

Integrating research information into a software for higher education administration – benefits for data quality and accessibility

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Summary

Project-related research and third-party funds play an increasing role in German universities (DFG 2009). Current Research Information Systems (CRIS) are developed with the aim to support the handling of research information. In this paper, we concentrate on a special kind of CRIS, Integrated Research Management System (IRMS). They are defined as software component that supports all research processes, sharing a common database with the other components that are integrated within an integrated higher administration software.

We describe the characteristics of an IRMS with regard to process orientation and workflow support. Using the example of the HISinOne Research Management and Technology Transfer segment, we describe the range of functions that is provided by an IRMS. This segment is fully integrated into the HISinOne software for higher education administration. HISinOne is a technically and functionally integrated and completely web-based solution to handle processes and structures at universities. It uses open source technologies and is independent of platforms and operating systems.

We conclude that the approach of developing an integrated system of this kind has considerable benefits for improved data quality and accessibility, mainly due to the fact that integration obviates the need for complex interfaces. Additionally, IRMS support the optimization of business processes in research management.

1 Introduction

Funding of scientific research in the German higher education system is currently in a fundamental change (Wissenschaftsrat 2006). In line with globalization and the opening of the European Research Area, also the financial pressure on German universities increased. Acquisition of external funding is necessary to provide a competitive level of scientific research and to ensure sustainable financing. Several incentives are established, for example the performance-related allocation of funds (Leszczensky & Orr 2004) or indicators for renowned university rankings (Berghoff 2011; DFG 2009). On average, the financial resources available to German universities are already based to one-fifth of external funding, at some universities even close to fifty percent (Statistisches Bundesamt 2009).

Consequently, project-related research and third-party funds play an increasing role in German universities (DFG 2009). The amount of related research information and the administrative effort increases correspondingly. Up to now, most universities use a combination of non-specialized software or an inhouse development to deal with research data. Since the 1980s, Current Research

Information Systems (CRIS) were developed with the aim to support the handling of research information. They are explicitly designed for a consistent processing of a large amount of research data.

In the following section, we give definitions for different types of Research Management Systems with the objective to place our approach of developing an integrated research management system in context.

Generally, a CRIS is defined as “... any informational tool dedicated to provide access to and disseminate research information. A CRIS consists of a data model describing objects of interest to R&D and a tool or set of tools to manage the data.”¹ Its general purpose is the assistance of recording, reporting and decision-making in research projects. Compared to non-specialized software that is used for research data management, a CRIS has several advantages. It provides easy monitoring and statistical analysis of research information and output. These evaluations can support decision-making and the presentation of research. CRIS are developed according to international standards. For example, the Common European Research Information Format (CERIF²) was developed to ensure data exchange between different systems or institutions. Due to the standardization, metadata sets of publications or research data sets are compatible with other systems. A CERIF-compliant CRIS serves as leading system for research data management and contributes significantly to improved data accessibility, exchange and quality.

Concluding from the section above, CRIS mainly focus on the evaluation and presentation of research output. In contrast, Research Management Systems (RMS), as a specific type of CRIS, additionally provide workflow support for the whole research process (Ebeling et al. 2011). From a general point of view, the research process starts with the development of a research idea and ends with the generation of research output. RMS support application procedures for third-party funds, the administration, and management of resources, and reporting. The aim of workflow support is to optimize the business processes related to research management. Further it facilitates the efficient communication between stakeholders who are involved in the research process. Workflows can be automated, e. g. when providing pre-filled reports. Within a RMS, information sets are provided according to the individual user requirements, avoiding the time-consuming search for appropriate information. The main advantage of a RMS is that it informs the researcher of the current status of all his projects. Using a RMS, the researcher can base his research management decisions on recent information with regard to resource availability, upcoming tasks or time limits.

The integration of CRIS or RMS into the existing heterogeneous system environment of a university is a challenging task. This is mainly due to the fact that a number of interfaces have to be developed to allow for information exchange among the systems. There is an approach around the problem of complex interfaces: RMS can be designed as an integral part of a complete administration software for higher education administration. We call this type of RMS “Integrated Research Management System” (IRMS). An additional benefit of this approach is the consistent reuse of data within the system. Data are entered into the IRMS only once and are subsequently used within different segments of the higher education administration software. This leads to considerable advantages for data consistence and actuality, as well as for the compatibility of data. IRMS use single sign-on technology to implement a coherent role and rights concept with individual access to information.

¹ www.eurocris.org

² Latest release: CERIF 1.4 (<http://www.eurocris.org/Index.php?page=CERIF-1.4&t=1>)

Concluding, we define an IRMS as software component that supports all research processes, sharing a common database with the other components that are integrated within a complete higher administration software. We argue that the approach of integrating Research Management Systems into software for higher education administration has considerable benefits for data quality and accessibility. We provide the example of the Research Management and Technology Transfer (RT) segment of the HISinOne software (HISinOne-RT) for higher education administration to elaborate on this argument. HISinOne-RT represents an IRMS according to the definition given above, because it is an integral part of the HISinOne software for higher education administration.

2 The example of HISinOne-RT: Concept for an Integrated Research Management System

2.1 The HISinOne software for higher education administration

The German HISinOne software, developed by the HIS GmbH (Higher Education Information System), gives an example for an integrated higher education administration system. For more than 40 years, HIS has developed IT solutions and offered consulting for German institutions of higher education (universities and universities of applied sciences). As a basic provider, HIS is an integral part of the German higher education system. This ensures a long-term not-for-profit performance profile that is best suited to meeting the needs of the higher education sector. The development of “HISinOne”³, the new software generation for higher education administration, started in 2007. By 2016, HISinOne will have completely replaced the preceding software generation (HIS-GX and HIS-QIS). HIS-GX and HIS-QIS offer a number of modules to support campus and resource management processes. Most of the German universities, universities of applied sciences and colleges of education, theology and art have used HIS-GX and HIS-QIS since the mid-1990s. HISinOne meets new IT standards and uses a holistic approach: HISinOne is a technically and functionally integrated and completely web-based solution with a service-oriented architecture. It supports all major processes and structures at universities. HISinOne consists of a web server (e. g. Apache) in a demilitarized zone, an application server (Java SE on Tomcat) behind a firewall and a database server (PostgreSQL or Informix). A variety of operating systems can be used as server platforms, e. g. Windows and many Unix-Systems, particularly Linux. HISinOne is set up using classical three layer architecture: Web presentation, domain logic and persistence. Persistence and domain logic are separated by a data integration layer based on the DAO design pattern, in which different data sources (e.g. Database, XML file, LDAP or web service) are provided for the domain logic. The domain logic layer provides its functionalities by a local service layer. Distribution and granularity of the services are based on the principles of service oriented design. The web presentation layer generally accesses the domain logic layer by the local service layer. This leads to the decoupling of the web presentation layer and the persistence layer regarding the structural changes within the domain logic layer being hidden from the web presentation layer. Due to the service oriented pre-structuring of the functionality, a release as a web service is easily achieved by a configurable adapter.

³ <http://www.hisinone.de/>

The purpose of this concept is to make information available for all stakeholders at any time. All objects are entered once and stored centrally in one common database. A consistent role and rights concept ensures that all users have access to data and services according to their requirements. The HISinOne software comprises the following segments:

- Core (business intelligence, data warehouse, identity management)
- Campus Management (covering the student lifecycle from application to alumni)
- Finance and Operating Management (financial accounting, controlling)
- Human Resource Management (people management)
- Research Management and Technology Transfer

The Core segment handles any data connected with identity management and the basic infrastructure of a university. It manages the access via identities, roles, and authorizations. Relevant data can be easily accessed through analysis functions that support the production of up-to-date figures and statistics.

The Campus Management segment in HISinOne covers the student lifecycle and accompanies every process from application to alumni management (Figure 1). The student lifecycle starts with the prospective student's application for a course of study (product area Application: "APP") (Figure 1). It proceeds with the administration of students and PhD students (product area Student management: "STU"). There is one comprehensive product area addressing the administration of courses of study, academic classes, and examinations ("EXA"). Once the student graduates from the university after his exam, he becomes an alumni. The product area Alumni management ("ALU") addresses all issues of alumni management. To summarize, HISinOne digitizes the whole process of application and enrollment, manages examinations, grades and certificates, and interconnects with common e-learning systems. As a result, the system enables smooth communication and data sharing between all stakeholders. HISinOne is compliant with the Bologna requirements; e. g. the examination management is explicitly designed to handle modularized courses of study.

The segments Finance and Operating Management and Human Resource Management include the management of financial accounting, staff, and room schedules. In addition, it integrates functions including controlling, cost accounting, and business intelligence. It communicates smoothly with the other segments, e. g. with regard to tuition fee management.

As of HISinOne Version 3.0 (released in October 2011), the Research Management and Technology Transfer segment is provided with the software. It features research and technology transfer management functionality and will cover the entire research project process including development, funding, and the presentation of research results.

By now, fifty universities, universities of applied sciences and colleges of education, theology and art decided to apply HISinOne. They also participate in the further development of the software, e. g. as pilot partner universities. About one-third of these universities already have started the productive usage. HISinOne is usually deployed in subsequent stages. Step by step, new processes and functionalities can be focused and established. The standard implementation procedure starts with the core segment. Subsequently, the modules Application (APP), Student Management (STU), Examinations (EXA) and Alumni (ALU) are implemented in this order. After the successful implementation of the Campus management segment and, subsequently, the Resource management segment, finally the RT segment is implemented. This procedure ensures maximum benefits from the linkages between the segments.



Figure 1: Student lifecycle

2.2 Overlapping processes

Higher administration software serves the purpose of supporting all business processes of a higher education facility. Besides Research Management, these processes can be grouped together into segments containing overlapping elements. Due to the linkages in content it seems appropriate to design a Research Management System not as an independent standalone solution, but as part of an integrated higher administration software. In the following, we describe which processes and elements of the segments Campus Management (all processes related to the student lifecycle), resource management (staff, finance, equipment), and business intelligence (reporting and evaluation) are relevant also for the RT segment of HISinOne.

Campus management

Students can be involved into research projects in different ways. As student assistants or PhD students, they become part of the research staff. These are often associated with research projects, eventually producing publications during this process.

With regard to lectures, there are talks given by researchers that are integrated in the schedule of lectures. Similarly, recent research results are referred to as basic literature for the students in lectures. Researchers can also be involved in designing new courses of studies at a university.

Alumni are considered a part of the student lifecycle (cf. Figure 1 in section 2.1). Accordingly, their role is also considered in the Campus Management segment. Alumni stay in contact with their university, and some of them may provide grants, e. g. to young researchers.

Resource management

The management of research project resources is one of the most time-consuming tasks in the project workflow. Funds, staff and equipment need to be managed according to the directives of the funding agency. Provision of rooms or labs with special facilities according to the requirements of the research design is necessary. An integrated solution of research management provides several benefits. With regard to Human Resource Management, the benefits are: The project members already are available in the system, from the staff data base. Data exchange between the research project manager and the staff department is facilitated. Thus, the process of employing persons can be accomplished efficiently. Additionally, project staff can be allocated more efficiently because data on their availability are provided within the system.

With regard to Finance and Operating Management, there are several benefits. Direct exchange between the research project manager and the financial department is provided. In the same way as it is true for the allocation of staff, also the allocation of funds is facilitated through the provision of recent information of the status of resources. Financial booking is facilitated through the direct access to the relevant data.

In summary, a faculty or university can plan the financial and staff resources much better when using an IRMS, because it always has a recent overview of all project related resources.

Business intelligence

The statistical analysis of research projects and the related external funds is a major decision support instrument for department managers as well as for the university directorate. Additionally, statistical indicators are used for evaluating research activities, and they influence the reputation of a university. Usually, a number of reports have to be provided when conducting a research project. Reporting is facilitated if it can rely on data that is already available within the system. A major benefit of an integrated solution is that templates can be pre-filled with all available data of the research project in a consistent way.

2.3 HISinOne-RT: Range of functions

Currently, basic RT functions are fully implemented in HISinOne-RT, e. g. project workflow and publication management. A number of integration functions are still under development, and more complex services like scenario planning or full mobile access are not yet implemented. For the further development, HIS plans to cooperate with pilot partner universities. They will be the pioneer users of this segment, and they participate in the further development of the RT segment. This encompasses functional and workflow design, menu navigation, priority of development requirements, and the role and rights concept. The main benefit of the close development cooperation is that the segment is developed according to the stakeholders' practical requirements.

In the following, the main research management functions of HISinOne-RT are described. HISinOne-RT supports all processes of different stakeholders that are part of the workflow, inside and outside the university (Figure 2).

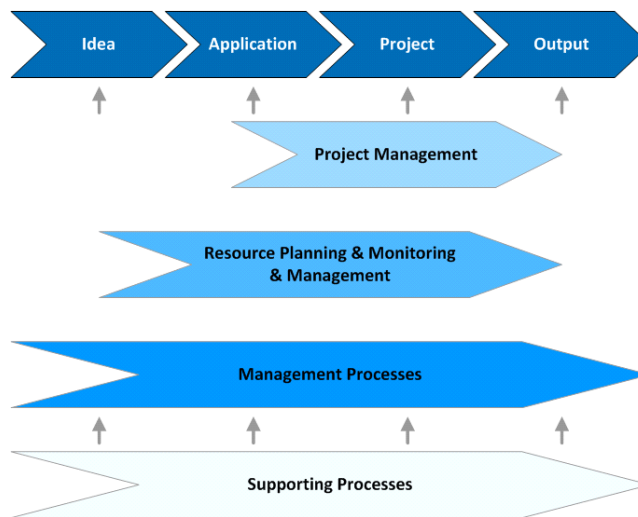


Figure 2: The four phases of the research management workflow

The research management process is divided into four phases (Idea, Application, Project, Output). The starting point of the project workflow is an initial “*Idea*” for a research project. In the next step of project development, HISinOne-RT helps the researcher to find cooperation partners and appropriate funding programs. Optionally, an idea can be shared and discussed with interested researchers or potential cooperation partners within and outside the university, with the help of the community function. When actually starting a project, HISinOne-RT provides support for accurate project planning, and it facilitates communication with the relevant. The “*Application*” phase starts when the funding program is selected. Now, the research idea can be easily transformed into an official research project of the university. Applications for funding are managed within this project-related data set. For standard funding procedures, the university can create specific application templates. The template can be pre-filled with data from the common data base. This procedure guarantees the agreement with formal requirements and improves the communication with the funding agency.

The “*Project*” phase starts with the approval of the project by the funding agency. The workflow management system supports the preparation of the project start, for example recruiting staff, purchasing equipment or creating a new project cash account. With the initiation of the project, a number of project management tasks are initiated that are related to different stakeholders. Besides the main tasks of conducting research and recording the results, the project resources (e. g. staff, finances, equipment, rooms) have to be continuously monitored and managed. These tasks are supported by workflows in HISinOne-RT, and they address not only the administrative department level, but also the institutional and the individual researcher level. For example, the research manager must always be informed about the current state of his projects. In HISinOne-RT, the required information is collected in a project management cockpit. The cockpit provides information according to the individual requirements of a stakeholder. Real time project information and monitoring facilitates communication and exchange. Workflow-based resource monitoring automatically alerts the researcher in case of exceeding costs, expiring staff contracts, reporting deadlines or important tasks or time lines. Researchers and cooperation partners continuously need to keep all project participants informed and share documents and results. Additional-

ly, they may want to document the complete process as a basis for later reports and publications. The HISinOne web-based technology and the community function allows for the real time communication and exchange with participants inside and outside the university.

The final phase of a research process is called the “*Output*” phase. Reports of research results and proofs of utilization of funds have to be created for the funding agency. Again, for standard funding procedures special template can be created and automatically pre-filled with the relevant project data.

Research output is produced in the form of publications or reports. Interfaces to libraries and usage of standard formats allow for an easy import or export of new publications. Publications are entered into the system only once, either into the HISinOne system or in the library system of the university. Publication and project data can be reused in another context, e. g. for a researcher’s CV or for the university website, to present research activities and output. Several research specific (statistical) analyses and reports can be generated to evaluate the research activity and output. They can be combined with additional data from campus and resource management, e. g. to improve resource allocation or decision support at the administration level. The CERIF standard is strictly followed by HISinOne-RT to ensure an easy exchange of research data.

3 Benefits of the integrated approach

The example of HISinOne-RT demonstrates that there are some additional advantages of the integrated approach over standalone CRIS or RMS systems. Mainly, the RT segment can benefit from all advantages of the new IT standards of HISinOne without the need of interfaces. The RT segment not only provides a complete research workflow support, but it is also integrated and balanced with the other workflows of campus and resource management. Furthermore, in the common data base all essential information is available without data transfer and thus avoids redundancy. For example, the full integration into a campus and Research Management System allows generating statistical analysis with the same business intelligence engine. The reports have the same design, can be generated in the same way and may include data from other segments. The users do not have to switch between software applications. Information access is controlled by a comprehensive role and rights and a view concept, which guarantees only authorized data access. Due to its flexibility and customizing options, HISinOne is equally suitable for small universities and large universities. It can handle centralized organizational structures as well as decentralized structures.

Due to the cross-sectional character of research management and information, many already implemented functions of other segments can be reused by the RT segment (e. g. business intelligence to generate reports and statistics, the community function to keep in touch with other researchers, interested persons or cooperation partners). Also information of the RT segment can be reused in other segments, like the personal research profile, current projects or publications.

The HISinOne “Portlet” function allows for individual configuration of the project management cockpit, to keep a comprehensive overview of the current project state. This individual overview can also be combined with data from other software segments, depending on the different roles of the user within his university. Thus, the user can customize a complete individual information cockpit for efficient management and enhanced decision-making. A reminder function for relevant time lines and tasks of research, campus and resource management is available. Also external

project participants, cooperation partners or funding agencies can use this function. In combination with a barrier-free and multi-lingual support, the web-based solution of HISinOne provides easy access to actual research information. Along with the consideration of the CERIF standard data model, this improves communication and documentation in cross-organizational and international projects.

The open source approach of HISinOne provides interfaces to other relevant systems, e. g. library systems or institutional repositories. Open interfaces and interchange formats secure the interoperability, longevity and security of the application.

4 Conclusions

We showed that the functionality of IRMS HISinOne-RT supports the whole process of research management. Further, we demonstrated that the approach of developing an integrated system of this kind has considerable benefits for improved data quality and accessibility. Additionally, the workflow support of HISinOne-RT supports the optimization of business processes in research management. Currently, the development of HISinOne concentrates on applications in Germany, but it will be extended as well to international applications.

When implementing only the RT segment of HISinOne, the advantages of an IRMS do not apply. The maximum advantage of an IRMS can only be achieved if the RT segment is implemented along with the other segments of the higher education administration software. In consequence, for a university with no integrated software solution and a heterogeneous IT landscape, a standalone RMS may be a more suitable solution. It should be considered that the current and future IT infrastructure strategy has an essential influence on the choice of appropriate research information system.

We close with providing an outlook on future developments that are planned for HISinOne-RT:

- Support of standard application procedures for research funding (e. g. German Research Foundation (DFG), EU Framework Programme for Research and Innovation)
- Extending the Community function with the aim to facilitate communication between research partners
- Mobile access to research data
- Specific support for Technology Transfer projects
- Improved portability of personal research data (import and export functions)

References

Berghoff, Sonja; Giebisch, Petra; Hachmeister, Cort-Denis; Hoffmann-Kobert, Britta; Hennings, Mareike; Ziegele, Frank (2011): *Vielfältige Exzellenz 2011: Forschung – Anwendungsbezug – Internationalität – Studienrendenorientierung im CHE Ranking*. Gütersloh: Centrum für Hochschulentwicklung GmbH.

- DFG (German Research Foundation) (2009): *Funding Ranking 2009: institutions - regions - networks*. Thematic profiles of higher education institutions and non-university research institutions in light of publicly funded research. Weinheim: Wiley-VCH.
- Ebeling, B.; Klages, M.; Breitner, M. H. (2011): *IT-gestütztes Management von Drittmitteln im Rahmen des Forschungsmanagements an deutschen Hochschulen*. In: Heiß, U., Pepper, P., Schlingloff, H., Schneider, J. (Ed.): *Lecture Notes in Informatics (LNI) - Volume 192 (Proceedings INFORMATIK 2011, Köllen, Bonn, p. 452)*. <http://www.user.tu-berlin.de/komm/CD/paper/090613.pdf>.
- Leszczensky, M.; Orr, D. (2004): *Staatliche Hochschulfinanzierung durch indikatorgestützte Mittelverteilung*. Dokumentation und Analyse der Verfahren in 11 Bundesländern. Hannover: HIS (Kurzinformation/HIS: A, 2004, 2). <http://www.his.de/Service/Publicationen/Kia/pdf/Kia/kia200402.pdf>.
- Statistisches Bundesamt (2009): *Hochschulstandort Deutschland 2009*. Wiesbaden. https://www.destatis.de/DE/Publicationen/Thematisch/BildungForschungKultur/Hochschulen/Hochschulstandort5213101099004.pdf?__blob=publicationFile.
- Wissenschaftsrat (2006): *Empfehlungen zur künftigen Rolle der Universitäten im Wissenschaftssystem*. Köln. <http://www.wissenschaftsrat.de/download/archiv/7067-06.pdf>.

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