A DIGITAL REPOSITORY OF SCIENCE RESOURCES OF RESEARCH INSTITUTE AS A SOURCE OF KNOWLEDGE FROM THE AREA OF PRODUCTION ENGINEERING FOR SMES

Btarzyńska¹, A. Klembalska²

¹Chair of Management and Production Engineering, Faculty of Mechanical Engineering and Management, Poznań University of Technology, ul. Piotrówko 3, 61-138 Poznań, Poland
²Industrial Institute of Agricultural Engineering, ul. Starołęcka 31, 60-963 Poznań, Poland

Abstract

One of the elements of building a competitive advantage of modern organizations is the appropriate use and development of knowledge resources. It also applies to the activities of manufacturing companies, in which both tangible and informational processes are realized. The last ones require support for both technical and managerial knowledge. In recent years, one of the ways to enrich the company's knowledge resources is to be able to acquire the knowledge from sources of digital repositories.

The article presents the concept of a knowledge repository, designed in a research institute working in the area of machine construction and operation. The proposed concept includes the structure of the digital repository of knowledge resources, a method of its creation and functioning. The project assumes that the main (in terms of number and interest in content) recipient of knowledge sharing services in the repository will be the manufacturing companies for which the research institutes' activities are research and development facilities. The proposed solution will be used by among others employees of small and medium manufacturing enterprises. In a case of a need for knowledge in the area of production engineering, the use of repository resources can be an effective way to supplement it.

Keywords:
Digital repository, knowledge management, SMEs, science resources, product life cycle, production engineering areas.

1. INTRODUCTION

A knowledge, as one of the basic intangible assets, is one of the fundamental factors that create the intellectual capital of an enterprise. The capital is built in the company among others based on available resources [1] and external sources of knowledge - in the area support is a science resource generated by research institutes.

The demand for a new knowledge arises from the fact that modern enterprise must respond effectively to changes in the economic environment, be constantly improving, manage production knowledge and innovations and bear the lowest costs (including costs of information acquisition and transmission). Flexibility and innovation are becoming a competitive advantage. The shortening of product lifecycle, the need to reduce production costs and reduce the time to deliver final products to the market generate increasing information needs, especially in the design and construction (R&D) departments.

The idea of creating a digital repository of knowledge as a ready-to-use product as a tool for conceptual and manufacturing work of manufacturing companies providing an open access to contents is embedded in contemporary trends in the use of modern technologies and policies for collaboration between science and the economy - both on a supply and demand model of processes of innovation, where the value of scientific research (R&D) takes an important place [2]. Research institutes, working for decades for the industry, have developed a number of solutions useful in developing innovative concepts and manufacturing processes. According to the paradigm that defines contemporary reality as an information mining era [3], the natural form of activity of both research institutes and enterprises is both dissemination of information and use of available resources. Information technologies support the functioning of the organization in such a scope. Digitization provides the flexibility of an activity and manufacturing profile.

Figure 1 illustrates the factors shaping the need to create the repository. These factors, created by the socio-economic and technological environment justify the need for such an IT tool. Taking into account that the science resources deposited in the repository and then effectively used in the enterprise create a new knowledge resource, the repository can be a tool for building a competitive advantage.

In addition, thanks to its functionality, it saves the time of employees seeking information and thus reduces the costs of acquiring the knowledge. It is up to date with working methods in the digital environment, according with the latest communication and information technologies, providing a global scope of the activity. It allows the company to react more quickly to changes and provide flexibility for its operations. Thanks to the broad thematic scope of published materials, R&D interdisciplinarity is supported. Due to the professionalism and long-standing specialization of the research work carried out by the research institutes, support in the form of repository resources enables to assure the quality of research departments of SMEs.
The main (in terms of number and interest in content) recipient of services related to the sharing of the science resources of the research institute in the digital repository will be enterprises, including manufacturing SMEs. Research institutes work most of all for the needs of large, small and medium-sized enterprises, serving facilities as research and development support for the industry. An extremely important target group to which the digital resources of knowledge gathered in the repository will be addressed are the constructors, technicians and employees of the research departments of industrial enterprises. The repository resources will be used by them during joint research projects or topics and using this knowledge in their individual work. Using the tool as an open digital repository of science resources can be transformed into the continuous development of knowledge that is the basis of a new product development. The mission of the research institutes is to cooperate with industry - as its scientific-research support, they are obliged to constantly cooperate to carry out ordered works and to monitor market needs. The knowledge of the needs arising from long-term cooperation with the recipients of the results indicates that there is a need to make available the resources of the institute's science. The cooperation is so pervasive that as well scientists and research institute researchers as R&D staff in manufacturing companies create and use a new knowledge, becoming its source and the user [4].

Research institutes are scientific units (beside universities, institutes of the Polish Academy of Sciences, Polish Academy of Arts and Sciences) [5] with a specialized activity profile (strictly defined by the national supervisory authority). The institute's core activities include:
- conducting research and development work;
- adapting the results of research and development to the needs of the practice;
- implementation of the results of research and development [6].

Research institutes (formerly till 2010 R&D units) have been established to carry out R&D activities for the specific industry. Established after the World War II, they were primarily aimed at supporting research and development for the developing of Polish industry. After 1989, many large manufacturing plants, factories and corporations were liquidated, privatized or taken over by foreign investors. Research institutes lost then their main customers. They had to adapt to the new market economy, offering their services mainly to small and medium-sized national companies (SMEs) and applying for research funding mainly from the state budget.

A particular important scope of the activity of research institutes includes the dissemination of scientific research and development works, the operation and development of databases related to the subject matter of the institute and the activities in the field of scientific, technical and economic information, inventions and the protection of industrial and intellectual property, as well as supporting the innovation of the companies [6]. Research institutes for decades have accumulated enormous science resources. Scientific information departments usually perform their tasks in the following areas:
- administration of knowledge resources, collection, sorting and dissemination of library activities;
- thematic bases;
- dissemination of knowledge through own publications (journals, monographs).

The statistics of recent years on the growth of the potential of R&D results have increased optimally - the share of new products introduced into the market resulting from R&D [7] increases [8]. New scientific programs - both national and EU - give the
opportunity to raise funds for R&D within the enterprise or in a scientific consortium.

2. A CONCEPT OF DIGITAL REPOSITORY OF SCIENCE RESOURCES

2.1. Existing solutions in the field of available repositories

Scientific resources are the results of research and development works in the form of scientific articles, monographs, scientific-research papers, conference materials, factual documents - photographs, films, raw data, information, instruction leaflets and technical documentation. Ignorance of these resources by potential beneficiaries adversely affects knowledge of the scope of activities of the institutes, awareness of their scientific and research potential. In addition, the collection is unprotected - it is often the material of several decades, which requires a digitization to survive.

The problem of effective cooperation (not only with industry - with other identified audiences: the sphere of science, education, business environment, administration, individual users) is unavailability of an existing collection of science resources.

So far, only a few scientific units (especially universities) have their own institutional repositories. These are repositories that are characterized by limited (mostly for employees and students) access to resources. Accessibility is also limited by content - only the summaries or the first pages of the publication are made accessible. Free, widespread and open access to scientific publications is increasingly emphasized in science policy, both at European [9], [10] and at national level [11], and the dissemination and promotion of scientific content is closely linked to the visibility of the scientific publications in the global network.

In existing digital databases (including institutional repositories) of scientific institutions, the collected resources are most often limited to publications in the form of scientific articles, theses and monographs. The projected repository of the research institute covers the whole range of creative works - apart from the above mentioned, the scientific-research reports, industry standards, raw data, multimedia files (films of tests) are planned to deposit. Due to its practical aspect, these materials are an invaluable source of knowledge and support for R&D departments in manufacturing companies. Thanks to the usefulness of the resource, the repository becomes in practice a applicable knowledge management tool that is part of the quality management system [12] and an effective support in formulating the company's strategy [13].

The collection of documents in the repository also unifies the existing variety of storage forms. Dispersing the resources (especially in analog versions) adversely affects the user's ability to find them - integrating full-text documents into one digital repository will significantly improve this situation and reduce the time taken to reach the document.

An access to a part of the collection of resources is restricted to designated libraries and limited (current or archived materials previously to be ordered). The solution greatly limits the flow of innovation and information from scientific units to industry. The existing distributed IT infrastructure was designed to meet the internal information needs of individuals and was not prepared for multiple queries and scaling of systems. The institutes have databases of scientific and research information. Unfortunately, these databases are distributed and available in different standards (ISIS, Marc21, MySQL) that require unification.

2.2. The planned structure of the repository of knowledge resources

The repository will include identifiable digital copies of scientific articles, monographs, scientific studies, conference materials and factual documents. The form and content of previously accumulated knowledge resources is presented (full-text versions) in the context of their suitability for conducting design, construction, technological, production, experimental and other work in manufacturing companies that are an important partner of research institutes in the area of technology transfer and innovation support. Figure 2 shows the functional layout of the repository. The research institute is responsible for supplying the resource collection of science materials in the form of among others: research reports, scientific papers, industry standards, raw data, media files. These resources are deposited in the form of digital files in the repository. Its users use the permanently archived materials in the open access formula, supporting the knowledge management process inside the organization.
2.3. An expected functionality of the repository

The repository in its functionality will meet the needs of the main user - the manufacturing company. Placing on a digital platform several dozen and in the future several hundred thousand copies of digital scientific publications do not guarantee that they are to be found and used by users. Hence the idea of paying particular attention to the searching function. Files will be described by respective descriptors, allowing segregation based on keywords, title, author, type of publication, date of creation.

It is planned to systematize collections, among others according to criteria particularly important for users of production companies: life cycle phases of product and production engineering areas. From the entrepreneur's point of view, it is important at what stage of the life cycle is the product on which the professional information is sought. Such classification gives the opportunity to select the appropriate information by chronological phases:

1) construction design of the product,
2) design of manufacturing processes,
3) organization of production processes,
4) production management,
5) operation [12].

Another search criterion, according to which interested users will more easily identify the needed files, is the division of production engineering areas. Digitized science resources will be assigned to the following groups:

1) organization and management of production and services,
2) selected issues in the engineering of manufacturing processes,
3) innovation management,
4) management of production and service projects,
5) supply chain of optimization and logistics,
6) quality management,
7) decision support systems; knowledge management,
8) forecasting in the company; modeling and computer simulation,
9) shaping the working environment; work safety
10) efficiency, productivity and organization of enterprises [14].

The proposed typing of the repository collection by product life cycle phases and production engineering areas will be the subject of a survey. The high level of functionality and orientation of the repository on the user is also evidence of the fact that it contains a full-text version of the publication. In most of these types of digital bases, the deposited files include title, keywords, and abstract of publications. In the repository the access to resources will be based on the “libre” principle and the content will be available under Creative Commons - Attribution 3.0 License.

2.4. Planned stages of work in the process of creating a knowledge repository (model of action taken)

In the presented case, the model proposed by Probst, Raub and Romhardt [15] was used to illustrate the whole process of creating a digital repository of science resources. In its original form, the model includes actions known as knowledge management processes, as shown in Figure 3.
The process of creating a digital repository of science resources involves the phases of locating, acquiring, preserving, developing, sharing and disseminating knowledge and, consequently, its application in business practice.

**Knowledge location** is done through the development of methods relating to the discovery of organizational knowledge. With regard to the situation of creating a repository of science resources in research institute, the process of locating knowledge includes:
- in the case of archival and existing resources - to determine storage locations of the collection,
- for resources produced within current operations - mapping the sources of knowledge, communications networking in the organization to provide information of updating the status of resources.

**Knowledge acquisition** in the sense proposed in the original model involves obtaining knowledge from external sources, out of organization (e.g. the acquisition of a new employee with the suitable qualifications). In case of the process of creating the repository, acquisition is carried out in a limited way - within the organization and consists in developing a system of transmission of individual copies (scientific papers, monographs, technical documentation) for further processing.

**Knowledge storage** is a process which in the original model is a further one after development of knowledge, sharing of knowledge, its dissemination and use. The specificity of creating a repository, however lies in the fact that the knowledge storage is the starting point for the next steps. At this stage a selection of acquired material is done, the result of which is the decision to include the resource in the repository. The decision depends on several factors. In the case of the science resources (like every author publication), copyrights disposal must be first determined - the authors who are employees of the entity, publishing with affiliation, generally conveys a right to dispose a form of publication for the institute. The content should be also examined in terms of usefulness for recipients and as well as the technical condition (not infrequently, due to age or way of storing the material is destroyed). A key step in the process of storage of knowledge is its safe-keeping. Before placing the material in the repository it must be digitized (if is not a digital copy yet) and properly prepared. The preparation consists of describing the file by metadata, enabling the identification of content. Files placed in the repository are subject to updating (expansion of content, change the description, replace the file on better quality one, foreign language versions).

**Knowledge development** understood as expanding the acquired knowledge in the case of a digital repository is manifested mainly in the systematic supply of collection in the new science resources. The process can be extended to customize the functionality of the base to the needs of users (thematic search, statistics, user-friendly interface, etc.).

**Dissemination and knowledge sharing** is the process of transferring the acquired knowledge and the creation of structures of its dissemination. The described repository as a rule guarantees open access to full-text materials, providing the workers of enterprises the ability to access the database from anywhere and at any time.

**Knowledge use** from the perspective of the creators of the repository (research institute) is independent of their plan. According to the idea of the operation of the repository, the knowledge is to be used, among others, by entrepreneurs to develop innovative technological concepts, facilitate cooperation of R&D sector with the economy and show the scientific potential of research institutes. Despite the obligation to apply the guidelines in connection with the further use of resources (Creative Commons licenses) there is the risk of theft of intellectual property. The threat of the use of information and results of research in an unauthorized manner by the company will be reduced by inscribing in the rules of the portal of the responsibility for the unauthorized use of data and simultaneous information on the benefits of cooperation presented in many places of the base.

The planned process of creating and operating a digital repository of science resources of research institute, based on the diagram of Probs, Raub, Romhardt [15] shown in Figure 2. Stage locating takes place within the organization (research institute), acquisition, retention and development processes closely related to the area of the repository, sharing, dissemination and use take place outside the organization and forming a supply base outside of the repository.
SUMMARY
The initiative to digitize and make accessible the science resources of research institutes is due to the need to adapt the activities of disseminating the scientific and research results of the activity of scientific institutions to the requirements of modern science and economy. Digital sharing of research institute science resources will result both in the repository supply unit and on the user side (including SMEs). By interacting outside the institute it will facilitate and accelerate scientific communication and collaboration between the various actors - both academically and non-academically, including entrepreneurs (knowledge transfer), to streamline the costs of knowledge distribution, facilitate archiving and long-term storage of digital content, and increase the capacity for building information society of knowledge. By anticipating cataloging of the collection by product lifecycle and production engineering areas, it will primarily support design and development departments in manufacturing companies by facilitating the search and acquisition of desirable data and expertise.

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