Finnish RIM ecosystems, German CRIS adoption is far from universal, and plans for aggregation at the national level do not exist. Even though these are not needed to help facilitate interoperability and scale, the use of persistent identifiers is widely encouraged as a best practice. An ORCID DE project was launched in 2016 with the stated intention to boost ORCID adoption in Germany. It is, however, not primarily driven by integration needs of existing local or national CRIS infrastructures. The lack of scaling efforts and data exchange opportunities is seen by some as a weakness and even a burden to a certain degree, and has led to bottom-up initiatives such as an agreement to develop a standard reporting model in the state of Hesse by 2019 "to do ourselves a favour."[36]

State- and national-scaling efforts are not seen in a positive light by all we talked to. These efforts also have the potential to create anxieties about local autonomy, at both the institutional and departmental level. The establishment of institutional CRIS systems rather than a single centralized system allows institutions to prioritize local processes and workflows and to select products that best meet institutional requirements. National-scale activities can be perceived as threatening this local autonomy, as scaling is not intended to address local problems, rather to address national or group problems. Researchers can have a similar ambivalence. On one hand, researchers appreciate interacting with centralized workflows that can reuse and share their information in order to reduce rekeying. But on the other hand, researchers oppose attempts at centralizing information for reporting to better understand researchers' careers, as this would create a level of national control they feel clashes with individual and local autonomy.

ICT organizations, national libraries, and national agencies are extremely interested in the provision of above-the-institution solutions, although these solutions may be ahead of specific problems being faced by local practitioners. Ultimately the leadership to drive nationalized CRIS and PID infrastructures will come from these types of organizations. In this context, LIBER also appears to be well positioned to advance "above-institution" understanding of and approaches to RIM, as part of its focus on scholarly communications and research infrastructures, and help demonstrate the value that libraries can add to RIM activity at multiple scales.[37]

Open science

The European Commission, OECD, funders, publishers, libraries, scientific societies, ICT organizations, and other stakeholders in scholarly communications are seeking to foster greater scientific research access, transparency, collaboration, use, and innovation. While there is no universally accepted definition of open science, the OECD describes it as: "efforts ... to make the primary outputs of publicly funded research results—publications and the research data—publicly accessible in digital format with no or minimal restriction." Open Science is an umbrella term that encompasses numerous components of the research life cycle, including open access to publications, open research data, open source software, open collaboration, open peer review, open notebooks, and open educational resources. Many professional organizations like LIBER have issued statements in support of open science, and research institutions and ICT organizations are working to develop infrastructure to support open science activities.[38]

In the course of our investigation, we asked our informants about the impact of open science on local and national research information management activities. Was open science a driver for CRIS systems, persistent identifiers, or national-scale activities? In all national landscapes we found the impacts of open science initiatives were modest—for now. In part, this is because CRIS implementations in the Netherlands and Finland, as well as the DAI, simply predated open science agendas. Nevertheless, open science objectives are seen as increasingly relevant today, and persistent identifiers for all objects available in research information regarded as the backbone of open science. One of our informants even told us, "I do not believe in open science without identifiers."

Both the Netherlands and Finland have outlined open science plans and articulated goals to become leading countries in openness of science and research. The above-mentioned Dutch open science agenda is one of several national efforts to support FAIR data sharing principles.[39] While institutional reporting requirements are still unfolding, the universities we spoke with, and SURF, had a keen interest in using CRIS systems to track progress towards the Dutch OA goal. Finnish institutions are similarly working to regularly evaluate progress toward open science goals. In Germany, solving institutional problems seems to take precedence over fulfilling open science agendas. Open access is actively supported and recommended by many parties, including the German federal government, but there is no national mandate or measurable objectives shared by all stakeholders.[40]

We observed increasing interoperability between local CRIS systems, institutional repositories, and data archives, driven in part by the need for user-friendly workflows for researchers depositing research outputs in response to open science mandates. We expect open science efforts in Europe to continue to influence the CRIS and identifier space.

Library involvement

Library involvement differs greatly among the three countries. While this had not been a focus of our study, and was not investigated systematically, our observations are robust enough to merit discussion.

In both the Netherlands and Finland, libraries play a strong role in the CRIS landscape. Most of the informants we talked to were based in or worked with the library, and activities such as metadata management and researcher support were universally described as being in the hands of and/or the responsibility of the library, or of library staff.

From what we could observe, libraries become involved at the point where workflows and activities around CRIS start to intersect with traditional library services and values, like publication metadata, open access, linkages to repositories for publications and datasets. Library staff enter metadata—primarily publication metadata—in the CRIS, or validate metadata entered by researchers or harvested from external sources.

Libraries also become actively engaged as the need to serve, interact with, and train researchers increases. Libraries support researchers by helping them manage their public profiles and scholarly reputation, validating metadata researchers have entered in the CRIS, training them to export and import metadata from other sources, assisting them in fulfilling OA deposit obligations, and educating them on copyright issues in this context. These educational activities also often include raising awareness of tools like ORCID, obtaining an ORCID identifier, importing works from external sources, activating the auto-update functionality, and linking the researcher's ORCID to the institutional CRIS. One might think of these activities as teaching "information literacy" for 21st century scholars, and thus a very traditional library role, just updated with new content.

Our research suggests that library support for institutional RIM activity is greatest in the CRIS implementation or post-implementation phase, when outreach, education, and customer support become important. Perhaps surprisingly, library expertise in researcher workflows and scholarly communications is not recognized as relevant to the selection or evaluation of RIM infrastructure.

On the other hand, libraries themselves seem reluctant to enthusiastically embrace RIM as a potential area of involvement. This is in marked contrast to their perspectives on research data management, which is now a major topic at library conferences, including the 2017 LIBER annual conference in Patras, Greece. Clearly, there is ambivalence about future library roles—and priorities—within and outside the library.

In contrast to the active library involvement in research information management observed in Finland and the Netherlands, German libraries are much less or not at all involved in RIM activities. CRIS systems are usually implemented as administration tools, managed by research administration departments, and this is where most of the work is done. In one interview, we observed open surprise from a German informant in reaction to the idea that libraries might have anything to do with the CRIS system. Another informant stated that requiring scientists to re-enter their data was seen as much easier than attempting integration with library databases for publication management.

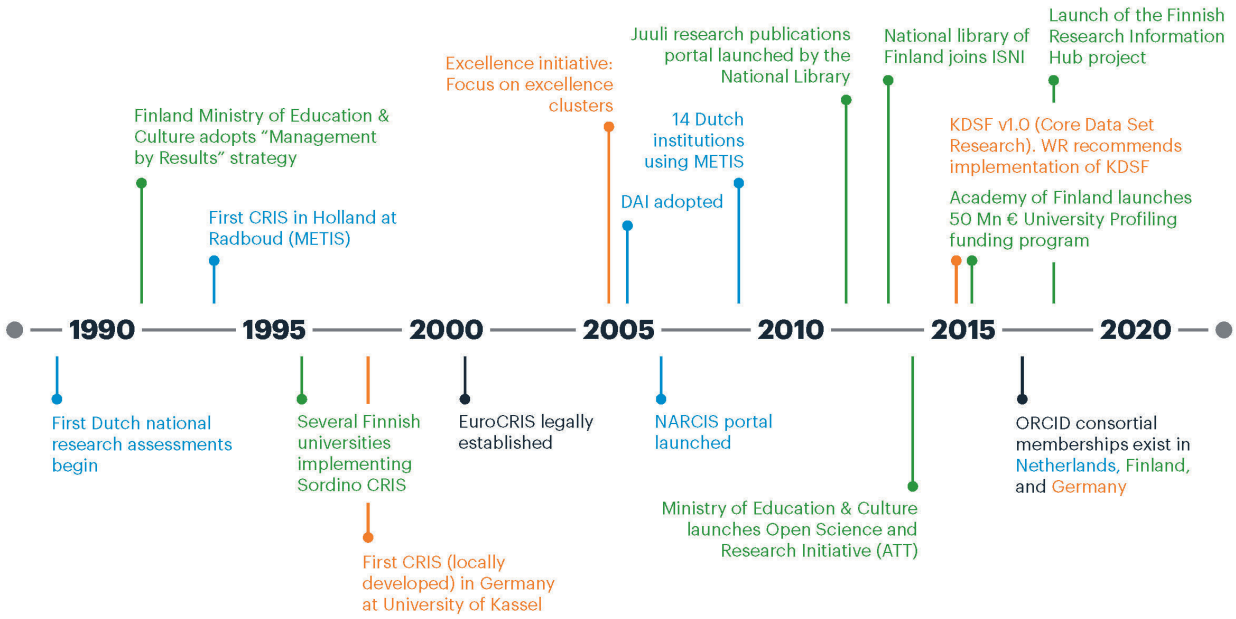

FIGURE 4. Timeline of Key Milestones in Dutch, Finnish, and German Contexts. The Netherlands milestones are blue, Finland milestones are green, and Germany milestones are orange.

One institution we interviewed had just recently begun a pilot in which users submitted their publications to the CRIS via the library, in order for librarians to validate, enrich, and correct the data. The administrative office in charge of this task previously found it challenging to do this systematically. With the library's enhanced role, support was expected to improve. Given that Germany is a young CRIS landscape, it remains to be seen how library involvement will develop over time, as systems mature, researchers expect support, and libraries—and research administrators—recognize the expertise and skills offered by the library.

RIM is developing as a strategic role for 21st century research libraries, with local libraries supporting institutional needs, and potentially also national libraries serving a wider community, within and beyond the library sector. As mentioned above, both the National Library of Finland and of the Netherlands are engaged with ISNI in the specific context of scholarly communications. The

German National Library is one of the partners in the ORCID DE project, working on integration between the national authority file, GND, and ORCID, and even more generally actively transforming this library asset into a "backbone for the web of cultural and scientific data."[41] The OCLC Research position paper *Research Information Management: Defining RIM and the Library's Role* articulates in more detail the ways that libraries can support research information management, including publications expertise, discoverability and reputational support, training and support for end users, as well as the stewardship of the institutional record.[42]

Research in the Netherlands

National funding and reporting requirements

Overall, the Dutch RIM landscape is characterized by universal adoption of CRIS systems, and a high level of national organization, influenced by national reporting and open-access requirements. The Netherlands has 13 research universities, which are organized into a national consortium called VSNU (Association of Universities in the Netherlands),[43] which represents research universities to the government and parliament on behalf of policy issues.[44] Dutch research universities have high research productivity, particularly for such a small country, and they fare relatively well in international ratings and rankings, with six universities in the QS World University Rankings top 100 in 2014/2015 as well as more than half of Dutch universities appearing regularly in the top 100 of the Times Higher Education World University Rankings.[45]

Beginning with an experimental assessment protocol in the late 1980s, research at all Dutch research universities and institutes has been assessed every six years using the Standard Evaluation Protocol (SEP),[46] which is jointly defined by VSNU along with the Netherlands Organisation for Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences (KNAW), and is intended to "reveal and confirm the quality and the relevance of the research to society and to improve these where necessary."[47] CRIS systems have long supported SEP activities by collecting the main categories of research output, including refereed articles, books and book chapters, PhD theses, conference papers, as well as research support and expenditures. However, since 2015 the volume of publications is no longer considered an evaluation criterion due to the negative publication pressure on researchers.[48]

The SEP research assessment is seen as overwhelmingly cumbersome and has been a significant driver for the adoption of local and national research information management infrastructures in the Netherlands. Researchers, administrators, and librarians would all like to reduce rekeying by faculty and support greater interoperability.[49]

The SEP research assessment is separate from the funding allocation system, and SEP outcomes are not linked to national funding opportunities. Significant research funding in the Netherlands is provided by the Ministry of Education, Culture and Science as well as NWO and KNAW. According to a 2016 comparative report on research performance-based funding by the European Commission's Joint Research Centre, 44% of national support for Dutch universities and medical centers was allocated on the basis of research criteria, including degrees awarded, PhDs defended, and with the largest portion (60%) allocated on the basis of block funding. Publication-based output assessments/indicators, in contrast to Finland, are not a component in the funding allocation model.[50]

The Dutch are pursuing an ambitious agenda for open access and open science. In February 2017 numerous research funders, universities, libraries, and ICT organizations jointly signed the Open Science Declaration, outlining clear ambitions, including 100% full-text open access to publications by 2020 and support for policy and technical developments to facilitate FAIR data.[51] Beginning in 2017, a coalition comprised of NWO, KNAW, and VSNU will begin examining how the open science

goals may be integrated into the SEP evaluation.[52] While institutional reporting requirements are still unfolding, the universities we spoke with, and SURF, had a keen interest in using their CRIS systems to track progress toward the national 100% open-access goal, whether the publication is made publicly available through a publisher or in a local repository. Interoperability between CRIS systems and repositories, and the need for user-friendly workflows for researchers for publication and data deposits, are rapidly growing in importance.

Research information infrastructures and research information practices

INSTITUTIONAL CRIS SERVICE PROVISION

Dutch institutions were early leaders in the development of RIM infrastructure. Responding to early reporting requirements, Radboud University developed the METIS CRIS system in 1993, and it was soon adopted by other Dutch research universities and KNAW. METIS is CERIF-compatible and adapted specifically for Dutch institutions, supporting interfaces with local human resources information systems, institutional repositories, and bibliographic metadata harvesting from sources like Web of Science, Medline, RIS, and BibTeX. In 2008, 14 Dutch institutions were using METIS.[53]

While CRIS systems were first developed as a tool for research management by administrators, the universities we spoke with emphasized how CRIS infrastructures have become increasingly important as an instrument for researchers themselves—to provide a user-friendly interface for depositing open-access publications and datasets, and to provide information for public profiles.

GROUP AND NATIONAL SCALE RIM SERVICES IN THE NETHERLANDS

The Dutch have worked collaboratively to create national infrastructures to support information management and discovery. Established in 2007, the National Academic Research and Collaborations Information System (NARCIS) is a national Dutch portal that combines data from three heterogeneous and independently managed types of sources:

- Institutional CRIS systems, aggregated in NOD (the Dutch Research Database)
- Digital academic repositories
- Research data sets, including those from the 4TU archive and in the DANS-EASY archive[54]

NARCIS aggregates content and provides access to scientific research, including nearly 500,000 open-access publications and datasets, from all Dutch universities, several research institutes, KNAW, and NWO.

In the late 2000s as the METIS platform aged and new functionality was needed, conversations turned to the potential for a single national CRIS system to replace METIS. Requirements were gathered based upon existing and highly customized functionality in METIS, and SURF issued a tender. No vendor solution was deemed appropriate to meet the extensive requirements for a single national CRIS, and as a result, individual universities began to examine their own requirements and contracting independently with proprietary providers.

Today, most Dutch research institutions have migrated from METIS to the proprietary Pure platform. Leiden University is the sole Dutch institution using the Converis system, and two institutions (Radboud University Nijmegen and Erasmus) continue to use METIS.

More recently, five Amsterdam-based institutions are also working collaboratively to select, implement, and share responsibility for the implementation of new CRIS infrastructure to replace their local METIS systems. This group-scale initiative, called the "New Amsterdam CRIS," was driven primarily by the need to support reporting requirements about researchers affiliated with multiple Amsterdam institutions. Within this context, the five institutions, which include two universities, two university medical centers, and one university of applied sciences, worked collaboratively to define requirements, select a system to be used by all institutions, and to establish workflows for cooperative management and reporting. Each institution has its own CRIS system, with workflows to support data sharing into a sixth instance that aggregates content and supports joint reporting.[55]

Adoption and integration of persistent identifiers

PERSON IDENTIFIERS

The Dutch were the early leaders with the creation of a national Digital Author Identifier, or DAI, a unique national number assigned to every author working at a Dutch university or research institute. It is used to support author name disambiguation, ensuring that publications are attributed to the correct authors, and it facilitates improved data consistency within NARCIS. It has been used since 2005 when it was adopted as part of the DARE (Digital Academic Repositories) programme led by SURF in collaboration with the National Library of the Netherlands (Koninklijke Bibliotheek or KB), Dutch universities, KNAW, and NWO. The DAI links Dutch Thesaurus of Author Names (NTA) metadata with CRIS metadata in NARCIS and is visible on researchers' profile pages in NARCIS. OCLC (and formerly PICA) has been responsible for the technical management of DAI, while the KB has supported functional management of NTA. DAIs can also be generated via a workflow in METIS, but this functionality is not enabled in newly implemented proprietary systems like Pure.[56]

The DAI has limitations in that it exists only within the closed Dutch library and research information infrastructure, and fails to reflect the increasingly mobile and global scientific community. Another limitation is that DAI is far removed from the research and publication practices of researchers. Since the launch of DAI in 2005, there have been several other efforts to support author name disambiguation, notably non-proprietary, global efforts like ISNI and ORCID, as well as proprietary efforts like the author-claimed ResearcherID (Clarivate Analytics) and the algorithmically created Scopus Author ID (Elsevier). In addition, as most Dutch institutions have shifted to proprietary CRIS solutions and no longer use METIS as their institutional CRIS, the workflow for creation of DAIs is changing.

SURF, the collaborative ICT organization supporting Dutch education and research, convened a working group that examined the evolving landscape of person identifiers in 2014–2015, focusing particularly on ISNI and ORCID. This evaluation documented complementary strengths and weaknesses between ORCID and ISNI identifiers from a Dutch perspective:

- ORCID has advantages because it is embedded in the publisher and funder workflows, CRIS systems like Pure and Converis have already integrated into their products, and it

is researcher controlled. No separate national infrastructure is needed. However, it doesn't cover historical and cultural heritage works, currently has weak engagement with humanities and social science publications, and there are also membership costs for institutions.

- ISNI has advantages because it can be used for deceased researchers and can help support non-scientific content otherwise unsupported by ORCID identifiers. As a certified ISO standard assigned by authorized organizations and with centralized quality control by the British Library and the Bibliotheque nationale de France, librarians have greater confidence in ISNI as a canonical and verified identifier. However, ISNI adoption requires the establishment of a national infrastructure for minting ISNIs. Furthermore, it doesn't have any meaningful integration with CRIS systems like Pure, is separate from researchers, and is not embedded in publication workflows.[57]

The working group recommended a hybrid model for managing person identifiers in which both ISNI and ORCID identifiers are used for name disambiguation throughout the Dutch information landscape:

- ISNI is to replace DAI in all national infrastructures: CRIS systems, libraries, and NARCIS. ISNI was chosen because it offers persistent access, requires no activity on the part of researcher, can be minted retrospectively, and the quality is managed by national libraries.

- ORCIDs will also be used as the primary identifier for scholarly communications, and will be incorporated into CRIS systems, repositories, NARCIS, and even potentially support single sign-on functionality within SURFconext federated identity management for CRIS and other environments supporting research.[58] ORCID is perceived as the de facto standard for scholarly communications, as it is being incorporated into publisher and funder workflows, is integrated into publication indexes like Scopus, is researcher-managed, and can offer advantages for the automated integration of data into CRIS systems.

Today, Dutch institutions are in the midst of implementing this strategy. The intention is that both ORCID and ISNI identifiers be recorded in CRIS systems, but the transition is slow. While ORCID integration is delivered in proprietary CRIS products, it requires action by each researcher to enable. Currently, several Dutch universities have joined together in a consortial ORCID membership in order to save on membership costs and to share integration experiences. Dutch organizations are eager for improved functionality for ISNI in CRIS systems as well as between the ORCID and ISNI identifiers themselves.[59]

The process for assigning ISNIs is also in flux. The Netherlands has established a Dutch Registration agency for ISNI, and it is working to develop workflows to replace the previously well-developed infrastructure for minting DAIs. Specifically, locally and nationally developed infrastructure like METIS and DAIs had close integration with NTA data to support pre-populated queries to conveniently and accurately support DAI minting. There is no such integration between the newly adopted proprietary CRIS systems and the international identifier ISNI, the creation of ISNI requires consultation with multiple authoritative sources, and the current processes are very labor intensive and out of sync with scholarly communication publication workflows.[60] During this period of transition, many DAIs have been converted to ISNIs, but DAIs are still being minted while workflows are optimized. In time, the DAI is expected to be retired.

Ideally, ORCID and ISNI identifiers for the same person can also be linked together. Note that linkages between a user's ORCID ID and any other person identifier must be managed by the user or their trusted individual (delegate).[61]

ORGANIZATIONAL IDENTIFIERS

While every Dutch institution we spoke with expressed theoretical support for using more identifiers in more contexts, we found no efforts to adopt organizational identifiers within CRIS infrastructures. While some institutions reported that all of their resources were focused on implementing person identifiers now, other institutions stated that from their institutional point of view, there was "no real problem [for organizational identifiers] to solve." Indeed, while the DAI person identifier has been used to support national-scale aggregation of library, CRIS, institutional repository, and data archive content for the majority of Dutch research through NARCIS,[62] it's notable that this achievement has taken place without a national organizational identifier.

Through our conversations, Dutch librarians and ICT managers shared that they thought widespread adoption of an international organizational identifier could significantly improve name disambiguation problems when harvesting publication metadata from external indexes. The availability of organizational identifiers in publication metadata (like DOIs and ORCIDs), would significantly improve data quality and completeness. Organizational identifiers were seen as a necessity for transnational scaling. Some informants suggested that future reporting requirements by funders (seeking to better connect grants to outputs, persons, and organizations) may create a greater incentive for organizational identifiers within CRIS systems.

Dutch ICT and CRIS administrators didn't specifically mention an organizational identifier solution, although they did cite the need for openness, international scope, interoperability, and the ability to incorporate organizational identifiers into scholarly communications workflows. In the meantime, they continue to follow conversations about organizational PIDs in the international community.

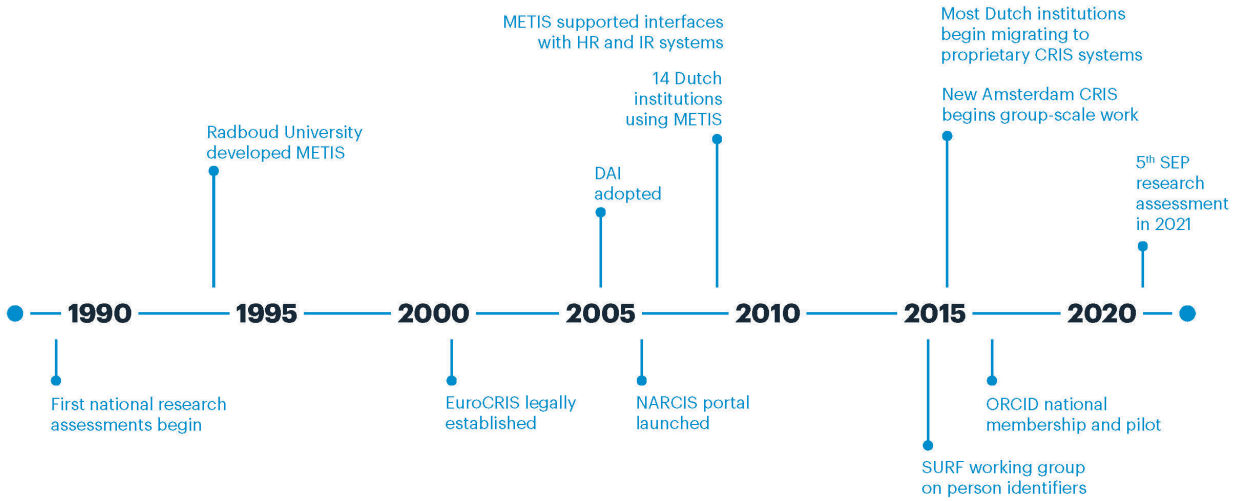

FIGURE 5. Timeline of Dutch Research Information Management

TABLE 1. Selected CRIS Implementations in Dutch Universities

University	Rim System	Comments and Links
University of Amsterdam	Pure	http://uba.uva.nl/en/news/midden/news/news/content/folder/2016/10/pure-goes-live.html
Vu Amsterdam	Pure	https://research.vu.nl
University of Groningen	Pure	http://www.rug.nl/bibliotheek/pure/
Leiden University	Converis	
Maastricht University	Pure	
Radboud University Nijmegen	METIS (with RIS researcher Interface)	http://www.ru.nl/research-information-services/
Erasmus University Rotterdam	METIS	https://www.eur.nl/researchmatters/add_publications/
Tilburg University	Pure	
Utrecht University	Pure	
Delft University of Technology (Tu Delft)	Pure	https://www.uu.nl/en/organisation/information-and-technology-services-its/services/research-support
Eindhoven University of Technology	Pure	https://avandeursen.com/2016/12/07/self-archiving-publications-in-elsevier-pure-at-tu-delft/ http://www.library.tudelft.nl/en/support/researchers/publishing-support/research-information-system-pure/ http://www.library.tudelft.nl/en/support/researchers/publishing-support/request-an-orcid/
University of Twente	Implementing Pure summer 2017	https://www.tue.nl/en/university/library/education-research-support/scientific-publishing/research-output-registrationuploading/implementing-pure/about-pure/#top
Wageningen University and Research	Pure	https://www.utwente.nl/metis/alginf/Metis-%20algemene%20info/
Hogeschool Van Amsterdam (Hva) or Amsterdam University of Applied Sciences (Auas)	Pure	http://www.wur.nl/en/newsarticle/Wageningen-UR-replaces-Metis-with-Pure.htm
Royal Netherlands Academy of Arts and Sciences (KNAW)	Pure	https://pure.knaw.nl/portal/

Research in Finland

National funding and reporting requirements

The two primary research funding bodies in Finland are the Academy of Finland, comprised of four research funding councils, and TEKES, which focuses on applied sciences and technology.[63]

With the shift to the "Management by Results" (MBR) approach to funding universities in the 1990s, the Ministry of Education undertook a re-evaluation of its university funding formula, which had long relied on performance indicators associated with the number of degrees granted, rather than direct assessment of research productivity or research performance per se. A specially appointed working group recommended that Finland adopt a process similar to the UK Research Assessment Exercise, with a rolling three-year review of research activity in Finnish Universities. However, the proposal met with stiff resistance from university administrators and was ultimately tabled. In this same period, the University of Helsinki developed an internal research assessment framework and proposed that it be shared across the Finnish higher education sector; ultimately, Helsinki was the sole institution to undertake a formal self-review.[64]

Following national university reforms in 2010, the Academy of Finland implemented changes in research funding allocations, in order to encourage differentiation of institutional research profiles at the 14 national universities. A university profiling funding program was officially launched in 2015. Individual universities are encouraged to devise their own strategies for identifying and assessing areas of research excellence, which are then submitted to the academy for competitive funding. Between 2015 and 2019, the academy expects to allocate a total of 50 million euros through the university profiling program.[65]

The Ministry of Education and Culture provides core funding to Finnish universities on the basis of institutional teaching and research performance. Research performance is judged in part by the volume of scientific publications produced by individual universities. Since 2011, the Ministry of Education and Culture has required that all Finnish universities provide publication metadata for all research outputs as part of the regular annual reporting cycle. The VIRTA publication database, which harvests metadata from university information systems, provides the data used in the annual research funding evaluation.

The quality of publications is assessed using a ratings system developed by the Finnish Publication Forum (JUFO). In the system, 23 expert panels consisting of leading Finnish scholars have rated the peer-reviewed publication channels used in each field into three categories based on their quality and importance. At present, 13% of university funding is allocated based on publication-based research ratings, 9% percent is based on the doctoral degrees awarded by the university. The VIRTA publication service was developed by CSC in 2016 to support the aggregation of publication data needed for the funding model; there are plans to pilot the use of this service on a European level.[66]

In recent years, national austerity measures in Finland have resulted in significant cuts to government funding for research in universities, and growing institutional competition for diminishing resources. Research funding from the Academy of Finland has dropped by 16% over

five years. Amidst concern over a growing "brain drain," as top researchers emigrate from Finland to other better-resourced countries, there is a new focus on institutional and faculty accountability, particularly focused on researcher productivity and publication activity.[67]

While there is no national open-access mandate in Finland, nor any fixed targets comparable to those in the Netherlands, there is longstanding support for increasing public access to research publications. Four of the universities (Aalto, Helsinki, Jyväskylä, and Tampere) have open-access policies encouraging or requiring authors to self-archive publications in a local institutional repository. The National Library of Finland provides centralized repository services and monitors progress toward open-access publishing goals, tracking the share of publications from each research university that are made available through "green" (institutional repository) or "gold" (publisher) channels. This monitoring relies on metadata harvested from university CRIS systems; thus, institution-scale RIM infrastructure is a critical component of national-scale RIM service provision. An assessment from 2017 reports that more than 28% of peer-reviewed articles produced by Finnish research universities in 2016 are available via open-access channels.[68]

A national open science initiative (ATT) was launched in 2014 to establish Finland as "one of the leading countries in openness of science and research by the year 2017." A formal assessment of this initiative in 2016 noted the importance of libraries in advancing the national open science agenda, with the National Library of Finland taking the lead on promoting and enabling broader participation in open access. The assessment report notes that "libraries understand they cannot carry out a cultural transformation on their own," but rather must work with institutional allies in research administration and campus computing to build support and awareness. While the importance of national infrastructure for open-access publishing and long-term preservation was acknowledged, library investments in supporting RIM (including adoption and integration of persistent identifiers) were not identified as important contributors to improving transparency in scientific practice or scholarly communications. As one Finnish informant in our study observed, institutional CRIS implementations predate the national (and international) open science agenda and continue to be driven primarily by local incentives to maximize research productivity and increase university research income.[69]

Research information infrastructures and research information practices

INSTITUTIONAL CRIS SERVICE PROVISION

Implementation of institution-scale CRIS is ubiquitous in Finnish universities. Each of the 14 universities has a commercial CRIS implementation in place. In contrast to the Netherlands, where the institutional CRIS landscape is dominated by a single provider, market share in Finland is equally distributed across three providers and products: Converis (Clarivate Analytics), Pure (Elsevier), and SoleCRIS (Solenovo). Many of the proprietary CRIS systems were launched in 2015–2016, as they were needed to supply the publication data collected for the new university funding model.

Five Finnish universities are members of euroCRIS: Aalto University, the University of Helsinki, the University of Tampere, Tampere University of Technology, and Hanken School of Economics.[70]

A list of CRIS implementations in Finnish universities is included below.

NATIONAL-SCALE RIM SERVICES IN FINLAND

Efforts to aggregate research information on a national scale in Finland date back to the 1970s, when the Ministry of Finance awarded a contract to the Technical Research Centre of Finland (VTT) to develop a digital registry of research outputs that was intended to serve as a model for a national research information system. In the years that followed, however, research information management—including the registration of researcher outputs—was primarily organized at institution scale, with individual universities and research institutes developing bespoke local systems. Following an unsuccessful effort in 1989 to develop a national research register, the Ministry of Education instead decided to develop guidance for standards-based systems to be implemented by individual universities; a formal recommendation was made that universities should monitor and manage research activity locally.

Since 1991, the Ministry of Education has followed a "Management by Results" (MBR) approach to funding universities, and this has encouraged broad implementation of management systems for performance assessment of teaching and research at all universities.[71]

Publication metadata for university research outputs is aggregated in the national Juuli portal; most of the metadata is contributed through annual university reporting, but some institutions contribute data via a harvesting mechanism through the VIRTA registry operated by CSC, a central ICT provider. Metadata for research data sets are aggregated nationally in the Etsin portal. A national Higher Education Data Model (XDW), developed by CSC, supports the exchange of data between university data warehouses and the national VIRTA registry. The XDW data model is described as "loosely CERIF compatible."

There is currently a project underway to develop a new data model to support a national Research Information Hub integrating information about researchers, research publications, related infrastructures (laboratories and equipment), and funding. This work is led by CSC and is expected to result in a data model and general service framework by 2020. CSC also coordinates the national Network of Research Services and Administration (TUHA), a forum where research administration professionals (including CRIS system administrators and librarians) exchange information and develop best practices related to research data management, research assessment, bibliometrics, data architecture, persistent identifiers, and science policy. The TUHA network currently comprises more than 300 members, including representatives from comprehensive research universities as well as universities of applied science and research institutes.[72]

Since 2011, the Ministry of Education and Culture has collected the research publication metadata from the universities. The focus of the data collection has later expanded to include the universities of applied sciences, state research institutes and central hospital districts as well. The systems and processes used in the data collection are coordinated by CSC, an ICT company owned by the Ministry of Education and Culture.

In 2016, CSC launched the VIRTA publication service, a data warehouse system, which has extensive APIs both for the automatic ingestion of the data in a XML format and for the reuse of the data in other systems. The custom XML format used in VIRTA is not based on CERIF, but the data is loosely compatible with it. Some institutions contribute their data via a harvesting mechanism to

the VIRTA registry, some of them provide it on an annual basis. The publication data collected into VIRTA can be viewed at Juuli, a VuFind-based research publications portal developed by the National Library of Finland.[73] Metadata for research data sets are aggregated nationally in the Etsin portal developed by CSC.

The National Library of Finland provides a range of national-scale services for research information management, including a national digital repository (DORIA, used primarily by universities that lack local repository infrastructure) and persistent identifier services. The latter include a URN generator, for assigning persistent identifiers to digital documents, and a partnership with ISNI to improve coverage of Finnish researcher/author names and organizational identifiers in the ISNI database. While the National Library is not an official assignment agency, it is a member of ISNI and (starting in 2016) has begun loading organization names for Finnish institutions for eventual ISNI identifier assignment.[74]

Adoption and integration of persistent identifiers

PERSON IDENTIFIERS

In contrast to the Netherlands, Finland has succeeded in harvesting publications from local CRIS systems without use of a national person identifier. However, de-duplication of bibliographic metadata and achieving comprehensive coverage of university research outputs pose significant challenges. In 2016, Finland's Ministry of Education and Culture commissioned CSC to develop and pilot a national service to connect individual ORCID identifiers with institutional identity management systems. A high-level goal of this initiative is the integration of personal information from university human resource systems with publication metadata, enabling better centralized tracking of national research activity.[75]

CSC currently manages the Finnish ORCID consortium and is working with individual universities to encourage researchers to register with ORCID. Researchers are strongly encouraged to claim and use ORCID identifiers; however, there is no mandate from the Ministry of Education and Culture.[76]

The Finnish ORCID consortium comprises 13 institutions, including the following universities: Tampere University of Technology, University of the Arts Helsinki, University of Helsinki, University of Jyväskylä, University of Turku, and University of Vaasa.[77]

We found no initiative in Finland comparable to the DAI/ISNI efforts in the Netherlands, which seek to centralize management of researcher name identifiers. None of our interview subjects reported any integration of national name authority files in CRIS or RIM workflows.

ORGANIZATIONAL IDENTIFIERS

The institutions interviewed for this project all reported using local system identifiers for organizational units (university departments, research laboratories, etc.) in institutional CRIS infrastructure. There is no agreement on the likely source of authoritative organization identifiers, though several interview subjects are monitoring the CrossRef/DataCite/ORCID organizational identifier working group.

One informant acknowledged that the increased internationalization of university research activity, and the growing need to track and report on international collaborations is creating new incentives for global standardization of organizational identifiers. Another observed that management of organizational identifiers for Finnish universities is not especially challenging, given the relatively small scale of the national university system. Contrary to our expectations, none of our interview subjects regarded the university mergers of 2010 as a particular challenge to institution-scale RIM workflows or management of organizational identities in CRIS systems.

The National Library of Finland has contributed approximately 40,000 organization names from the national authority file to the ISNI database for identifier assignment. At the time this profile was completed, ISNI assignment was still pending.[78] Among the countries examined in this project, Finland was unique in having national-scale investment directed at encouraging the adoption and integration of organizational identifiers in RIM systems.

OTHER IDENTIFIERS

CSC maintains a national registry of research infrastructure (laboratory equipment, data resources, ontologies, and thesauri) in Finnish universities and other research organizations. Only infrastructure funded by the Academy of Finland is currently included. URNs are used as persistent identifiers for these items. None of the institutions interviewed for this project are currently integrating these identifiers in local CRIS systems.[79]

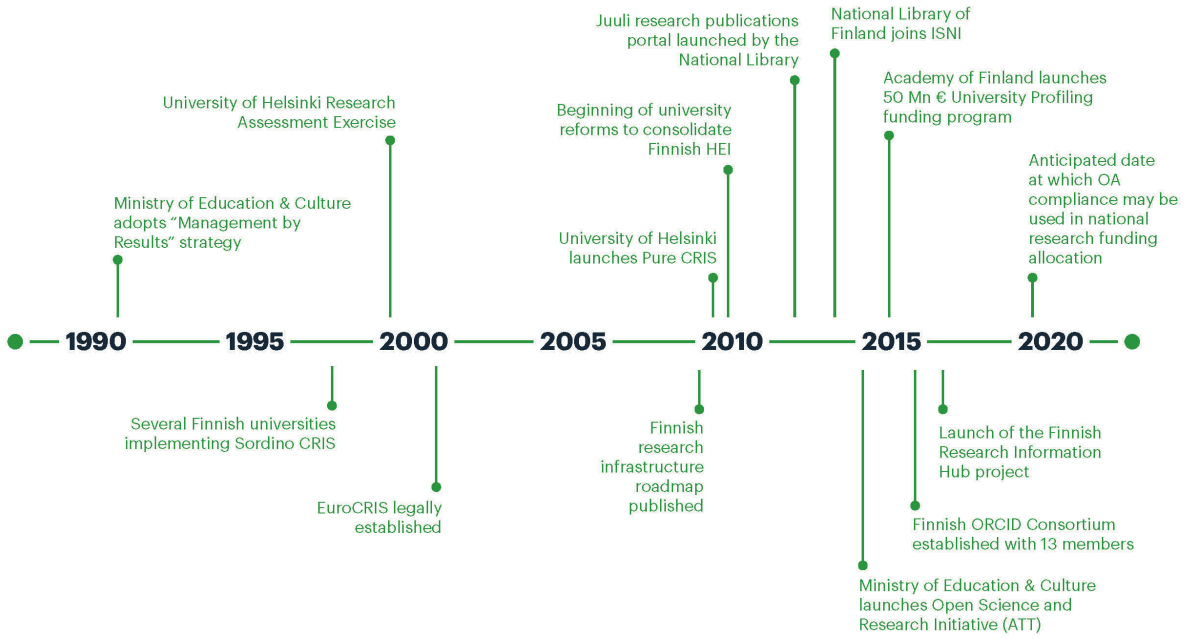

FIGURE 6. Timeline of Finnish Research Information Management

TABLE 2. Selected CRIS Implementations in Finnish Universities

University	Rim System	Comments and Links
Aalto University	Pure	https://research.aalto.fi/en/
Åbo Akademi University	Converis	http://research.abo.fi/converis/publicweb/startpage?lang=1
Hanken School of Economics	Pure	http://hanken.halvi.helsinki.fi/portal/en/ [system is hosted by the University of Helsinki]
Lappeenranta University of Technology	Converis	http://research.lut.fi/converis-lut/publicweb/listPage?show=PUBLICATION&filterQueryString=&fsearchkey=&fcypher=All&page=1&sortBy=PUBLICATION_YEAR&sortAsc=false&items=10&freset=true&showAsTree=false&showAll=&lang=1
Tampere University of Technology	Pure	https://tutcris.tut.fi/portal/
University of The Arts Helsinki	SoleCRIS	https://cris.uniarts.fi/crisyp/disp/_/en/welcome/nop?kieli=1&menuid=0
University of Eastern Finland	SoleCRIS	ivi.uef.fi/crisyp/disp/3_/en/welcome/nop?menuid=0
University of Helsinki	Pure	https://tuhat.helsinki.fi/portal/en/
University of Jyväskylä	Converis	https://converis.jyu.fi/converis/portal?lang=en_GB
University of Lapland	Pure	https://lacris.ulapland.fi/en/
University of Oulu	SoleCRIS	https://solecris.oulu.fi/crisyp/disp/_/en/welcome/nop?kieli=1&menuid=0
University of Tampere	SoleCRIS	https://solecris.uta.fi/crisyp/disp/_/en/welcome/nop?kieli=1&menuid=0
University of Turku	Converis	https://research.utu.fi/converis/portal?lang=en_GB
University of Vaasa	SoleCRIS	https://taika.uwasa.fi/crisyp/disp/_/en/welcome/nop?kieli=1&menuid=0

Research in Germany

National funding and reporting requirements

The German research landscape with its over 100 universities and 1,000 public and publicly funded institutions for science, research, and development is characterized by great heterogeneity in terms of type and size of research locations, federal- and state-level policies governing research, funding options available, and reporting practices in place, with different conditions in the individual federal states, and a focus on freedom of research as well as institutional autonomy of universities.[80]

Research funding is provided by many different organizations and institutions, among which the Deutsche Forschungsgemeinschaft (DFG) and government programs at the federal and the state level play the most important role by far. A good third of all third-party funding granted to German universities comes from DFG. Since 2005, a special funding program called Excellence Initiative was created and later expanded by the Excellence Strategy, with the objective of strengthening the competitiveness of German research. The Clusters of Excellence funding line within that program, under the responsibility of DFG, provides funding for research projects. The Universities of Excellence funding line, in the responsibility of Wissenschaftsrat (German Council of Sciences and Humanities), is more focused on strengthening and developing research conducting institutions (universities or university consortia) in the longer term.[81]

While competitiveness is embraced, research assessment or evaluation in Germany is lightweight compared to other countries in Europe such as the UK or the Netherlands. The Humboldt Ranking measures attractiveness of research institutions to international researchers. Creating transparency regarding funding sources, the very popular CHE Ranking developed by the Centrum für Hochschulentwicklung (Centre for Higher Education) compares study programs to help students make decisions on where to study, by subject, and some German institutions participate in international rankings such as Times Higher Education World University Rankings. But national reporting mandates are not in place at all, and existing methods of evaluating research projects, e.g., as part of the Clusters of Excellence funding line, are focused on qualitative aspects. In 2013, a national research assessment ("Forschungsrating"), ased on informal peer-review and by discipline was recommended by Wissenschaftsrat. The proposal was presented and discussed, mostly positively, in the science community during 2013 and early 2014. However, the rating was never introduced.[82]

Instead, universities and research institutions were asked to collect data on their research activities and make it available in a standardized national format, the Kerndatensatz Forschung (KDSF - Research Core Dataset). This (mostly) CERIF-compatible standardized data set was developed with involvement of many stakeholders; version V1.0 of its specification was published in 2015. The project was initiated by the Wissenschaftsrat, with funding from the Federal Ministry of Education and Research, BMBF. The KDSF was intended to be a minimal data set suited for usefulness in as many contexts as possible, and designed to interfere as little as possible with the decentralized management of research information and institutional reporting processes. Adoption of the KDSF is recommended, but optional. Regional initiatives such as CRIS.NRW in North-Rhine-Westfalia (NRW)

and HeFIS in Hesse are expected to provide support around implementation of KDSF as part of their wider interest in the implementation of CRIS systems at the federal state level. It remains to be seen which effects, if any, the KDSF will have on the research information landscape in Germany.[83]

Another area in which national mandates are not in existence, for similar political reasons, is open access. Open access is actively supported and recommended by many parties, including the federal government, but there is no national mandate or measurable objectives shared by all stakeholders in the community. In its open-access strategy, the federal government supports initiatives to make open access the standard for scientific publishing in Germany, but implementation of open access and the development of a comprehensive open-access culture is seen as the responsibility of the scientific community. Federal states are encouraged to incentivize open-access policies in universities. Funders are encouraged to recommend open-access publication. Some research organizations have targets for open access, such as Helmholtz or Fraunhofer, which aim at making 60% and 50% of publications, respectively, open access by 2020. There is a lot of activity in creating an open-access friendly environment.[84]

Research information infrastructures and research information practices

INSTITUTIONAL CRIS SERVICE PROVISION

In sharp contrast to national adoption in the Netherlands and Finland, there is no widespread adoption of CRIS systems in German universities today. Exact figures are not easily available, but surveys conducted among universities in 2014 (all of Germany) and 2016 (state of NRW only) revealed that only 10% to 15% of the responding institutions had fully integrated CRIS systems in place. A larger group of universities is relying on systems covering some aspects of RIM such as research portals, university bibliographies or project databases. These are often self-developed, and a still small but growing number of institutions are in the process of implementing one of the available proprietary CRIS solutions.[85]

The key reasons for the comparatively hesitant uptake of fully integrated CRIS in Germany lies in the peculiarities of the German science system described above, with its lack of those national mandates that have been significant drivers to professionalizing the research information landscape in other countries, such as reporting mandates, assessment regimes, or OA directives.

System adoption in the RIM space is intensely locally driven in Germany. This also accounts for the many problem-specific systems developed in the past. Whatever is implemented is done so to meet institutional needs after careful consideration of all options; the fully integrated CRIS being just one of them. The absence of external mandates leaves room for conscious discussions of cost and benefit expected. Personal and financial effort involved in the implementation, coordinational challenges, or lack of support for such projects by either researchers or university leadership are all important barriers to adoption of a fully integrated CRIS.[86]

This has not prevented uptake of CRIS systems in those institutions that did implement them comparatively early, such as the University of Kassel, where a local system was developed as early as 1997 before it was later replaced with a proprietary solution; the University of Münster; or Leuphana University of Lüneburg, which all had CRIS systems in operation by 2011.

The 2007 Excellence Initiative, although not a key driver, did have some influence on developments. Faced with the need to register research activities, the lack of ability to identify focal points of institutional research for decision support became evident to the university leadership. Local information needs changed—and lack of research information transparency was suddenly uncovered.

Some institutions began to look at CRIS in order to learn about research activities across all departments, to compile research information at the institution (university) level—in short, to support strategic decisions with business intelligence data. For others, ROI is not so clear. In 2015, it was suggested that empirical studies on the effects of CRIS implementations, covering implementation, cost and benefits, and also end user feedback, could provide some justification for future implementation projects in research institutions.[87]

This perceived "lack of justification for CRIS implementations" makes Germany stand out, at least within the scope of this study. However, there are similarities between the German and US RIM landscapes: both are highly decentralized centers of high research productivity with few national-level mandates for either reporting on research productivity or open-access compliance. Institutions in both countries respond to mandates for national-level educational reporting. US institutions, as in Germany, are now beginning to develop RIM capacity to address local needs such as improving faculty activity reporting, decision support, and demonstrating research activity through public profiles.

It remains to be seen if the slowly growing number of institutions implementing proprietary CRIS solutions in Germany today means that Germany is going to "catch up" over time. The German science and RIM landscapes are likely going to remain heterogeneous—and interesting to watch—for the foreseeable future.

GROUP AND NATIONAL SCALE RIM SERVICES IN GERMANY

A national CRIS, aggregating content from institutional CRIS systems and other sources, does not exist in Germany and is not planned; this is not surprising given the state of local CRIS adoption, but also in view of the political landscape. Only some state-scale or discipline-specific initiatives to bundle research project information are in place, such as SciPort RLP in Rhineland-Palatinate or Research Profiles of Niedersachsen in Lower Saxony, and the GESIS-SOFIS research portal for the social sciences.[88] Along the same lines, a national open-access repository does not exist either. The Bielefeld Academic Search Engine (BASE), however, has a coverage of 94% of all open-access repositories in Germany and is the best of comparable aggregators. It hence serves as a de facto national repository with additional international content, covering this important part of most RIM infrastructures.[89]

As a funder, DFG runs a database of current DFG-funded research projects, GEPRIS. It is accessible online, and is considered an important and authoritative source of project information (including project identifiers) for CRIS systems. However, it could be even more useful as a scaled service if better data exchange options existed.[90]

Adoption and integration of persistent identifiers

PERSON IDENTIFIERS

ORCID is seen as the de facto standard identifier for researchers in Germany. By June 2017, 78,000 ORCID iD records were registered in Germany, which accounted for 22% of all researchers (FTE) in the country[91]. ORCID had been widely discussed in Germany since at least 2014. It was recommended by DINI AG ePub (Electronic Publishing) for use in repositories to link author names, and by DINI AG FIS (Research Information Management Systems) for use as person/researcher identifier in CRIS systems. In the context of the KDSF, the use of identifiers was highly recommended by Wissenschaftsrat, and ORCID was explicitly mentioned as one of the recommendable identifiers[92].

In 2016, the ORCID DE project, initiated by DINI and funded by DFG, was launched with the stated intention to boost ORCID adoption in Germany and more specifically to support institutions considering ORCID implementation. ORCID DE is a collaborative effort: Helmholtz Open Science Koordinationsbüro at Deutschen GeoForschungsZentrum (GFZ) lends its expertise in the areas of open science and persistent identifiers. Deutsche Nationalbibliothek, operating GND, adds its expertise in standardization initiatives nationally and internationally, and Universitätsbibliothek Bielefeld, operating BASE, brings in expertise in aggregation and enrichment of OAI-metadata and in search engine–based indexing. Potential legal concerns were addressed by a legal assessment that was conducted as part of the project, to identify or eliminate a potential barrier to institutional adoption upfront. In 2017, it confirmed ORCID to be a best practice example from a data protection point of view.[93]

The ORCID DE project is not primarily driven by integration needs of existing local or national CRIS infrastructures, or a need to replace or enhance an existing researcher identifier infrastructure, such as in the Netherlands. Project objectives are not very specific on what systems to integrate with, and most of all why, however, with some highly visible exceptions.

As part of the project, an ORCID claiming service was developed for BASE, which allows users to claim their ORCID identifier for publications listed in BASE from within the BASE interface. The ORCID ID is then displayed after the author's name in BASE, and the ORCID record updated with publication information from BASE, given author approval. Discovery services in BASE that will use ORCID are in development. All of this will add value to BASE as a metadata source[94].

Another part of the project aims at interoperability of GND with ORCID. Since 2015, ORCID IDs can be entered in GND, and are included as "same as" relationships in the linked data representation of GND; similar functionality is planned for other identifiers such as ScopusID, ResearcherID, and ISNI. The ORCID DE project objectives for GND are defined as linking identifiers, developing semi-automatic linking mechanisms, and aggregation of metadata from both sources, to complete author profiles. Ideally, whenever an identifier is created in one of the two systems, a search is prompted in the other and an existent identifier is linked. The ORCID-GND initiative is part of a larger plan for GND to become a linking hub in the landscape of identifiers, and to serve both scientific and cultural heritage communities in addition to the library world in the longer term.[95]

An early—and at this stage rather unexpected—effect of the ORCID DE project, is that 18 institutional members signed up in October and November 2016 alone to form the ORCID Germany Consortium, thus indicating serious institutional level interest and investment. The key incentives for institutions to become ORCID member institutions so far lies in a mix of name disambiguation, authoritative institution names, and publication harvesting, i.e., expectations regarding more complete publication lists for the university. It remains to be seen what the key benefits for local institutions will be once additional mature implementations are in place.[96]

In late 2016, PANGAEA, an open-access library for georeferenced data, released functionality that allows users to claim authorship for datasets they have deposited with PANGAEA. In June 2017, 9% of registered users had their account linked to ORCID.[97]

In comparison, apart from ORCID, other person identifiers, such as GND, ISNI, Scopus Author ID, or ResearcherID, play marginal roles or none at all in the German RIM landscape today.

ORGANIZATIONAL IDENTIFIERS

Adoption of organizational identifiers is hardly traceable for Germany. While some German institutions have GRID identifiers registered, and there is anecdotal evidence for usage of GND or other external identifiers in local systems, there is no evidence of a systematic approach or a shared understanding as to which organizational identifier might emerge as a standard.[98]

A group of identifiers that might provide some real benefit for local institutions are DFG identifiers for persons, organizations, and even projects, if only effective data exchange options were available, which—to the regret of many—they are not.

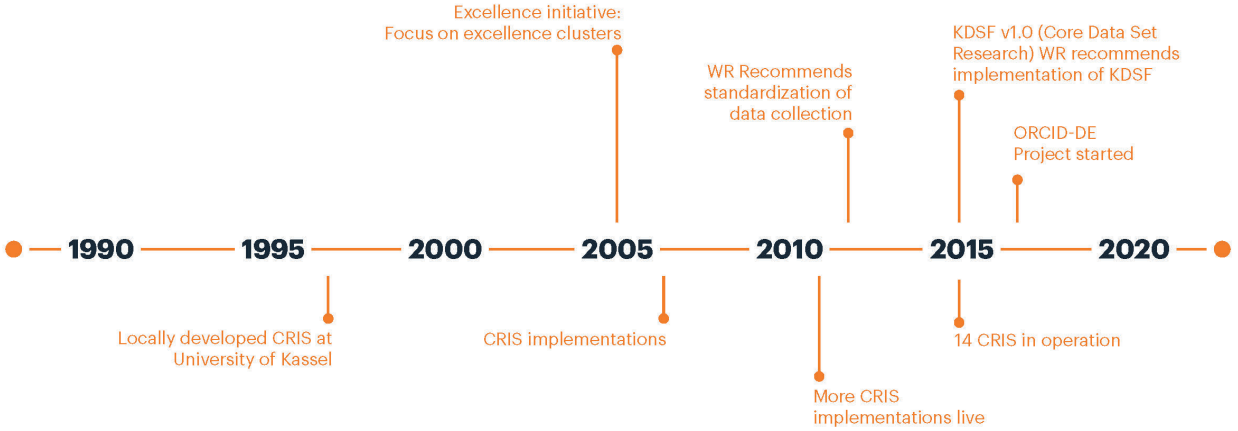

FIGURE 7. Timeline of German Research Information Management

TABLE 3. Selected CRIS Implementations in German Universities

University	Rim System	Comments and Links
Humboldt-Universität Zu Berlin	Converis	https://fis.hu-berlin.de/converis/publicweb/startpage?lang=2
Friedrich-Alexander-Universität Erlangen-Nürnberg	Converis	https://cris.fau.de/converis/publicweb/startpage?lang=1
Universität Kassel	Converis	http://forschung.uni-kassel.de/converis/portal?lang=en_GB
Leuphana Universität Lüneburg	Pure	http://fox.leuphana.de/portal/en/
Westfälische Wilhelms-Universität Münster	Converis	https://www.uni-muenster.de/forschungaz/area/3763?lang=en

GLOSSARY

GENERAL

CERIF: Common European Research Information Format is a data model for defining research entities and their relationships, and is recommended by the European Union for use by its member states to facilitate improved information sharing and benchmarking. The CERIF standard is maintained by euroCRIS.

CRIS: Current Research Information System (CRIS) is used to refer to a database or system used to manage institutional research information, including researcher names, publications, research activities (projects, events, etc.) and infrastructure (laboratories, scientific equipment, and the like).

CORDIS: Community Research and Development Information Service. European Commission's primary portal for results of EU-funded research projects.

euroCRIS: A Dutch-based non-profit membership organization established in 2002 to foster "collaboration within the research information community and advance interoperability through CERIF."

ICT: Information and communications technology (ICT) organizations, such as SURF (Netherlands) and CSC (Finland).

ISNI: International Standard Name Identifier, ISO 27729. ISNI is an identifier for the unique identification of public identities across all fields of creative activity, governed by a nonprofit ISNI-IA (International Agency). The ISNI database, operated by OCLC on behalf of the ISNI-IA, is a cross-domain resource with contributions from a variety of reputable sources, including authority files, rights management societies, the music industry, and book suppliers. In addition, ISNI accepts input from the general public that is monitored by the ISNI Quality Team headed by the British Library and Bibliothèque nationale de France.

LIBER: Ligue des Bibliothèques Européennes de Recherche (Association of European Research Libraries) is Europe's largest network of research libraries, with over 400 members.

OpenAIRE: Open Access Infrastructure for Research in Europe. Network of open-access repositories, archives, and journals that support open-access policies.

ORCID: Open Researcher and Contributor ID. The ORCID iD is a unique, persistent identifier for researchers. ORCID requires researchers to self-register and maintain their own records. When researchers use their ORCID iDs when submitting a paper to a publisher, they can have their ORCID record automatically updated (via CrossRef or DataCite) upon publication.

PID: Persistent identifier.

RIM: Research Information Management. OCLC Research defines RIM as is the aggregation, curation, and utilization of metadata about research activities. Research information management systems collect and store metadata on research activities and outputs such as researchers and their affiliations; publications, datasets, and patents; grants and projects; statements of impact, and much more. The term is largely analogous to the term CRIS, which is widely used in Europe.

THE NETHERLANDS

DAI (Digital Author Identifier): is a unique, persistent identifier assigned to Dutch researchers as a form of authority control.

DANS: Data Archiving and Networked Services. DANS focuses on three core services: data archiving, data reuse, training, and consultancy. DANS is an institute of KNAW and NWO.

DANS-EASY: provides a web-based interface for uploading research datasets to a national-scale research data preservation repository and issues DOI and persistent URLs for data contributed to the archive. Most content is open access. DANS data is discoverable in NARCIS.

KB: Koninklijke Bibliotheek or National Library of the Netherlands.

KNAW: Koninklijke Nederlandse Akademie van Wetenschappen, or the Royal Netherlands Academy of Arts and Sciences, supports the advancement of science and the arts in the Netherlands. It operates several research institutes and awards prizes for outstanding contributions to Dutch scholarship.

METIS: CRIS software developed by Radboud University Nijmegen in 1993, and soon adopted by other Dutch research universities and KNAW.

NARCIS: The National Academic Research and Collaborations Information System is the Dutch national portal for scholarly information. NARCIS collects and provides access to content collected from all Dutch research universities, Dutch universities, KNAW, NWO, and a number of research institutes. NARCIS combines data from three distinctive types of sources: institutional CRIS systems, digital academic repositories, and research data sets, including those from the 4TU archive and the DANS-EASY archive. NARCIS provides open access to nearly 500,000 publications and datasets.

NTA: The National Thesaurus of Author names, the Dutch national authority file.

NWO: Nederlandse Organisatie voor Wetenschappelijk Onderzoek, or Netherlands Organisation for Scientific Research is the Dutch national research council, within the Dutch Ministry of Education, Culture, and Science. NWO provides research funding for researchers at Dutch universities and institutes. It also has eight of its own research institutes.

SEP: Standard Evaluation Protocol. Research at all Dutch research universities and institutes is assessed every six years using the SEP, which is jointly defined by KNAW, VSNU, and NWO.

SURF: A national cooperative focused on information and communications technology (ICT) in Dutch higher education and research. SURF has three distinctive sub-organizations within its non-profit makeup. SURFnet develops and operates a trusted, shared ICT infrastructure network. SURFmarket negotiates with ICT providers on behalf of member institutions. It also supports software licensing for faculty and students. SURFsara is the Netherlands' national supercomputing center, which supports tech transfer activities and supplies high-performance computing services and data storage to the academic and business communities.

UKB: is a library consortium comprised of 13 Dutch university libraries and the KB.

VSNU: The Association of Universities in the Netherlands is a consortium of 14 Dutch research universities and serves an advocacy function to political and civic audiences.

4TU: is a consortium of four Dutch technical universities (TU Delft, Eindhoven University of Technology, University of Twente, and Wageningen University & Research). These institutions collaborate on the 4TU.Centre for Research Data (formerly known as 3TU.Datacentrum) for managing, archiving, and sharing research data. 4TU datasets are discoverable in NARCIS.

FINLAND

ATT: Finnish Open Science and Research Initiative, sponsored by the Ministry of Education and Culture of Finland.

CSC: A state-owned ICT service provider serving the Finnish Higher Education and Research sector.

DORIA: National institutional repository service provided by the National Library of Finland, based on DSpace.

Etsin: National aggregation of research data sets.

JUFO: Research publication rating and classification system used in the quality assessment of Finnish university research activity, managed under the auspices of the Federation of Finnish Learned Societies (TSV).

JUULI: National research publications portal managed by the National Library of Finland in conjunction with CSC and the Ministry of Education and Culture.

SoleCRIS: A commercially licensed CRIS system developed by Solenovo and implemented by several Finnish universities.

VIRTA: A registry of student achievement in Finnish universities, including details on course of study and institutional degrees awarded; managed by CSC.

VTT: Technical Research Centre of Finland is a state-owned technology company focused on applied science and technology transfer.

GERMANY

BASE: Bielefeld Academic Search Engine, operated by Bielefeld University Library. BASE is one of the world's most voluminous search engines especially for academic web resources with more than 100 million documents from more than 4,000 sources, and OA full texts available for about 60% of the indexed documents.

CRIS.NRW: Initiative to provide support for the implementation of KDSF and of CRIS systems in universities and universities of applied sciences in the state of North-Rhine-Westfalia.

DFG: Deutsche Forschungsgemeinschaft. Primary third-party research funder for higher education institutions.

DINI: Deutsche Initiative für Netzwerkinformation or German Initiative for Network Information, founded to coordinate and support the management of changes in information infrastructures of higher education institutions and other research institutions.

DINI / AG FIS: DINI workgroup on the implementation and operation of CRIS systems.

DINI / AG ePub / Electronic Publishing: DINI workgroup on electronic publishing with a focus on open access.

FIS: ForschungsInformationsSystem, which is a German language equivalent to CRIS.

GEPRIS: German Project Information System. DFG online database of current DFG-funded research projects.

GND: Gemeinsame Normdatei or Integrated Authority File. Authority file for Persons, Corporate bodies, Conferences and Events, Geographic Information, Topics and Works for German speaking libraries in Germany, Austria, and Switzerland.

HeFIS: FIS (CRIS) in Hesse. Cooperative for the implementation of CRIS systems in Hesse.

HRK: Hochschulrektorenkonferenz or German rectors' conference. Association of public and government-recognized universities and other higher education institutions in Germany.

KDSF: Kerndatensatz Forschung or Core Dataset Research. Data set and exchange format for research information.

Research Explorer: Research directory operated by DFG, contains information about universitarian and non-universitarian research institutes in Germany.

SciPort RLP: Science portal Rhineland-Palatinate, Germany.

Wissenschaftsrat: German Council of Sciences and Humanities.

Appendix A: Discussion topics for interview

This list of topics was shared with interview partners prior to interview discussions.

General Questions

0. Introductions. Can you describe your current and past roles supporting research information management?
1. Can you remark on what are the primary drivers for research information management infrastructure at:
   - Your local institution?
   - Your regional/national context?

Questions about research information management

2. Tell us about your CRIS/RIM implementation. What are/were the goals? Who are the players? And what does the system do? Has (any/all of) this changed over time?
3. How do researchers use and interact with the CRIS/RIM?
4. Can you describe how data from the CRIS is used in other systems, such as other university information systems, but also national/regional/disciplinary infrastructures? If so, what are the effects of this? How do you see (any/all of) this changing in the future?
5. Specifically for Finland: Effects of institutional mergers on CRIS/RIM?

Questions about Persistent Identifiers

6. Tell us about person identifiers (identifiers for researchers and authors) in your CRIS. Are you including ORCID, ISNI, national identifiers or authority files, etc.? Is assignment or 'claiming' of person identifiers something the university library has a role in? What is the value of the different person identifiers? If you are using multiple identifiers, are you working to link these? And how?
7. Tell us about the use of organizational identifiers in your CRIS. Could you tell us about your current practice and needs for the future?
8. Other identifiers in use?
9. Data models? Do you use CERIF? Others?

Other CRIS/RIM questions, as time permits

10. How do you know that implementing CRIS/RIM functionality is successful? How do you measure ROI?

Appendix B: Interview script and notes template

This template was used to prepare the interview with institution specific questions, and during the interview for note-taking. Additional aspects or clarifying questions were taken on board as research progressed, without changing the general flow of the interview.

<Institution> interview

- Institution:
- Informant(s):
- Date:
- Link to their CRIS portal:
- Notes:

Introductions

OCLC Research is engaged in a joint research collaboration with LIBER, exploring the adoption and integration of persistent identifiers in European research information management (RIM) infrastructures. We are particularly interested in examining how research information management practices are being adopted and scaled at the local, national, and even transnational scales. Persistent person and organizational identifiers are critical infrastructure necessary for scaling, and we are interested in individual, local, and national decision making and practices.

In talking with you today, we are interested in learning more about how CRIS infrastructure works at scale in <country>. We are eager to learn more about the status of identifier adoption--and what needs must be satisfied to encourage greater adoption and integration.

Our primary research team is on our call today:

- Senior Program Officer Rebecca Bryant
- Research Scientist Constance Malpas
- Senior Product Manager Annette Dortmund

Constance & I are based in the United States; Annette is based in Germany.

We also have additional research engagement from members of the LIBER Steering Committee on Scholarly Communication & Research Infrastructures.

We will be recording today's conversation (any objections?), but this is only to support our own knowledge and research. Neither the recording or any transcript will be shared outside the OCLC-LIBER research team.

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