"All roads lead to Rome": Establishing Best Practices for the Implementation and Introduction of a CRIS: Insights and Experiences from a CRIS Project at the University of Münster

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Summary

The management of research information becomes more and more important and essential for universities to strengthen and manifest their position in the competitive research environment. In order to facilitate these tasks, an increasing number of German universities launched projects to introduce research information systems. However, the development and introduction of a university-wide research information system tend to be a sophisticated task. The goal of this paper is to support this task by discussing procedures for the implementation and introduction of research information systems based on the experience of a university-wide project at University of Münster and in this way to establish common practices.

1 Research Information Systems as an Instrument for the Dissemination of Research Information

„Science is a global enterprise." (Royal Society 2011) The current research landscape is significantly characterized by two potentially conflicting properties: competition and collaboration (cf. Lis 2011). In order to position itself in an increasingly evaluation based competition about scientific reputation, talents and (financial) resources, universities are confronted by the challenge to actively communicate the research activities and results and thus to turn out the own research strengths and make them sustainably visible (Gläser et al. 2008; Krücken & Maier 2006; Münch 2006; Walstad 2002). Driven by the complexity of current research problems and the accompanied international and interdisciplinary orientation, universities have to promote their research potential in order to attract research partners from other disciplines and countries (Royal Society 2011; Carayol & Matt 2004; Fox 1992).

Against this background universities are more and more interested in communicating information about the own research activities and results to the different stakeholders and hereby achieve distribution, reputation, acceptance and application (Cheng et al. 2008). However, for the universities it is more difficult to extract, consolidate and communicate the required research information beyond the borders of single disciplines and research federations (Krücken & Meier 2009; Bovelet 2006; Fox 1992). In order to facilitate these tasks in an efficient and effective way, an increasing number of projects are launched at German universities to introduce research infor-

mation systems, with the goal to provide a university-wide integrated management, provision and communication of research information.

Comparable to the introduction of a company-wide software solution, the development and introduction of a university-wide research information system is a sophisticated task (Akkermans & van Helden 2002; Somers & Nelson 2001; Estevens & Pastor 2000). Reference models like the Common European Research Information Format (CERIF) (Jörg et al. 2012) or Knackstedt (Knackstedt et al. 2009) propose universal data models for current research information systems (CRIS), which can be reused and adapted within such introduction projects to reduce the development effort and to obtain a certain standardization.

But these models do not provide general procedures for their application or in general for the organization of deployment projects. Hence, the goal of this paper is to discuss procedures for the implementation and introduction of a CRIS based on the experience of a university-wide project at University of Münster (WWU) and in this manner to establish best practices. For this purpose the initial situation and the target for the introduction of a research information system at the WWU will first be characterized in order to turn out the general conditions for the project (Section 2). On this basis the general procedure will be presented and by means of the single phases the gained experiences will be discussed (Section 3). In terms of "lessons learned" the contribution ends with a summary in consideration of best practices (Section 4).

2 Initial Situation and Objectives of a CRIS at the WWU

2.1 Characteristics of the WWU

With about 37.000 students in more than 110 subjects and 250 courses, the University of Münster is ranked under the five biggest universities in Germany. With 15 faculties (Medicine including), over 550 professors, approx. 3800 researchers and a wide range of scientific disciplines (except engineering) the WWU has the classical attributes of a full-range university (University of Münster 2010; Statistisches Bundesamt 2010). The research profile covers the humanities and social sciences, economics and law, life sciences, natural sciences and mathematics and links these together. These combinations are expressed by an intensive culture of interdisciplinary research centres and highlight an essential characteristic of the research landscape at the WWU.

In order to position itself in the national and international competition about scientific reputation, talents and resources, universities are faced by the challenge to extensively make research output visible. Thus, research profiles and according research strengths and achievements have to be communicated (Cheng et al. 2008). As for many universities it is also important for the WWU to communicate their own research activities and results to the different stakeholders and hereby to achieve distribution, acceptance and application. For this purpose the WWU currently uses a strongly decentralized approach of research reporting and science communication. Therefore, the communication of research achievements is managed mostly independent by the single faculties and institutes in the form of institution- and project-related websites, research reports or other print and online media. Consequently, information about the research achievements of the WWU exist in different decentralized and isolated data pools, which are communicated in different kinds of presentations and extents. As a result of this heterogeneity a discipline-spanning and uniform access to information about the research achievements is difficult and also the perception of the research strengths of such a big university like the WWU will get sustainably hampered.

2.2 Objectives and Application Scenarios of a CRIS at the WWU

By introducing a university-wide research information system the WWU follows an integrated concept for the management and provision of the different kinds of research information in order to cope with the heterogeneity, which is a result of the decentralized research reporting. Hence, the following goals are perused with the introduction of a central research information system:

- University-wide harmonization and consolidation of the decentralized pools of research information in a central research information system.
- Establishment of a central instrument for a consistent and continuous communication, documentation and reporting of the research activities and results.
- Strengthening of the perception and visibility of the research profile and the interdisciplinary research activities of the university.

These goals can be summarized by the slogan "provide information once and use it multiple times" characterizing the complete CRIS project. This results to general requirements for a CRIS, which affect the technical design and the resulting application scenarios of the CRIS as well as the procedure during the implementation and introduction project.

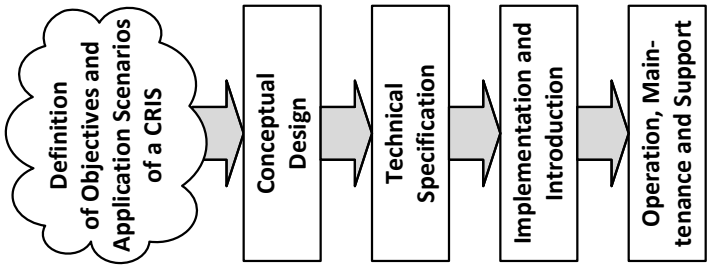
In order to cover a wide and interdisciplinary oriented research landscape like the WWU, the numerous research cultures with the discipline-specific characteristics and dimensions of research information have to be considered during the creation of a CRIS (Jörg et al. 2012; Alexander von Humboldt-Stiftung 2008; Berghoff et al. 2009; Hornbostel 2001). Hence, it is not sufficient to consider only publications and/or research projects in a CRIS (Münch 2006). In order to fulfill the demands of the various disciplines it is necessary to pursue a *multidimensional approach* in the consideration of research information where in addition to publications and projects also received awards, the promotion of young scientists with the meaning of graduation and habilitation, granted patents as well as the integration of scientists in scientific networks and committees is taken into account.

In relation to the central slogan of the introduction project at the WWU - to address a wide circle of use cases and users with the collected data - the research information system has to pursue a *multi-perspective approach* (cf. Jörg et al. 2012; Landry et al. 2001; Closs & Cheater 1994). On the one hand, concerning the strengthening of the perception and visibility of the research achievements, research information have to be available to external users like funding agencies, experts, other scientists as well as to practitioners and the general public via a university-wide research portal. On the other hand the research information should serve as basis for the central research reporting and documentation of the WWU as well as for scientists to create personal research profiles and CVs for project applications.

3 Procedure of the Implementation and Introduction

The basic procedure for the introduction and implementation of a university-wide CRIS is based on the procedure model of the Architecture of Integrated Information Systems (ARIS). ARIS originates from the field of business informatics and is an established approach for enterprise-wide integrated application systems and organisational design and its implementation. To this end, the ARIS-approach provides a continuous framework of methods for the conceptual design, technical specification and implementation of information systems (cf. Figure 1) (Scheer 2001).

Since ARIS is an established and well-documented framework that is not restricted to a specific application domain, we used this as guidance for the implementation of a CRIS at the WWU.



(Source: adapted from Scheer 2001)

Figure 1: General Procedure Model of the Project

3.1 Definition of Objectives and Application Scenarios

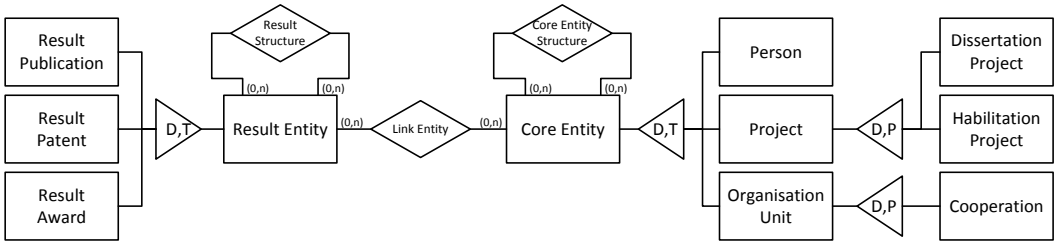
As an initial step of the overall project the objectives and associated application scenarios of a CRIS have to be defined. The major intention of this step is to generally clarify the scope and the related information needs that should be served by the CRIS (e.g., the creation of the annual research report with publications, projects, and honours of each organisational unit). The results from this step can be understood as major requirements, which have direct implications on the subsequently design of the data model, the functionality, and consequently on the suitability of the CRIS to serve the application scenarios and information needs and therefore the projects' success. However, the importance of this initial step is often neglected in software projects.

The definition of the objective of a CRIS at the University of Münster was part of the overall strategic positioning process of the whole university and was specified previously to the initiation of the implementation project at a management level by the rector´s board. As a result, a general understanding of the purposes, application scenarios and information needs of the CRIS was given as starting point for the project (cf. Section 2.2). To get a better and precise understanding of the general requirements, we concretized the information needs with the help of various stakeholders at the WWU (e.g., researcher, administration, dean's office). As result of the first project phase we developed a catalogue of questions, which describe the information needs of the stakeholders as well as an abstract framework of fundamental dimensions of research information, which are necessary to answer the questions and therefore must be covered by a CRIS. These results served as basis for the conceptual design.

3.2 Conceptual Design

Within the conceptual design phase the requirements defined in the previous step are specified in more detail. Conceptual models have been proven for the discussion and identification of requirements on a conceptual level with the different stakeholders as well as for the derivation of a consistent technical implementation (Sarshar et al. 2006; Scheer 2001). To this end, these models abstract from concrete technical details but allow for a more formalized description of the requirements.

For the design of a conceptual specification of the CRIS at the University of Münster we primarily used Entity-Relationship-Models (ERM) (Chen 1976). ERMs are traditionally used in the field of data management to describe the different types of information or the information objects (entities) as well as the relations between these objects in a structured manner. To allow for a stepwise refinement of the general requirements, we translated the more textual description of the multidimensional framework of research information with the help of the CERIF-model into ERMs. As a result we derived a structured and CERIF-based description of the main information objects and their relations, which have to be covered by a CRIS (cf. Figure 2).



(Source: adapted from Lis 2011; Jörg et al. 2012)

Figure 2: CERIF-based Dimensions of Research Information

The *persons* doing research at the different scientific *organizational units* or *cooperations* of the WWU and therefore can be involved in *research projects* or graduate within *dissertation (PhD)* or *habilitation (postdoctoral) projects* are the core information objects of this model. The results of the research activities are described by scientific *publications*, granted *patents* and *awards*. To get information about the context, in which research results are obtained, the core entities as well as resulting entities can be related recursively and can be interrelated and linked to each other (cf. again Figure 2). This allows storing and getting information beyond the boundaries of certain research disciplines that - for example - a person is author of a publication, which is written in the context of a certain project and was honoured with a best paper award. This way, the interdisciplinary character of the research profile of the University of Münster can be pointed out clearly.

Since the multidimensional framework of research information provides only general description of the dimensions of research information, we refined this model and developed a detailed conceptual specification for each information object. To describe the detailed internal structure (entities and their relationships) of each information object we also used ERMs. Furthermore, the information objects and detailed entities were also specified concerning their characteristics (e.g., publication type, title, authors, journal and publication year as common attributes for publications). To assure readability and not to overload the models with detailed information about the characteristics of each entity, we decided to specify the particular attributes separately in tabular manner whereby only substantial descriptive attributes are considered. Technical attributes like Ids or database keys were neglected consciously.

As a starting point for the development of the detailed conceptual specification we also used the CERIF-data model, analysed it and adapted the detailed specification to the general requirements of the WWU. This way we got a first universal version of a detailed conceptual specification that may not cover all specific requirements of the WWU, but provides a common means for the dis-

cussion and identification of discipline specific requirements. In order to cover the whole research landscape with the broad range of disciplines and research cultures we discussed the different models with a representative group of persons from each of the 15 faculties as well as from the university administration. To consider different perspectives on research information, the group of each faculty consisted of people from the deans` office, from the director's board of a research institute and of individual researchers. In a first round we discussed and identified requirements separately with each faculty and afterward consolidated and integrated the results into the overall conceptual specification. In a second round the overall specification was critically reviewed together by all faculties. As result we got a detailed conceptual specification of the data model, which is accepted as common sense by all stakeholders and would serve the initial defined requirements and information needs[1].

3.3 Technical Design

During the technical design phase the conceptual specification will be enriched by technical details regarding to the implementation. A general task of this phase is the identification of possibilities to reuse information from existing data sources in the CRIS. For this purpose the complete landscape of application systems of the university should be analysed as well as external data services. Within a university typical sources of information about persons and the organizational structure are the identity management system and the HR-system, whereas information about publications can be obtained from an institutional repository or the university bibliography. Furthermore, information about funded research projects is typically available in the financial system. With the Web of Science (WoS), SciVerse Scopus, PubMed and for the German area the German National Library also promising external data sources are available for publications. Project information is also provided by most of the funding agencies in a structure manner via a research portal (e.g., GEPRIS of the German Research Foundation[2] or CORDIS of the European Commission[3]). Unfortunately, these data sources do not provide an interface to establish a direct connection to a CRIS.

At the WWU information about the person and their affiliation to the organizational units is available from the central identity management system that in turn is provided by the HR-system of the university hospital and by the HR-system of the non-medical part of the WWU. With the help of the identity management system both sets of personal data are consolidated to establish a unique identity per person. This identity is used to automatically generate personal profiles in the CRIS and to provide access to the CRIS. Furthermore information about third-party funded research projects of the non-medical part of the WWU is available in a financial system whereas publications are only available for the university hospital in an evaluation system called EVALuna.

During the analysis of the different data sources concerning their integration potentials it become apparent, that the challenges of the integration and harmonization of the different data sets are not solely related to the establishment of technical interfaces. The major challenges are characterized more by questions of an appropriate structure and quality of the data sources. Even when personal or project information is available via a HR- or financial system, within a CRIS this information is put into another context of use. Since a CRIS may pursue other objectives and thus has other

[1] A detailed description of the conceptual specification is provided in (Herwig et al. 2012)

[2] http://gepris.dfg.de

[3] http://cordis.europa.eu/

requirements to the data as a HR-system has, the original data from the HR- or financial system must not necessarily meet the requirements of the CRIS. For example, the financial system of the WWU holds financial information about all funded research projects in form of financial accounts. Each account represents a single project and has only a restricted set of descriptive information. In case of collaborative projects the financial system did not provide relationships between the accounts of the different sub-projects. On the other side there are also situations where one project has two or more separate accounts and in fact of missing information from the financial system these accounts cannot be summarized to one project within the CRIS. Hence, regardless of the technical feasibility of the integration, every data source has to be analysed in detail concerning the structure, in which the data can be provided as well as concerning the quality of data and related processes of data maintenance.

3.4 Implementation and Introduction

In this phase the requirements - the data model and functionalities - specified during the conceptual and technical design have to be realised and implemented in form of a software tool. The implementation of such a tool can be done in different ways. First of all, it has to be decided whether the software is developed in house or externally by software firms. In this conjunction it has also be decided whether a CRIS should be developed from scratch as individual solution or a standard software is available that meets the requirements or can be customized.

At the University of Münster we decided to search for an external software partner that possibly provides a standardized solution for a CRIS. On the one hand, we do not have the resources for the initial development and especially for the further maintenance and development of an individual solution. On the other hand, we hoped to benefit from experiences of the vendor and from existing functionalities for research information management to reduce the duration for the implementation. For the selection of a specific software vendor and software solution we decided to involve all stakeholders in the decision process and hence to pass through a more extensive procedure than required by the procurement law. The possible vendors not only had to provide a proposal but also had to present their solution to a broad audience of representatives from the management level of the university and from each faculty as well as representatives from the university administration, data centres, university library, staff council, and for data privacy. At the end of the selection process we decided to base the CRIS on CONVERIS from AVEDAS AG.

During the implementation we matched the basic data model and the functionalities of CONVERIS against our requirements. Since the software provides a configuration interface to allow for a flexible customization of the data model and the respective user interfaces we followed the approach of rapid prototyping and developed a first prototype that was adjusted and enhanced in an iterative manner. Unfortunately, due to time restrictions we discussed and adjusted the prototype only in a very small group of possible users. To assure that the implementation meets the specific research cultures and to promote a first feeling and understanding for the intention of the system and its functionalities, the prototype should also be discussed with representatives of each user group. To this end, from each faculty a “typical” research institute can be selected, which serves as a kind of pilot user.

After the implementation has reached an acceptable status the CRIS has to be introduced and established by all users of the whole university. This can be done on different ways with different strategies. One way would be the “big bang” strategy where the system is introduced university-wide for all users at the same time. The other way would be a stepwise introduction of the system

with the help of pilot institutes from each faculty. This way, potential problems with the configuration can be discussed in small groups and does not affect all users. Furthermore, these pilot users may serve as a kind of multiplier to motivate and consult other institutions using the CRIS. Compared to the strategy of a big bang, the stepwise introduction may last longer to establish the CRIS for the whole university but allows for a better guidance and closer communication to the users. This way, the understanding, identification and acceptance of the CRIS will be promoted strongly.

Due to a very close timetable of the overall project at the WWU we had to follow the strategy of a big bang. In the retrospective, we can say that the effort to prepare the step of opening the CRIS for all users is very low compared to the effort we had afterwards and also currently have to communicate the intention and the concept of the system, to handle and clear preconceptions and fears of the researchers about control, transparency, and privacy of their activities as well as to train and motivate the users using the CRIS.

4 Lessons learned

Universities are faced with the challenges to act and position in an increasing evaluation and funding based competition about scientific reputation, financial resources, talents, and research partners. To meet these challenges especially in Germany more and more universities start to introduce research information systems as an instrument for the documentation, communication and dissemination of their respective research activities and results and thus to turn out the own research strengths and make them sustainably visible.

The introduction of a university-wide CRIS tends to become a complex, extensive and thus challenging project. Based on the broad range of research cultures within a university and the different application scenarios of CRIS there are different questions and obstacles that have to be taken into account during the conceptual design and technical implementation of a CRIS as well as by the definition of the project organization and procedure. From the experiences gained during the implementation and introduction of a university-wide CRIS at the University of Münster general recommendations or common practices for the procedure and organization of such a project can be derived, which may serve as a kind of guidance for the implementation and introduction at other universities and research institutions.

- The objectives and application scenarios of a CRIS should be defined clearly with all possible stakeholders just before starting the overall project.
- Use the defined application scenarios and information needs as starting point for a stepwise derivation of at first a conceptual specification of a data model and functional requirements, second of a technical definition of integration potentials of other data sources, and at last the implementation.
- Allow for an early and closely integration of all user groups and stakeholders across all research disciplines in all phases of the project. This way, the specific requirements of the different research cultures can be taken into account as well as a better understanding and acceptance of the objectives and intentions of the CRIS can be promoted.
- Communicate the objectives, application scenarios and benefits of the CRIS in an open and proactive manner to all users. This way, preconceptions and fears of the researchers about control, transparency, and privacy of their data can be prevented.

- Reuse information from existing data sources to avoid inconsistencies and additional effort, but analyse each data source in detail, if the structure and quality of the provided data meets the requirements of the CRIS. Possibly the structure or process of data maintenance have to be adjusted.
- Use a stepwise introduction of a CRIS with the help of pilot users or institutions if possible. Otherwise the CRIS should be well known by all researchers to reduce support efforts and to prevent loss of acceptance due to nebulosity and misunderstandings.

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