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INFORMĀCIJAS SISTĒMAS KONCEPCIJAS IZSTRĀDE RTU ZINĀTNISKĀS DARBĪBAS ATBALSTAM

DEVELOPMENT OF THE INFORMATION SYSTEM'S CONCEPT FOR SUPPORTING RESEARCH ACTIVITIES AT RIGA TECHNICAL UNIVERSITY

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Research information system, business processes, knowledge management

1. Introduction

Globalisation, technological advances, necessity to integrate investigations of several scientific fields, and dependence on requirements, which are set by different financial foundations, are features of scientific environment that has created new advantages and challenges for researchers and research organisations. It will not be possible to handle the complexity of the new research situation, i.e., to benefit from its advantages and meet its challenges without appropriate Research Information Systems (RIS) that is able to support researchers, research activities and research administration.

Several universities and research centres are already aware of necessity and advantages of such information systems (IS) and actively engaged in development and improvement of their RIS. But generally accepted guidelines and workplans for RIS development in technical universities are not available. Several investigations and applications are made in RIS development field [1, 2, 3, 4, 5], but none of these can meet all research support goals identified at Riga Technical University (RTU). In most cases suggested solutions focus on the

support of administrative processes and communication, but they do not address essential needs of researchers, who often are overloaded by administrative routines that hinder research productivity and put unnecessary psychological pressure on the researcher.

This paper proposes guidelines for the development of knowledge management and researcher oriented RIS, which could be implemented at RTU. In the proposal needs of researchers as well as support of administrative activities are taken into consideration.

The context of university research activities is described in Section 2. In Section 3 the related work in IS support for research activities is considered. The methods used for development of RIS concept, main business processes of the research activities, mission, vision, strategy and main goals of research as well as the key goals of RIS are described in Section 4. Further, in Section 5, the guidelines for development of RIS in RTU are proposed. In Section 6 implementation strategy of RIS is proposed. Section 7 consists of brief conclusions.

2. The context of research activities

The most important part of the science is research – a combination of theoretical knowledge and experiments directed towards finding scientific explanations of phenomena. Research is commonly classified in two types: (1) pure (basic) research involving theories with little apparent relevance to human concerns; and (2) applied research concerned with finding solutions to problems of social or commercial importance. The main difference between scientific activities of a technical university and institutions dealing with natural and social sciences is that technical (engineering) sciences have direct or indirect impact on the development of new artefacts. Professional knowledge affects research process itself, because various standards, patents and certified methodologies are used in the development of the research artefacts.

A simplified knowledge flow of research activities in the university is illustrated in Fig.1. We can see there that pure research, applied research and consulting directly impact scientific and professional knowledge inside the university (and vice versa) as well as indirectly they impact the process of education.

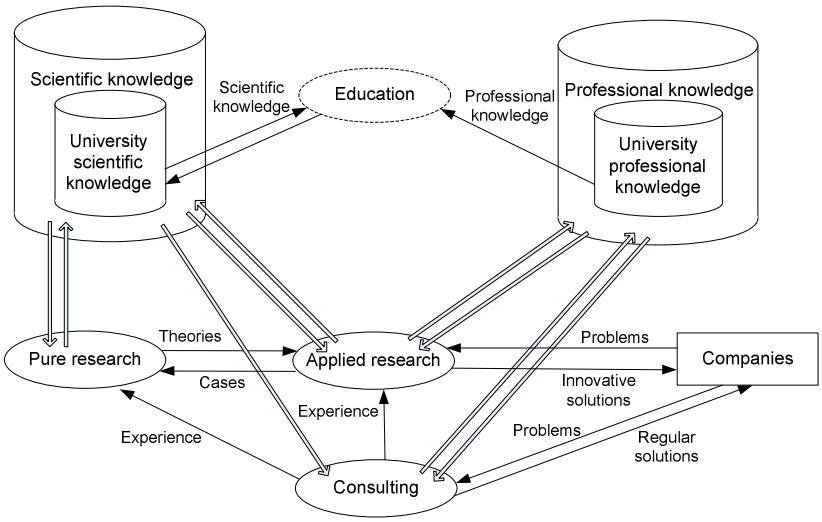

Figure 1. Knowledge flows (simplified, shown by arrows) in the university research context

Knowledge management and researcher oriented RIS is necessary to ensure successful support of research work and its administration. As seen in Fig. 1 RIS has to support all the processes related to research as well as education in terms of doctoral studies and academic staff.

In Fig.2 a typical scheme of a research process is shown. While the RIS in this paper is in no way considered as a substitute for ordinary research work, it still can be beneficial for almost all research activities. Idea creation can be supported as RIS gives access to international data basis of scientific papers and the library system. RIS can generate automatically a significant part of project application; it can support research activities management if analytical tools and tools for management of financial resources are included in the RIS. Reports can be generated partly by RIS, too. It is not possible to generate a scientific paper by RIS, but RIS could help in archiving the paper and creating references to it.

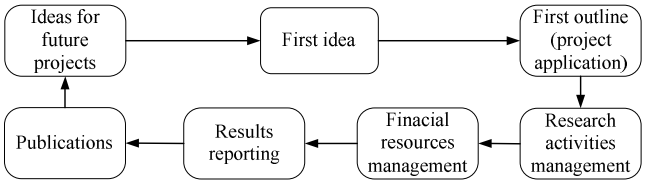

Figure 2. A typical scheme of a research process

3. Related work

One of the broadest frameworks for research support systems is given by Yao (2003) [3], who groups information technology tools around seven phases of scientific research, namely: idea generation, problem definition, procedure design/planning, observation/experimentation, data-analysis, results interpretation, and communication phases. The workflow system that consists of exploring support, retrieval support, reading support, analysis support, and writing support is suggested. The system should provide profile management, resource management and data/knowledge management facilities. It should consist of discipline independent component that supports general research process and domain specific components that support research in specific disciplines. Expert systems, machine learning, data mining, text mining, computer graphics, data visualisation and intelligent information agents are advocated as feasible tools for the workflow system's implementation. The framework given in Yao (2003) [3] is quite broad, but it does not show exactly how each phase of research process is supported and how supporting components may be organised in an integrated research support system. The main emphasis in the system is on information retrieval in the early phases of research, data analysis and writing.

Many universities are developing research support information systems. At Monash University, in Australia, such system has already been implemented [4]. This system provides infrastructure to collect, store, and disseminate research information to facilitate strategic decision making to a range of stockholders. The system consists of the following three parts:

- ResearchMaster – system witch unites scientific information (grants, CVs, evidence portfolios);
- TARDIS (*Total Access Research Data Information System)* – system, which pulls together data from University's three entirely separate enterprise databases. It makes possible to access general research information from the web.

- ROPES –subnet of TARDIS web application and as such, shares many similarities. It pays primary attention to the requirements of academic researchers' needs. The most useful features of ROPES are possibility to put together data required for managing research activities, and also possibility of secure storing of personal researchers' information.

RIS concept and its integration success have been discussed in several scientific conferences. The results of RIS research in different institutions have been summarized during euroCRIS conferences, which are held with the aim of providing exchange of experience among RIS developers [5, 6, 7]. This forum attempts (1) to get a clear view of what are primary requirements for RIS and (2) to develop a RIS shell that could be useful for different types of research institutions.

According to euroCRIS a RIS has to support different stakeholders of research activities [1]:

- Scientists – need easy access to necessary information and related software support.
- Scientists – leaders, university administration – to streamline research activity measuring and analysis, to simplify access to research information for research financing optimization.
- Technology transfer points – to streamline new ideas and knowledge transfer from research centres, to facilitate identification of previously made related research and competing research projects.
- Society – to facilitate access to research result presentations.

One of the most noticeable projects performed by euroCRIS community [1] is the development of unified RIS data model standards CERIF (*Common European Research Information Format*) [5, 6, 7, 10] that include guidelines for RIS development. The aim of the CERIF development is the following: to help RIS developer by providing necessary IS components; to assist developers, who plan to enlarge existing RIS facilities; to provide instructions, how to structure and index IS data; to simplify data exchange between similar RIS. Taking into account such standard in designing and developing RIS would create universities RIS compatibility with other RIS. There are several RIS, which are designed on the basis of CERIF standard: SICRIS [11], CRIS-MER [12], AURIS-MM [13], Scottish Research Information System [14], ARAMIS [15], INTACCOMP [16], and SAFARI [17].

It has already been emphasized that RIS has to support a researcher who needs, from his point of view, logically represented and easily accessible information [8]. The following issues are identified as the main requirements for RIS from the point of view of researcher [9]: information and other scientific resources searching and mining facilities; finance pegging support, collaboration with partners, research result (publication, patent, etc.) managing, help desk, project management support; analytical tools and intellectual property management. However, none of the existing RIS development approaches suggest well organized tools for supporting all needs of an individual researcher.

Generally, the related work shows a tendency to aim at the support for all research activities and stakeholders at different levels and configurations of research and administration. This knowledge has to be taken into consideration while developing a particular university RIS. However, none of the approaches suggests an easily customizable method for RIS development. The reports and suggestions are either very general or a particular university specific and not easily reusable. Therefore the research approach for development of the concept of RTU RIS has to utilize general principles as well as certain best practices; and simultaneously has to be based on a particular theory that provides a reliable framework for combining theoretical and practical knowledge about RIS. The research approach, used for the development of RTU RIS concept, which meets the above

mentioned requirements, is described in the next section. The approach is grounded in knowledge management and business process modelling theories.

4. The research approach

The investigation of RTU research activities was performed using knowledge management approach for the development of knowledge management systems [18]. Thus knowledge on RTU research activities vision, mission, strategy and goals was obtained at the very beginning of project and afterwards was used as a reference point for sticking together pieces of theoretical and practical knowledge. The vision and mission of the scientific research work at RTU were defined on the basis of the summary of interviews that were held with RTU researchers, doctoral students and representatives of RTU administration (vice deans of research and other employees responsible for research work administration). The strategy of the RTU research work was formulated using SWOT methodology [18].

The goal model was defined by using modified EKD modelling approach (described in [19]) during the modelling sessions where researchers, doctoral students and representatives of administration participated and shared their knowledge. While searching the ways how to support these goals, the relationships among goals and potential RIS components were defined.

Established relationships, experience of other research centres and universities and previously developed mission, vision and strategy of RTU research activities have provided necessary information to define goals of the RTU RIS.

The methodology used during the development of RTU RIS concept is shown in Fig. 3. Although it can be found from the figure that the concept of RTU RIS is obtained from the table that stores relationships among goals and corresponding RIS components, all the other knowledge sources depicted in the figure were also taken into consideration. Further in this section the steps of research methodology used for development of the concept of RTU RIS are described in more detail.

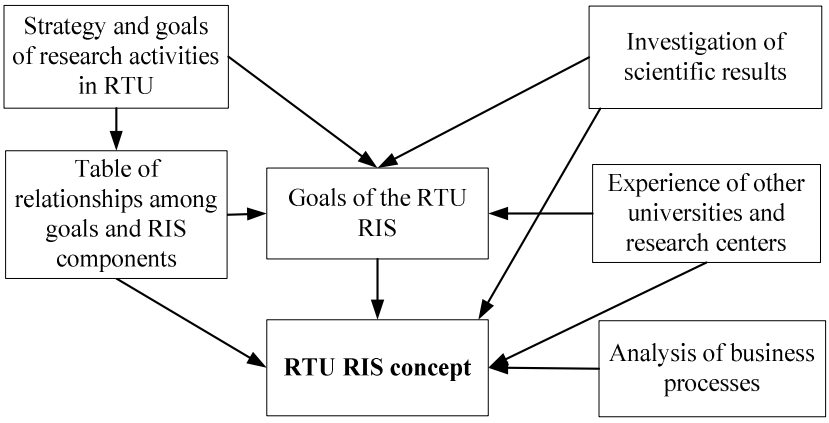

Figure 3. The methodology used in the development of RTU RIS concept

4.1. Analysis of RTU research business processes

According to the information systems development theory and best practices, one of the primary tasks that should be undertaken while developing RIS is the analysis of business processes that make up research work at RTU.

The main tasks of the analysis is to figure out the most important processes of research work at the university, collect information about those processes and build the formal model that should strictly define the main activities in research processes, as well as the sequence and actors of these processes. The main idea of business process modelling is building formal models, arranging and classifying processes, which later may help to find bottlenecks in the process and modify the process to improve performance.

The models of the business processes can be used later to define the concept of RTU RIS: define functional requirements; define main components of the system and data flows among them. The formal, graphical models of business processes can be used as descriptive material for researchers and administrative workers. Authors believe that graphical models of the processes will be more descriptive and usable in practice than normative documentation. Fig. 4 demonstrates an example of such model. Figure represents the process of gathering and summarizing information about scientific work in RTU needed for annual report to the Latvian Council of Science.

Scientific projects are an important part of research activities of RTU. Therefore researchers are obliged to work with huge amounts of documentation. As it was mentioned by the interviewed members of the scientific projects, currently the major issue is a lack of information about the administrative part of the projects that, in turn, causes ambiguity and a lot of mistakes while carrying out the projects. One of the possible solutions that was applied by the authors is the analysis of processes inside research projects at RTU. When performing analysis the attention was paid to the most important project types, that currently are carried out by researchers at RTU (projects done in cooperation with Latvian Council of Science, projects funded by RTU scientific grants, cooperation projects of RTU and Ministry of Education and Science, projects funded by European Social funds and European Regional Development Funds and other international and cooperation projects).

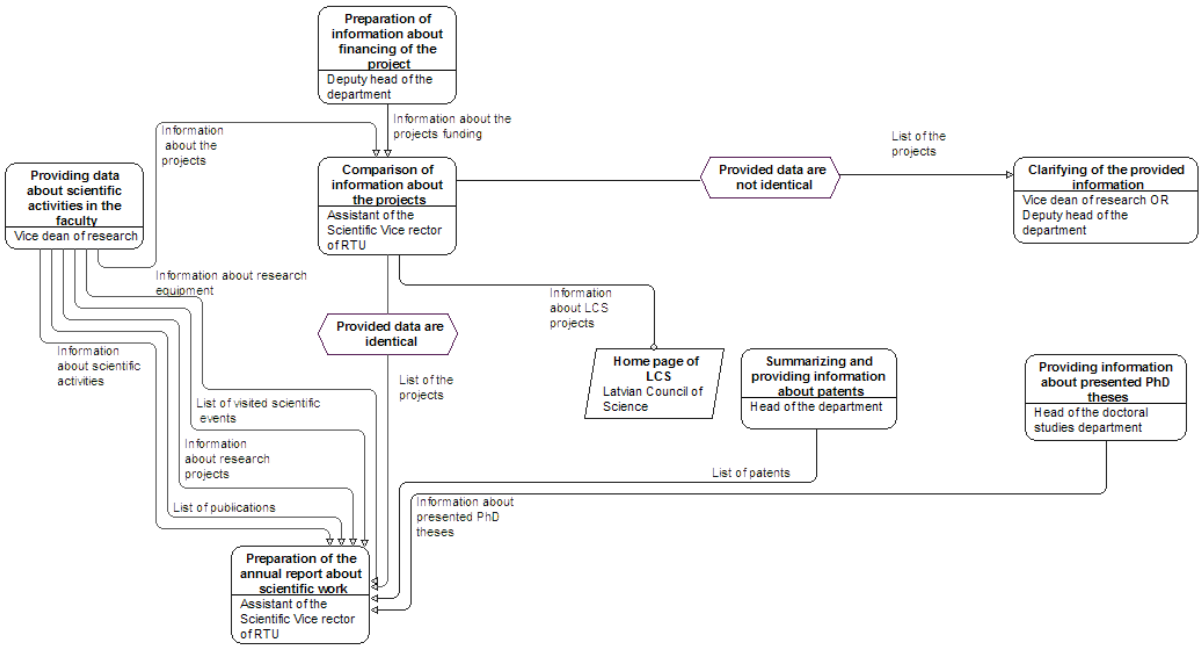

Figure 4. An example of the graphical model of the process: gathering information about scientific work from RTU scientific departments

4.2. Vision, mission, strategy and goals of research activities in RTU

As mentioned at the beginning of Section 4, the RTU research vision and mission were defined by questioning researchers, doctoral students and administrative workers. As the result, the following definitions were formulated:

Vision: Research activities of RTU are highly estimated by the public, internationally well known, supported by governmental and business organizations, economically effective and significant relating to history of civilization. Research activities are well supported in terms of materials, information, technology and finances. Working conditions of researchers facilitate succession of generations and high quality of education. Researchers are creative, professional and open to the larger society; healthy competition exists among them.

Mission: The mission of research activities at RTU is to support the high quality of education and personnel at RTU, as well as to enable researcher's self-development and scientific discoveries by enhancing society's interest in science with the purpose to attract new scientists and financial funds, discover new solutions for support of production processes and services, to build a high prestige and competitiveness of the university and country, and stimulate formation of knowledge based society in Latvia and country's economical and social progress.

The next thing that was developed is a goal hierarchy. It was done by using EKD method described at the beginning of the section. The three main strategic goals in this hierarchy are professional personnel, high capacity of research and high quality of research. These principal goals are to be supported by appropriate research infrastructure. (See Fig. 5).

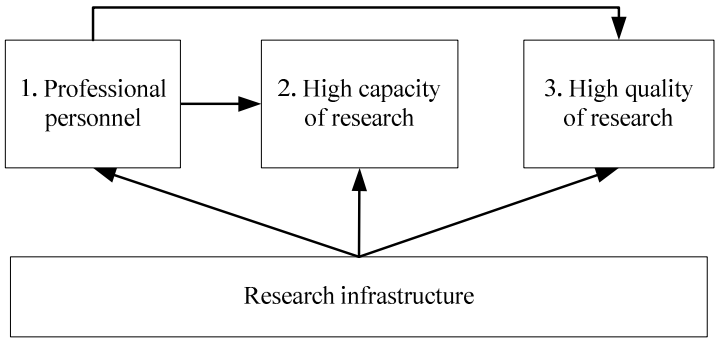

Figure 5. Main goals of research activities in RTU

To provide full support to main strategic goals by RIS, a higher degree of decomposition of the goals is needed. Such decomposition leads to a goal structure, which is shown in Fig. 6. This structure can be further decomposed. For example, to achieve generation succession, it is vital to pay attention to high quality doctoral studies, balanced workload of researchers, economical and social warranties holding. Conference organizing, papers in international journals and proceedings will support international contacts and international recognition. In the same way knowledge about existing technologies, fundamental knowledge, professional knowledge of researchers and knowledge about future opportunities will allow to forecast situation.

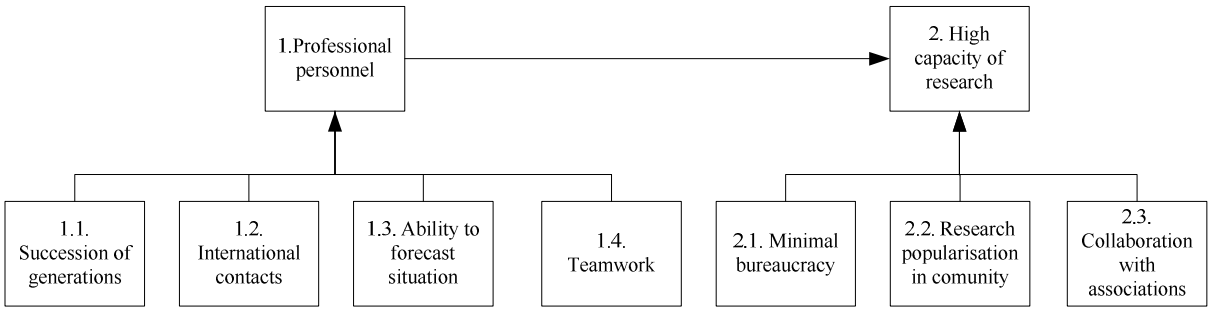

Figure 6. Next level of RTU research activities goals decomposition

4.3. Goals of RTU Research Information System

RTU RIS goals, which were acquired using the research methodology reflected in Fig. 3, are listed in the second column of Table 1. Additionally, Table 1 contains links between RTU goals, RTU RIS goals and IS components, thereby showing, which RTU research goals are supported by particular RTU RIS goals and which IS components support particular RTU RIS goals. RTU research goals are represented using numbers from Figure 6. IS components are also represented by numbers from hierarchical RTU RIS structure which is shown in Figure 7 and is described in Section 5.

Table 1. Goals of RTU RIS, their relationships with RTU research goals and potential RIS components

RTU goals	*RTU RIS goals*	*RIS components/ subcomponents*
1.3;1.4;3	1. Offer searching by different criteria in all possible repositories	14
1.1;2;3	2. Enable access and publishing of own publications and patents	8.1;8.1.1; 8.1.2;8.1.3;9
1.1;2;2.2;2.3	3. Make patent and publication repository available for public access	8.1;8.1.1;8.1.2; 8.1.3;10
1.1; 2.1;2.3;3	4. Ensure availability of RTU and different industry standards	7;7.1
1.1;2.1;3	5. Make bureaucratic procedures easy accessible and understandable by RTU researchers	7;7.2
1;1.1;1.2;1.4; 2.3	6. Provide announcements and knowledge push system to researchers	12.1;12.2;12.4; 15;15.1;15.2
1.2;2.2;2.3	7. Popularize research activities in community, using external homepage	10
1.1;1.4;2.1;2.3;	8. Offer functionality for partly automatic report generation	13
1.3;2.1;2.2;2.3	9. Generate statistics	13
1.1; 1.3;2.1;2.3	10. Get information about opportunities to apply projects automatically and in time	12.1;15;15.1
1.1;1.4;2.1;	11. Deliver mandatory information corresponding to every knowledge workers category	15;15.1;15.3
1.1;1.2;1.4;2.2	12. Save and make available information about research equipment and corresponding contact persons.	5.1;6
1.1;1.2;2.2;2.3	13. Offer functionality for automatically generating parts of researcher's CV and publish CV using yellow pages service	3;6
1.1;2;2.1;	14. Maintain records about current and past projects and contracts for generating statistics and reports	12;12.2;12.3; 13;13.1
1.1;2;2.1	15. Offer functionality for automatic generation of parts of project application forms	12.4;13
1.1;1.4;2;2.1; 2.3	16. Provide automatic report, project applications and other documents sending facilities	12.4;13;15; 15.1
1.2;2.2;2.3	17. Publish information about partners	10;11.1
2.1;2.2;2.3	18. Give an opportunity to researchers and clients to find each other	11
1.1;2.1;2.3	19. Offer an easy mechanism to automatically inform administration and partners about project status	12;12.3;13;15
2.1	20. Use only one login to access all information	9
1.3;2.1;2.2	21. Offer mechanism to evaluate organizational units using statistical data	13;13.1

5. The blueprint of RTU RIS

The blueprint of RTU research activities was developed on the basis of analysis of the following issues (see Fig. 3): (1) vision, mission and strategy of RTU research activities, (2) basic research and research administration processes at RTU, (3) current research papers on support of research activities, (4) best practices of other universities, (5) goals of RTU RIS.

The blueprint of the RTU RIS consists of main components of RIS and relationships among them. For the sake of simplicity of representation, the hierarchical relationships and the data flow relationships are represented separately. The hierarchical structure of the blueprint of RIS is shown in Fig. 7. Due to scope, only data flows among external home page and other components are shown (see Fig.8). The blueprint of RTU RIS includes a considerable support for the researcher. Some of advantages provided by RIS are as follows: possibility to enter information only once and then reuse it for different purposes, possibility to receive information about project application opportunities, integrated library system,

automated report and proposal generation subsystems, and availability of easy available and understandable information about project specific bureaucratic procedures.

All the above mentioned advantages suggest that RTU RIS should be *researcher oriented* solution to free the researchers from certain routine non-creative activities and to be used without hesitation in their every day work. On the other hand, as seen in Table 1 and Fig. 7 and 8, the RIS supports research administration as well and includes all administration support components common in universities and other research institutions where RIS have already been introduced and tested.

6. RTU RIS development strategy

RTU RIS development strategy consists of a sequence of tasks concerned with acquisition or development of particular RIS components to support research work and administration with all necessary information technology solutions. The results driven systems development approach [18] was used to detect the sequence of component introduction. This approach requires consideration of immediate business result of the introduction of a particular component as well as mutual dependency of the components and their acquisition opportunities. Taking into consideration mutual dependencies of the components, the most desired by researchers automatic report and application generation component, is listed only as number 8 in the RIS development strategy, because it depends on other components that support data for report and application generation.

The sequence of tasks in RTU RIS development strategy is as follows:

1. Create an internal home page, where, by single authorisation, all necessary information is available for the researcher, including RTU library system and external libraries of scientific papers.
2. Develop a comfortable messaging system that gives an opportunity to send messages to one or several recipients or to the groups of recipients, which can be chosen by particular criteria. The messaging system has to be supported by feedback system that informs the sender about the success of the delivery of the message. Another role of the messaging system is to provide timely information about conferences and project opportunities. The system is supposed to include a category system that enables researchers to acquire information pertaining to categories interesting for them, as well as enable distribution of mandatory information to particular groups of users.
3. Create a help-desk where to report about incompatibilities, inconsistencies and failures.
4. Create a project management system, that includes project and grant data bases comprising information about existing and previous projects and grants. To envisage the possibility to inform automatically partners and administration about the progress of a project, as well as the possibility to automatically deliver reports, project proposals and other documents. Analytical instruments helpful for the project management are to be included in the system as well.
5. Create a mechanism (e.g., intellectual agents) for automatically finding information in the Internet about possibilities to submit project proposals and participate in the conferences.
6. Create repositories of patents, publications and product descriptions in the form of archive (1) enabling the scientist to edit his patents and publications; (2) ensuring that in browsing mode the information is available to all interested persons.

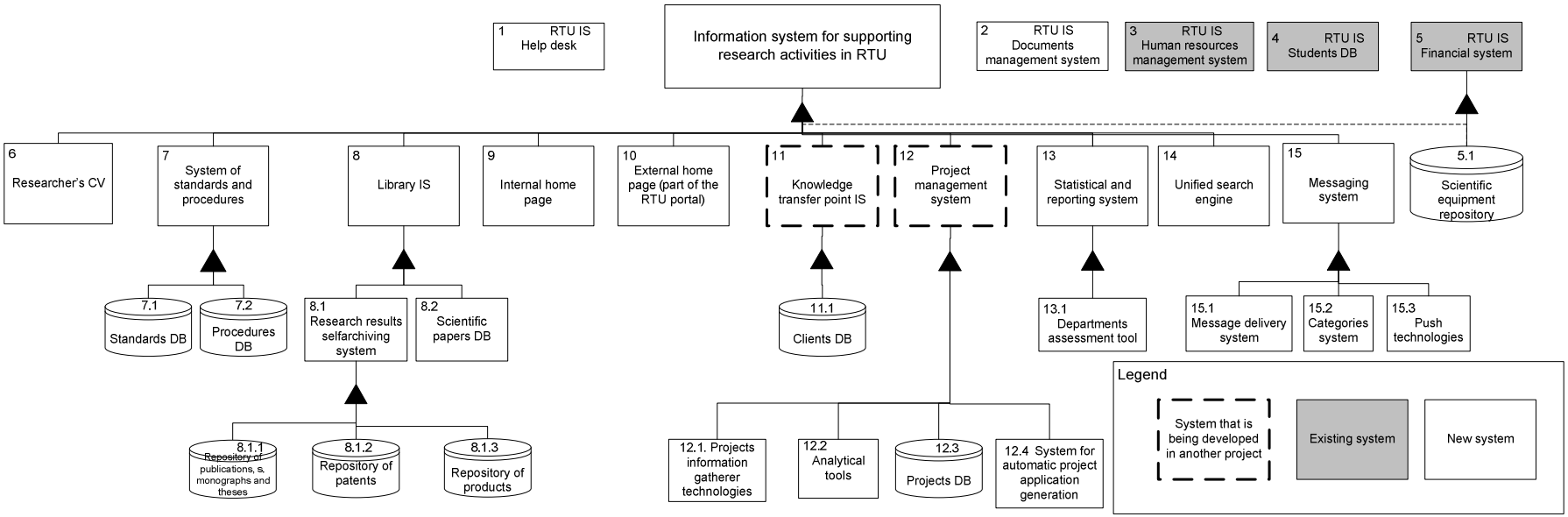

Figure 7. Hierarchical structure of information system for supporting research activities in RTU

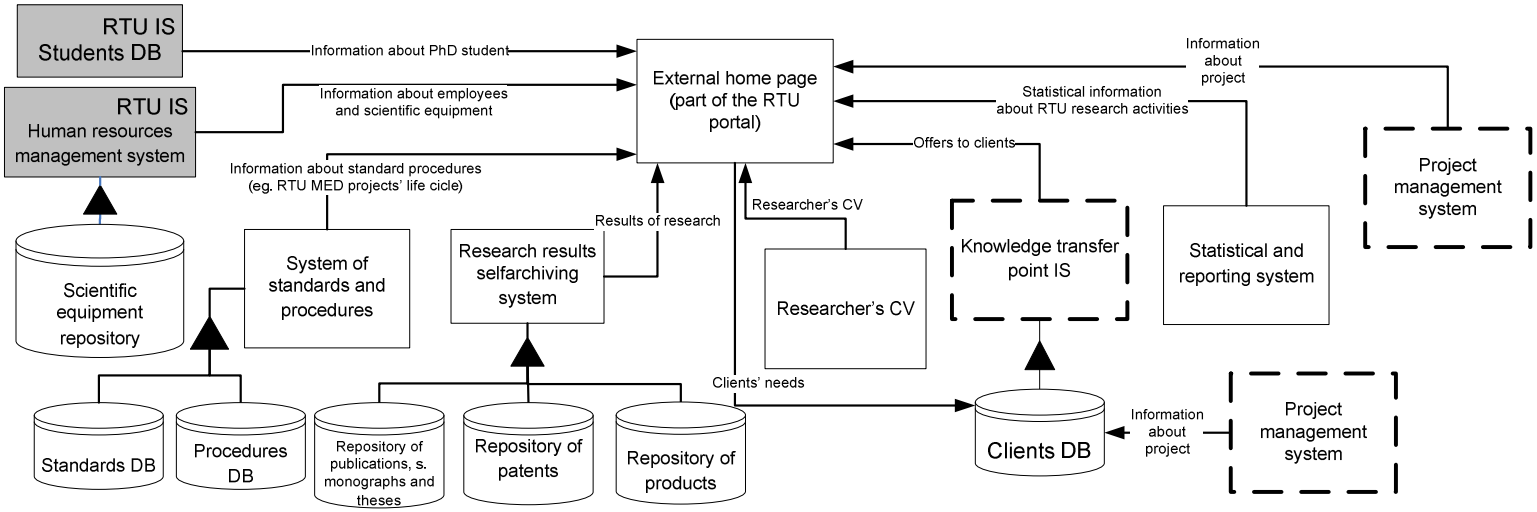

Figure 8. An example of a data flow diagram

7. Create a repository of standards, where all relevant RTU internal and field specific standards are stored; as well as a repository of bureaucratic procedures in an easily understandable form (e.g., in the form of business process diagrams) that would increase the productivity of researchers work.
8. Build a system enabling automatic generation of parts of project proposals, reports and researcher CVs, thus supporting reusability of information.
9. Build a system for automatic statistics generation enabling to estimate the work of structural units on the basis of statistical data.
10. Create a knowledge transfer point system enabling the client and the researcher to find each other.
11. Create a search server that finds the required information accordance to different criteria from all existing repositories.
12. Supplement RTU external homepage by high quality information about research activities to make science more publicly popular as well as to publish information about project partners and researcher's CV thus supporting the yellow pages service.
13. Create the database of research equipment and its corresponding contact persons.

7. Conclusions

Main goals of the research at RTU, goals of the RIS at RTU are defined, business process analysis is performed and latest experience of other universities in the development of RIS is investigated. As a result, components necessary for support and administration of research activities have been defined and classified in a hierarchy to show the blueprint of RIS, which can be upgraded later. Other links between subsystems of RIS are shown as data flows between system components (in this paper only part of these flows are illustrated). The paper is closed with the RIS development strategy, which defines which activities should be performed to provide necessary IT solutions for the researcher at RTU.

Investigations described in the paper were performed adhering to knowledge management methods which ensure that RIS is able to support the needs of scientist by the use of knowledge management and other contemporary technologies.

One of the most common failures of RIS development is focusing mainly on research administration needs. Thus the main person in the research activities, the researcher, is left without proper support and faces even grater workload. In such situation researchers are not open to use the RIS. Concept of RIS proposed in this paper is researcher oriented therefore probability of its use is higher.

This paper and other results of investigations can be used in further stages of RIS development at RTU.

In continuation of our work we intend to propose a more detailed RIS development strategy and guidelines for the implementation of RIS and integration of it in the future overall RTU IS.

Acknowledgement

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Lavendelis E., Stankeviča L., Atvare D., Pozdņakovs D., Kirikova M. Informācijas sistēmas koncepcijas izstrāde RTU zinātniskās darbības atbalstam

Pēdējos gados zināšanu pārvaldības un biznesa procesu pārvaldības sabiedrībā galvenokārt tiek pētīti procesi, kuros notiek intensīva zināšanu apmaiņa. Tādi ir arī zinātnē notiekošie un pētnieciskie procesi. Šajā rakstā tiek piedāvātas vadlīnijas informācijas sistēmas, kas atbalsta Rīgas Tehniskās universitātes zinātnisko darbību, izstrādei. Tās izstrādātas, izmantojot zināšanu pārvaldības metodes. Rakstā sniegts galveno RTU zinātniskajā darbībā notiekošo biznesa procesu raksturojums, misijas un vīzijas formulējums, parādīti arī galvenie zinātniskās darbības mērķi un zinātniskās darbības informācijas sistēmas mērķi, apskatīta ārvalstu pieredze šādu informācijas sistēmu izstrādē un zinātnisko darbu pētījumi. Vadlīnijas izstrādātas, izmantojot iepriekš uzskaitīto, un veidojot tās uz rezultātu orientētas – paredzot iespējami lielu ieguvumu iespējami mazā laikā. Zinātniskās darbības atbalsta sistēmā paredzēta orientācija uz zinātnieku, tā vēlmēm un vajadzībām, protams, ņemot vērā arī administrācijas vēlmes. Tas, ka paredzēts aptvert visu ieinteresēto pušu intereses, ir pamats domāt, ka sistēma tiks izmantota un nākotnē padarīs zinātnieka dzīvi krietni vienkāršāku un ērtāku, darot pievilcīgāku šo nodarbošanos jaunatnes vidū.

Lavendelis E., Stankevica L., Atvare D., Pozdnakovs D., Kirikova M. Development of the Information System's Concept for Supporting Scientific Activities at Riga Technical University

During recent years in knowledge management and business process management communities' mainly knowledge intensive processes have been researched. Processes in science are knowledge intensive as well. In this paper guidelines for the development of knowledge management based information system for supporting research activities in the Riga Technical University have been proposed. They have been developed on the basis of knowledge management. Main business processes of the scientific activities in RTU, mission and vision are given, as well main goals of the science and goals of the information system for supporting scientific activities, experience of other universities and investigations of scientific research are presented in this paper. The above mentioned has been used in the development of the guidelines and makes them results driven implying the biggest possible benefit in as short time as possible. Information system for supporting research activities is oriented towards the scientist, his needs and wishes, the needs of the administration have been taken into the consideration too. This information system will cover all the interested parts so we can expect that information system will be used and in future will make life of scientist comfortable and simple thus making this profession more popular among young people.

Лавэндэлис Э., Станкевича Л., Атварэ Д., Поздняков Д., Кирикова М. Разработка концепции информационной системы для поддержки научной деятельности в Рижском Техническом университете.

В последнее время сообщества, занимающиеся исследованием научных процессов и бизнес процессов, более всего уделяли внимание процессам, в которых происходит интенсивный обмен знаниями. Такими процессами являются и научно-исследовательские процессы. В данном реферате описаны основные указания для создания информационной системы для поддержки научной деятельности в Рижском Техническом университете. Данные указания были разработаны, используя методы управления знаниями. Реферат содержит описание главных бизнес процессов научной деятельности РТУ, здесь также указанны основные цели научной деятельности и информационной системы, рассмотрен опыт аналогичных исследований и разработок, проводящихся за границей. Описанные в реферате указания ориентированы в первую очередь на получение максимального результата в минимальные сроки. Информационная система, концепция которой предлагается в данном реферате, ориентирована на научно исследовательский персонал, принимая во внимание его пожелания и потребности, при этом, конечно, не забывая требования администрации. Так как в концепции системы предусмотрено охватить интересы всех заинтересованных сторон, есть основания полагать, что система в будущем будет востребована, и ее использование значительно облегчит работу научного персонала, сделав профессию ученого более привлекательную для молодого поколения.