Cap. de livro

Boughzala, I., Ermine, J.L (Eds).

2005

Chapter 16

Appraising the Knowledge in a Radio-pharmacy Center based on Process Mapping and Knowledge Domain Cartography

16.1. Introduction

Knowledge is being widely recognized as one of the most important assets, if not the most important asset, of any modern organization. As a consequence, this issue has also captured the attention of research and development centers, which are institutions whose missions depend on the creation and use of scientific and technological knowledge. The concept of treating organizational knowledge as a valuable strategic asset has become almost a consensus in these organizations and as such they must effectively create, capture, harvest, share, apply, preserve and protect their knowledge. Although the concept is clear for the majority of such centers, the methodology, means and tools to deal with the above-mentioned processes may not be in place, and may even not be in the awareness of the people in charge of managing those institutions.

Chapter written by Rita Izabel RICCIARDI and Antonio Carlos DE OLIVEIRA BARROSO.

11578

16.2. The importance of knowledge identification and evaluation within organizations

As the ability to manage knowledge seems to become more and more necessary, it is recognized that the management of resources is effective only when this can be defined in terms of their relevance, demand, availability, repositories and other pertinent characteristics that can influence the administration of the resources. To achieve this, we need to map the relevant pieces of knowledge and to identify and characterize their attributes and repositories.

Most of the knowledge that is relevant for an organization is already inside its boundaries. It is organized (or scattered) within its systems, databases and files, and, possibly, a part of it is already incorporated into automated processes, although a substantial part resides within the minds and intrinsic abilities of the employees. Nevertheless, the contents of these repositories need to be constantly complemented with new knowledge, which can be acquired externally or generated in the organization, recycled, adapted and reused in new circumstances. In summary, one can say that this core knowledge should be continuously leveraged and managed to generate more and more value with its use.

In principle, knowledge can be appraised with respect to its "criticality" by assessing its relevance (in terms of value aggregation to the organization) and vulnerability (possibility of loss and recovery difficulty). Furthermore, by evaluating the current maturity or development level of "pieces" of knowledge within the organization, and what would be ideal (practicable), a diagnosis of the knowledge gaps that the institution should cover can be produced.

Such evaluation is also necessary in order to have a coherent knowledge management strategy that guarantees the continuity and the development of this resource according to the objectives and goals of the organization, in terms of its vision of future. Knowledge identification and evaluation combined with the intended objectives of the knowledge management help to unveil possible solutions that correspond to the organization's needs for each knowledge domain (capitalization, preservation, sharing, appropriation and knowledge creation) and it helps the prioritization of different knowledge management initiatives.

16.3. The case study

16.3.1. *History and context of the Radio-pharmacy Center*

IPEN – the Energy and Nuclear Research Institute – is the largest research institute of the Brazilian National Nuclear Energy Commission (CNEN). It has 1200

employees, 65% of whom are researchers or engineers. Brazil has developed a considerable amount of knowledge in the nuclear area over the last 40 years, through long-term investment in research and technology transfer. At present, as in many other countries, the nuclear field is undergoing long-term problems due to lack of research funds, low support from governmental policies and little interest from young students. As a consequence, this considerable body of knowledge is, to a certain extent, "decaying" as its rate of utilization and dissemination is diminishing continuously. Moreover, it is not being adequately renewed, since both the investment and the number of people involved in related Research and Development is also being reduced. Of course, there are some exceptions in a few particular application areas, but in general there is a large risk of non-preservation.

The Radio-pharmacy Center (CR) has been created by the transformation of a typical research unit, inside IPEN, into an industrial-like production unit with certain aspects of a business unit. It has been certified according to ISO 9001/2000 standards and has as its mission "to produce and to distribute radio pharmaceutical products for nuclear medicine (diagnosis and therapy)". Today it is the most important unit of IPEN from a social and economic point of view, since it supplies some 300 hospitals and nuclear medicine clinics in Brazil, covering about 98% of the demand for radio-pharmaceuticals in the country.

Geographically, 64% of the demand is concentrated in the south-eastern region, 14% in each of the southern and north-eastern regions, and 6% and 2% respectively in the center-west and northern regions of Brazil.

It is necessary to note that: (a) the Center employees are workers in the public sector, where there is limited management autonomy; (b) production of radioisotopes and radio-pharmaceuticals is still a monopoly of the government in Brazil and (c) demand grows at 10% per year but nevertheless there has never been a problem of demand not being met.

Figure 16.1 shows the organization chart of IPEN with its units, where one can see the position of CR within it. Some of these units interact with CR rendering administrative, infrastructure and quality assurance support: administrative and information services, personnel training etc.; infrastructure supporting services etc.

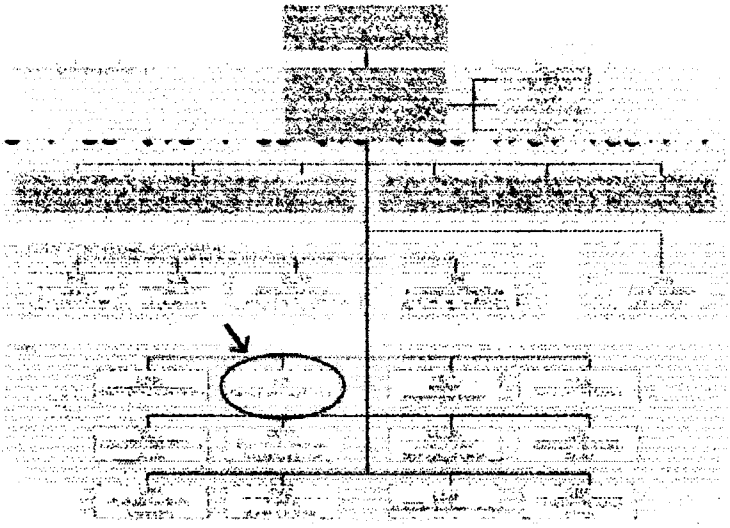


Figure 16.1. *The organization chart of IPEN and its units (taken from [INF 04])*

The CR management is organized in three divisions: Production, Quality Control and Assurance, and Research and Development of New Products (CRP, CRQ and CRPD respectively). The CRP division is subdivided into workgroups: Primary Radioisotopes and 99m Tc (technetium-99m) Generator, Labeled Compounds, Lyophilized Reagents (kits) and Support.

16.3.2. *The Center profile and key comments on its knowledge issues*

The history and initial objectives of the Radio-pharmacy Center have extensively influenced its current profile and its knowledge capital characteristics.

In the past, because of the mission of IPEN, the Center's activities were only geared to research and development in its field of interest (radioisotopes and radiopharmaceuticals). The role of the staff was mainly to follow new discoveries in this field and to master its underlying processes, envisioning a future application of the outcoming technologies on behalf of the Brazilian community. For these reasons, most of the efforts were concentrated on obtaining new technologies from abroad and adapting them to the reality of the country. For any product, much research and

experimentation was done and many prototypes were tested until it was proved possible to produce it in the Center. However, the efforts and the circumstances that allowed CR to migrate from its exclusive position as a research center to the current configuration of a business unit, scaling up the scientific research in laboratory to an industrial scale, were not preceded by any planning concerned with managing its intellectual patrimony.

In the following years, increased demand and the production of radio-pharmaceuticals with the degree of reliability required by clients caused the Center to adapt to its new functions and employees started to devote practically all their time to production activities.

More recently, with the growth of Center facilities, the increase in its production and the diversification of its products, it was necessary to enlarge the Center personnel. This involved the transfer of people from other areas of IPEN. However, many of those did not have the knowledge that was entirely appropriate to the needs of the Center, because, up to then, they had carried out activities in different fields. In addition, compared with CR people, they did not possess the extensive set of competencies and specific abilities, built through several years of research, because they had not participated in the activities that made up the development of the Center.

Today, however, it can be said that practically all the employees have the most important knowledge and abilities that are relevant to their functional performance. These were acquired partly as a result of their training or specialization and partly through accumulated experience in the development of their activities, contributing indeed to the importance of the intellectual capital of the Center.

If this historical background is analyzed and the primary vocation to research kept in mind, it becomes clear that there has accumulated in the Center a vast knowledge repository of high technological content concerning the research and development phases of the current products. Many of the researchers who were responsible for most of the projects that have yielded this knowledge are still working in the Center. Also, some part of this knowledge has been structured and codified, because of the ISO certification. However, a very significant part of it still remains unstructured: some of this may be in explicit forms such as personal notes and scientific publications, but the largest part remains tacit in the mind of the researchers and engineers, some of them near retirement age. One can say that there is a significant portion of knowledge that is at a considerable risk of being lost, at least, partially. This characteristic is, to a certain extent, common to research areas that have not been concerned about management of their knowledge assets, even if they have become enterprising units at a given moment in their history.

Most of the processes developed, involving production, quality control and radiation protection, are structured in the Operational Procedures and Work Instructions of the Quality Management System and they are available at the operators' work place, either on-line or off-line. This set of documents constitutes a substantial part of an "Organizational Memory" (OM), the part that describes in a procedural form (operational processes) "what is done in CR" and "how it is done". However, the essential part of the "CR intelligence", in other words, the reason why a process is carried out in a particular way and how it has arrived at this present form, is not structured and registered. It is really important to include those portions of knowledge (CR intelligence) in the Organizational Memory (OM documentation). What we mean here is to register, in a didactic and objective way, the knowledge and the reasons why the current processes have reached their current form, as well as the reasons why the products in today's portfolio were developed, including which other technological routes were considered and tried, together with an explanation of the reasons for choosing one and abandoning the others.

It must be mentioned that there seem to be no barriers among the personnel to sharing knowledge. Through internal consultations, when a person has a need, he or she can usually find someone to share the desired knowledge, although this is usually sporadic and non-systematized behavior.

Besides its operational divisions, the Center has recently created a Research and Development Division, which is in charge of research projects for the development of new radioisotopes and radio-pharmaceuticals. This division will also contribute to the development of improvements and modifications in the operational activities of CR, something that is currently under the control of some senior people from production.

A set of KM actions to accelerate the interaction between these two areas and, at the same time, to facilitate the systematized documentation and recovery of all generated knowledge would be of great importance. Such initiatives would transform the OM into a lively repository and a very useful instrument for organizational learning, as well as resulting in shorter time for the development of improvements and modifications.

This summarized diagnosis describes the main "frontiers" in CR, where knowledge management would produce sensitive gains. In addition, other critical areas can certainly be pinpointed, whose processes could be improved and facilitated through KM. For such an aim, knowledge identification and evaluation are necessary to identifying these "frontiers" and to suggest the best KM actions that will close the gaps.

16.4. The KM project

A five-phase approach was adopted for this pilot project. First, an internal analysis was performed with the objective of identifying and understanding the main processes. Second, the enabling knowledge for these processes was identified and its repositories were characterized, both phases proposed by Barroso [BAR 01] and used by Silva [SIL02]. Third, the identified knowledge was organized in a knowledge cartography representation. The fourth phase consisted of a "criticality" analysis according to a set of criteria chosen from a KM optics and adapted to the context of the Center. The last phase used previous results to propose a set of sensible KM initiatives for the Center.

Comment [DWP1]: Please explain what is meant here.

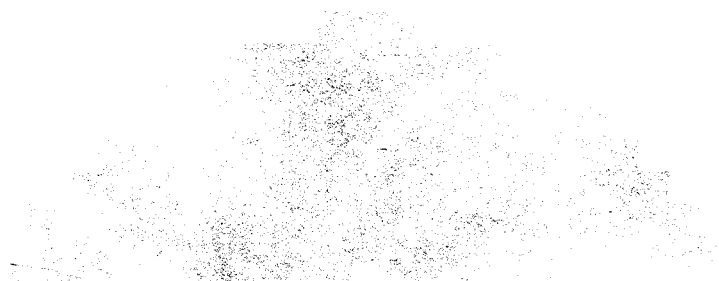
16.4.1. *Study of processes*

The study of the processes had the objective of more systematically understanding the foundations of the operational processes and their interfaces. Knowledge identification was accomplished through the study of center processes and underlying activities. Different means were used in a complementary mode: documentation review and analysis; interviews with leading personnel of the organization; writing up of summaries; and validation with the experts. Processes defined how the inputs work and how the existent resources are used so that the organization fulfills its mission.

In fact, this work was facilitated by the thorough documentation available as a result of the ISO certification. The Radio-pharmacy Center was studied in terms of the logic of its processes, their work and the information flow, as well as their interfaces. The processes of CR have been described in a classic manner using flow diagrams. The macro-processes were identified from the Quality Management System Documentation (Integrated Management Norms, Operational Procedures, Work Instructions and other documents) and they were decomposed into the respective processes and activities. From this analysis, the processes enabling knowledge were identified and characterized.

16.4.2. *Knowledge identification ("enabling knowledge")*

Once the Center processes were understood, a discussion with the (knowledge) actors of the processes helped to classify more precisely which knowledge and operational abilities are necessary and sufficient to achieve an adequate outcome from each process. This fine process analysis made it possible to elaborate and table related processes, activities and knowledge (with some supplementary information on products). To be thorough, in this pilot project, it was decided to focus on all



production and research and development processes. Therefore only a few off-core processes were not included. Several tables for detailing processes, identifying their enabling knowledge, were elaborated although, for reasons of confidentiality, this information could not be included here.

16.4.3. *Construction of the knowledge cartography*

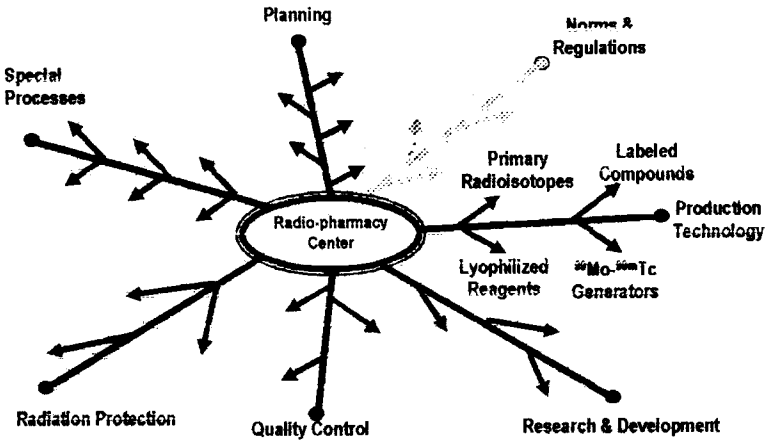
An interesting problem, for which there is not a widely accepted solution, is how to represent the organizational knowledge in a way that produces a representation that is both visually friendly and accurate. In other words, how to have a good reflection of the organization's intellectual assets.

There are many ways to picture, in structured fashion, the tangible resources of an organization. However, knowledge assets are more difficult to represent. The approach used in this project, called "Knowledge Domain Cartography", is based on a classification by domains, according to themes and final outcomes, which was proposed by Ermine [ERM 02] and used by Peil *et al.* [PEI 01] and Aubertin *et al.* [AUB 03].

The construction of the cartography starts with a central node that corresponds to the main purpose of the organization. Then, a set of outward flowing axes starts from this node, each one representing a strategic knowledge theme, usually associated with one of the main components of the mission of the organization. Depending on the level of detail that one wishes to show, the main axes can have secondary axes representing sub-themes and these give rise to branches that represent the knowledge domains. Sometimes, these domains can even be further split into sub-domains. Usually a top-down approach is used, with some charts to show themes and sub-themes and then separate charts to detail each axis (theme) into sub-themes, domains and eventually sub-domains. Sometimes some of centered support axes are used to represent important knowledge that is not directly connected with the main purpose of the organization but with support activities related to it. A more detailed description of the Critical Knowledge Domains Cartography representation was published by [AUB 03].

The Knowledge Domain Cartography of the center was represented using eight diagrams. The first one gives a general view of the main axes, or strategic knowledge themes, according to the following categorization: Planning, Production Technology, Research and Development, Quality Control, Radiation Protection and Special Processes; plus a support axis (Norms and Regulations). The next seven are used to detail the domains pertaining to each of the main axes down to the level of domains or sub-domains.

Figure 16.2 shows the general vision of the Knowledge Domains Cartography of CR. To avoid a very dense drawing only the sub-themes of Production Technology have their names shown.



Comment [DWP2]: Is this the correct figure caption ?

Figure 16.2. *The organization chart of IPEN and its units (translation from [INF 04])*

16.4.4. *"Criticality" analysis*

The objective is to assess the relevance of each domain in terms of the objectives and goals of the organization and the degree of vulnerability of the objective. This kind of analysis gives important hints for choosing the most effective KM solution for each domain.

In this project, the analysis model created was based on the reference [CLUB 00], using evaluation criteria that were aligned with the goals and needs of the organization. Two criteria were used to "measure" the relevance of the knowledge domains – quality and complexity of knowledge and importance for the strategic objectives of the organization – and three criteria were chosen for the vulnerability assessment – difficulty of knowledge acquisition, capacity for sharing in the context of CR and knowledge rarity. A three-point scale was used for each criterion (0, 1.5 and 3).

Questionnaires and planned interviews were used for the analysis. The choice of the experts to collaborate in the assessment was based on their leadership, experience and proficiency in knowledge area of assessment.

The compound grade for relevance was an average of the grades for its individual criteria and the same was done for vulnerability. A knowledge domain was considered critical if the global grade was greater than or equal to 1.5 (grades are 0, 1.5 and 3) and if there was a grade 3 in at least one of the criteria. About 30% of domains ended up being classified as critical. The themes in the cartography of CR that were found to have critical knowledge domains were: Production Technology, Planning, Special Processes and Research and Development.

As example, Table 16.1 shows the details of two sub-themes of the Production Technology theme. The knowledge domains and sub-domains are shown and those that were considered critical identified

Theme: *Production Technology*			
Sub-themes	Knowledge domains	Knowledge sub-domains	Critical knowledge domains
Primary radioisotopes	Radioactive material processing	Cyclotron target preparation	X
		Reactor target preparation	X
	Supporting techniques	Glove-box handling	
		Glove-box cleaning	
	Radioisotope processing	Solutions preparation	
		Dilution calculations	
		Ph measurements	
		Impurity segregation	X
		Activity measurement	
Labeled compounds	Supporting techniques	Glove-box handing	
		Glove-box cleaning	
	Compound processing	Solutions preparation	
		Labeling	X
		Activity measurement	
		PH measurement	
		Dilution calculation	
		Purification	

Table 16.1. *The organization chart for IPEN and its units (translation from INF 04)*

Comment [DWP3]: Again, is this the correct caption ?

16.4.5. *Setting up a KM plan of action*

There are many actions in the "classical" KM repertoire that can be suggested for leveraging generation, sharing, utilization and improvement of the knowledge domains that are considered to be essential for the Center. The best choices depend on many factors, such as the type of knowledge conversion, formatting and the actions appropriate in each knowledge domain.

The identification, mapping and analysis that were performed in this project provide a clear perception of which the critical knowledge domains are, how critical they are and why. This is the kind of knowledge that allowed a short list of tailored KM actions to be proposed, as follows:

– knowledge data (video and sound) concerning the critical aspects of the processes (Critical theme: Production Technology);

– a knowledge database of "problems and solutions" (Critical theme: Production Technology);

– a program "RC teaching RC" – meetings and mentoring (Critical theme: Production Technology);

– virtual communities of practice (Critical theme: Production Technology);

–an internal program of Contamination Control and Best Practices in Fabrication (Critical theme: Special Processes);

– a KM-oriented functional development program (all themes);

– an organizational memory (Critical theme: Research and Development);

– a knowledge portal (all themes).

A few initiatives are currently in progress, such as the elaboration of an organizational memory using knowledge books and the MASK method [ERM02].

16.5. References

[AUB 03] AUBERTIN G., BOUGHZALA I., ERMINE J.-L., *Cartographie des connaissances critiques: Extraction des connaissances et apprentissage*, Hermès, 2003.

[BAR 01] BARROSO A.C.O., *Processos Corporativos e Outros* [notas pessoais de aula TNA 5773, 2o. Sem. 2001].

[BAR 01] BARROSO A.C.O., *Raizes, História e Conceitos Envolvidos na Gestão do Conhecimento* [Notas de aula TNA 5773, 2o. Sem. 2001]

[COL 00] Club Gestion des Connaissances, Ermine J.-L., Laude H., "A Knowledge Maturity Model", Actes du Workshop "Knowledge Management; Theory and Practice" J-L. Ermine (dir.), PKDD2000 (Principles of Knowledge Discovery from Data), pp. 13-18, Lyon, 12 September 2000.

Comment [DWP4]: Would it be helpful to provide an English translation of this ?

Comment [DWP5]: Also here

[ERM 00] ERMINE J.-L., *Les systèmes de connaissances*, Hermès, 2nd ed, Paris, 2000.

[ERM 02] ERMINE J.-L., *La Gestion des Connaissances*, Lavoisier & Hermès, Paris, 2002.

[ERM 02] ERMINE J.-L., *Initation à la méthode MASK*, CD-ROM edited by the University of Technology of Troyes, 2002.

[INF 03] *Informe Anual IPEN*, Publicação IPEN, August 2004.

[PEI 01] PEIL O., AUBERTIN G., ERMINE J.-L., MATTA N., "La Cartographie des connaissances critiques, un outil de gestion stratégique des connaissances", Actes du Colloque CITE'2001 – Coopération, Innovation, Technologie; 29-30 November, 2001, pp. 237-308, Troyes, France.

[SIL 02] SILVA D.D. DA, SERNIC R., BARROSO A.C.O.; RICCIARDI R.I. "Projeto de gestão do conhecimento para uma grande empresa multinacional do ramo gráfico", In XXII Simpósio de Gestão da Inovação Tecnológica, 6-8 November 2002, Salvador, BA. Anais p. 148 and CD-ROM.

Comment [DWPG]: Please provide the English equivalent.