Knowledge Management and Evaluation for Industrial Research Processes

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Abstract. Knowledge management can support industrial research processes. In order to improve the identification of external information, a knowledge management system could propose functions to facilitate the integration of external relevant solutions into internal industrial research processes. Therefore, a knowledge evaluation process should support this knowledge management system. However, the evaluation of knowledge and thus the measurement of a "difference" between external and internal knowledge is directly related to access problems concerning knowledge and information. This article discusses the introduction of a knowledge management system for the specific context of industrial research processes.

1 INTRODUCTION

For companies the sharing of knowledge constitutes a strategic perspective [10]. If knowledge and know-how are under control, it becomes a resource and a strategic factor for constant product and activity quality improvement [3].

The role of an industrial research unit is to provide industrial operational units and customers with new knowledge, by answering posed problems quickly and by carrying out a technological monitoring of external environments [12]. Nowadays, in order to respect the constraints of quality, delay and cost, the managers in charge of industrial research activities and the industrial researchers need new methodologies and tools to support research activities. Among these methods and tools, we identified "knowledge management" methods and tools to counter the difficulties and constraints of industrial research processes [5]. These functions need to be supported by mechanisms of comparison, transfer processes, and a dynamic of sharing. The mechanisms of comparison are related to an evaluation of internal knowledge compared to external knowledge. This evaluation would allow to identify and transfer "useful" knowledge in order to "make it mature" for the needs and use of the operational customers and units. The results of an evaluation could initiate new research activities and thus initiate a development process of new knowledge. In order to illustrate the integration of knowledge management methods and tools for industrial research activitiesand processes, we will first illustrate our perception of industrial research and its existing knowledge flows. In the second part of our communication we will develop possible functions for a knowledge management tool for industrial research processes and the methods necessary to support these functions. A third part will detail the possibilities of knowledge evaluation, which we consider as being necessary to support the functions of a knowledge management tool.

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2 INDUSTRIAL RESEARCH

Industrial research can be considerate as the interface between the industrial world and the one of sciences. Industrial research unites are in constant relationship with industrial operational unites on the one side and with academic research institutions and organizations on the other side. The existence of industrial research is due to industrial managers and executives decisions. Being not satisfied with simple relations and co-operations with external research laboratories, they decide to develop their own research centers, integrated in their enterprise structure and organization. This is a strategic decision [8].

Industrial research, its processes and activities can be characterized and modeled differently. As we are in a logic of knowledge management we propose to characterize and model industrial research activities from an information flow, process and exchange point of view. This allows us to identify critical knowledge flows, necessary to be able to introduce knowledge management methods and tools. We propose two description models for industrial research processes: a macroscopic description of research processes including a strategic perspective and a microscopic description of research processes describing various levels of research activities and their knowledge / information flow.

2.1 Industrial Research Processes – A Macroscopic Description

Industrial research processes are characterized by the anticipation of industrial operational unit requirements: an industrial research unit tries to anticipate the customer requirements (the customers are located in the operational system of the group). This obliges the industrial research units to know and include/understand the customer problem environment and to take them into account for the

research processes. Providers of new external technologies and information constitute knowledge resources. The researchers use these resources to drive and fulfill research activities, in order to experiment new methods and techniques. This means to develop and combine new knowledge by meeting the research objectives and the customer requirements.
The industrial research units of the EADS group stand between an *external information provider system* (e.g. technology suppliers, academic laboratories, etc), and an *industrial operational system* of the industrial group (operational units like the design office, the assembly factories, etc). (Fig. 1).

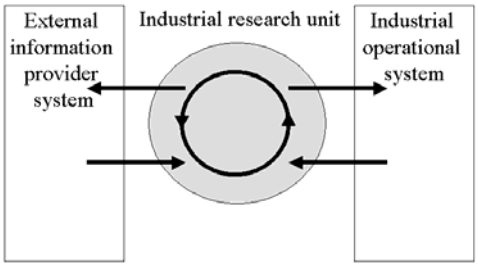

Fig. 1. Industrial research processes – a macroscopic description

2.2 Industrial Research Processes – A Microscopic Description

A research process is initiated by a need to improve processes and/or products of the operational system. This includes also the information and data management environment supporting these processes and products. A research process can also be initiated by the discovery of the importance of new innovative concepts. According to the maturity degree of the researcher's knowledge, the research process can be decomposed into activities describing an *exploratory research*, en *experimentation research* and *operational driven research* (Fig. 2) :

- The activities of an exploratory research characterize the identification of new research domains, the watch of new technological possibilities and activities with the aim to constitute state of arts about new technologies and new methods.
- The objective of the activities describing the experimentation research is to focalize on new technologies and methods and to acquire new knowledge and competencies.
- Operational driven research is directly related to the operational units requirements. The objective is to experiment illustrators, prototypes and methods with concrete data coming from the operational units.

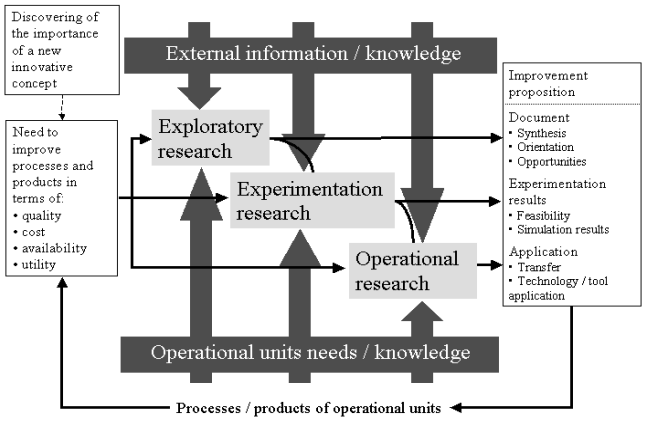

Fig. 2. Industrial research process – a microscopic description

As we haven seen, the different phases, exploratory research, experimentation research, and the operational driven research are not independent activities. Therefore, describing research activities with the notion *process* can lead to the misunderstanding that industrial research activities are sequential processes. This is not the case. The different forms of research activities depend on each other as well as they can be totally independent. Nevertheless, we will keep the notion of *research process* because it is widely used.

2.3 The knowledge flow in industrial research processes

Industrial research processes are characterized of knowledge exchanges and flows and the combination of new knowledge. According to the different activities in a research process and to the different phases, the mechanisms to collect or create knowledge are different:

- In the phase describing "exploratory research", the research activities focus primarily external knowledge,
- during the activities of the "experimentation research" phase allow the experimentation of new knowledge in order to verify new methods and technologies.
- For the activities in the "operational research" phase the customer requirements play a significant role.

As a result, the knowledge flow in industrial research processes can be characterized as follows: investigating, monitoring and transferring of external knowledge into internal knowledge [13]. The knowledge management, with its global integration dimension, organizational and technological aspects can support industrial research organizations in order to support and optimize the knowledge flow, the exchanges around knowledge, and the creation of new knowledge.

3 A KNOWLEDGE MANAGEMENT SYSTEM FOR INDUSTRIAL RESEARCH PROCESSES

A knowledge management system has to be integrated in research activities for all phases of the industrial research processes. This determines the environment interfaces for such a system: it is in interaction with external information suppliers, internal information suppliers, information resources concerning the customer requirements (operational units), and teams of researchers.

3.1 The Functions of a Knowledge Management System – Requirement Analysis

In order to analyze the requirements of researchers concerning a knowledge management system, we carried out a functional analysis to identify the characteristics of the potential functions of a knowledge management system for industrial research processes. These functions support partially the interactions between the environment interfaces of the potential knowledge management system (Fig. 3). The functions are described below:

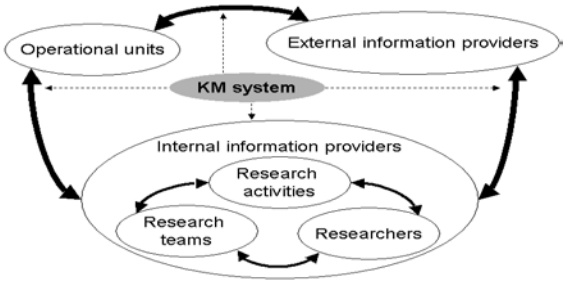

Fig. 3. The environment interfaces of a potential knowledge management system for industrial research processes

- The system should help to identify external industrial problems comparable with the problems of the research customers.
- The system should help to identify external solution proposals (methods and technologies) for the research customer requirements.
- The system makes visible the gap between the research activities undertaken by external research organizations and the internal research activities [19].
- The system helps to identify external elements (concepts, methods, technologies, tools, and competencies) in order to carry out internal research activities.
- The system should show how and in which way the research activities cover the customer requirements.
- The system should support a sense of sharing among internal researchers working in the same research area [19].
- The system should help to identify internal elements (concepts, methods, technologies, tools, and competencies) that help to carry out internal research activities.

These knowledge management functions could be supported by knowledge evaluation and decision support mechanisms: evaluate internal capitalized knowledge against external knowledge and compared to the customer requirements and activities. This form of evaluation would give a dynamic aspect to the knowledge capitalization activities: it would give the possibility to re-orientate the knowledge capitalization activities and the knowledge content to capitalize. This evaluation mechanism and decision-making support could help to increase the efficiency of knowledge management activities and ensure, with the definition of clear, precise and exploitable objectives, the use of a knowledge management system for industrial research processes. The decision support mechanism could help both, the manager of research activities to manage his research projects, and the researcher to help him in his research activities by providing him with the necessary knowledge to take the right decisions to support the efficiency of the research process.

3.2 Knowledge Evaluation – A Support for the Functions of a Knowledge Management System

The functions of a knowledge management system described in the last chapter are partially characterized by comparison mechanisms comparing external research activities and internal research activities. The objective is to identify external technologies and methods in order to be able to experiment them and if necessary to transfer, adapt and use them for internal problems [4]. These comparison mechanisms are related with a technology and method evaluation process. The industrial researcher evaluates the utility of unknown technologies and methods in order to be able to judge their use for his research activities. We define that the utility evaluation is related with the maturity of technologies and methods [2]. Therefore, we distinguish four maturity levels for technologies and methods:

- First level: technologies and methods not yet developed but existing as concepts.
- Second level: technologies and methods developed in academic laboratories but not yet used among industrial users.
- Third level: technologies and methods available at technology providers but without significant use context.
- Fourth level: technologies and methods available with an important industrial use context.

The maturity of technologies and methods depends on their use context. Therefore, we propose an evaluation process based on the evaluation of the maturity of external knowledge compared to the maturity of internal knowledge. The evaluation criteria are determined by taking into account the objectives of research activities and help to express the different maturity levels. Information and knowledge passed by this evaluation procedure can give a baseline for a decision support and the development of new knowledge. The positioning of information and knowledge according to indicators can for example indicate a difference concerning the control over the maturity of internal knowledge or technology know-how concerning a specific research sector compared to the maturity external knowledge or technology know-how (Fig. 4).. The transfer of external technologies or methods, thus parts of external knowledge, has to be integrated in industrial research processes [11].

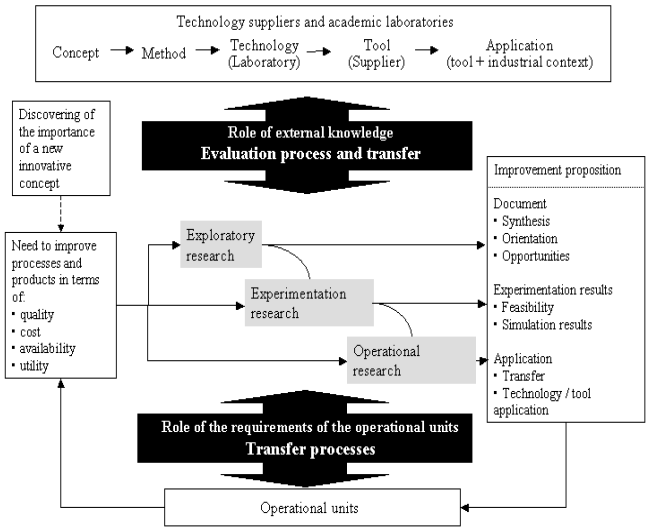

Fig. 4. Knowledge evaluation in industrial research processes

The methods for measuring the intellectual capital [17] in companies can be considerate as a first support to develop indicators for the evaluation of information and knowledge. For our problem context, we focused on two approaches of immaterial actives evaluation methods: value based management approaches and productivity based management approaches. These two approaches propose structures which could correspond to knowledge evaluation indicator structures for industrial research processes. Among the productivity based management approaches we focused on methods proposed by Sveiby [17], [18], Kaplan and Norton [6], [7], Celemi and Skandia [1], [16], and Göran and Roos [14]. The results of this work remain to be tested.

Nevertheless, in a knowledge evaluation process, it is important to take into account that knowledge is always situated in a use context. This implies that an evaluation is always to see in situation: to take into account the evaluation of the results generated with knowledge. The evaluation of knowledge is thus to see in the context of industrial research processes and therefore needs its own evaluation method.

4 CONCLUSION AND PERSPECTIVES

Knowledge management is very often interrelated to innovation and innovation processes [15] Although there is a good understanding of the interrelation between knowledge management and innovation processes, there is a lack in literature describing the interrelation between knowledge management and research processes and particularly with industrial research processes. Of course, innovation processes are embedded in industrial research processes. Nevertheless, there is a difference between these two processes. Innovation processes very often focus on particular technologies or even ideas. Industrial research processes cover global concepts including methods, technologies and tools. The objectives and context are different and industrial research processes need their own knowledge management concepts.

A knowledge evaluation process could constitute a basic framework for the functions included in a knowledge management system for industrial research processes. However, the evaluation of knowledge and thus also the measurement of a difference between external and internal knowledge could be related to access problems concerning explicit knowledge in order to be able to compare it: a precise knowledge description which will be evaluated seems to be necessary. Knowledge is in general in a use and action context. This context should be taken into account to be able to generate objectives evaluation results. Concerning the evaluation of the maturity of knowledge, it is necessary to define internal levels of maturity comparable to external levels of maturity.

The knowledge evaluation in specific research context and for given problems can initiate new research projects which can lead to the development of new knowledge. We have thus some mechanisms allowing to use information and knowledge in an actionable research context. D. Schon talks about "actionable knowledge" [9] in order to exceed the usual distinction between knowledge and know-how. A knowledge evaluation mechanism is thus part of the basic functions for a knowledge management system for industrial research processes.

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