Knowledge Management Techniques for Know-How Transfer Systems Design. The case of an Oil Company

Djilali Benmahamed*, Jean-Louis Ermine**

* Centre de Perfectionnement de l'Entreprise Sonatrach, Département Informatique
BP 78 – Ain el Bia, Oran – 31230 – Algérie
dbenmahamed@cpe.sonatrach.dz

** Institut National des Télécommunications, Département Systèmes d'Information
9, rue Charles Fourier, 91011 Evry Cedex – France
{djilali.benmahamed, jean-louis.ermine}@int-evry.fr

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Summary

This paper presents a research in progress on the use of knowledge engineering and knowledge management techniques for the development of a strategic approach for the transfer of professional know-how. This transfer is based on the design of devices for sharing and learning clearly identified knowledge in the oil industry domains. This work is based on a pilot study which was carried out in the PED department (Petroleum Engineering & Development) and it deals with upstream activity of the oil group Sonatrach. A mapping of this know-how was established using a method based on mapping strategy. The main steps of the current approach are the strategic analysis for required competences, the processes analysis for professional know-how and a cross analysis for strategic competences and critical know-how. Emphasis is put on the strategic and critical aspects in the areas of knowledge where efforts are to be made in terms of capitalising, sharing, learning and transfer.

Key words: Knowledge Management, Knowledge Map, Strategy Map, Knowledge Engineering, Learning, Knowledge Servers, Computer Assisted Human learning, E-learning.

1 Introduction

In today's context (globalisation, harsh competition, knowledge based economy, ever growing international mobility, etc.), the management of knowledge in companies has become an extremely important issue at stake. The potential damage caused by the loss of a key competency and the significant number of leaves in terms of planned departures or else in terms of the most experimented staff, has caused concern in an ever increasing way, thus calling for the necessity to adopt a strategy of knowledge management. In this article, we define the elements of a strategy of know-how transfer for the Oil Group Sonatrach[1]. This research work is based on practical application in the company and is sponsored by Sonatrach.

Sonatrach is the Algerian company for research, exploitation, transport by pipeline, transformation and trading of hydrocarbons and their derivatives. It also operates in other sectors such as electricity production, new and renewable energies and the desalination of sea water. Its activities represent approximately 30% of the GNP in Algeria. It employs more than 120.000 staff and workers.

[1] www.sonatrach-dz.com

The organization policy and operating principles adopted by the Sonatrach Group organize its activity around its core business with a reinforcement of the capacities of the Top Management in terms of development of the strategies and policies, an effective decentralization and a simplification of its functioning. Operational activities involve the operational activities in the Group and the development of its business capacities both in Algeria and Overseas with upstream and downstream activities, transport by pipelines and commercialisation.

Sonatrach Top Management has launched the knowledge management project as a strategic project. This Project is thus based on a global vision of the Company (and it is supported by the Top Management) together with local and effective actions aiming at producing noticeable profits in the short run. It aims at preserving the strategic potential of knowledge that has been acquired throughout the years, but which has remained tacit for its holders.

The mapping studies which were initiated during the early stages of the project constitute the backbone for a future observatory of competencies in the Sonatrach Group. Similarly, knowledge management has proven to be a powerful and inevitable tool for the forthcoming Sonatrach Corporate University.

Our research aims first at showing the feasibility of a capitalization strategy and the transfer of know-how in oil industry domains as much as it aims at describing the conditions of success in such environments. The re-use of the strategy as well as of the devices and their deployment for every unit constitutes one of the expectations of the Company.

From a scientific point of view, we try to validate a formal approach of know-how transfer based on strategy and on knowledge management and knowledge engineering techniques. The first result is based on an effective action plan which involves innovating concepts of knowledge management such as strategy maps, knowledge mapping, critical analysis, knowledge engineering, management for community of practice, collaborative work, etc.

The scientific framework of this study is based essentially on some concepts such as strategy maps [14], knowledge maps and criticality analysis as developed by the Knowledge Management Club[2], strategic alignment of knowledge [8], knowledge modelling as in the MASK method [6] and [7], as well as other knowledge engineering techniques (Graqc[3]), learning groups and communities of practice [24], modelling of the elements and structures of the various learning units with the help of IMS specification [12] as well as the computer assisted human learning environments [23], and E-learning. The synergy resulting from the interconnection of these concepts during the various stages of our research constitutes the formal and innovating framework of the ongoing study.

Our exploratory study is interested in the operational activities within Sonatrach, particularly the upstream activity (research, exploitation and production of hydrocarbons). It appears to us more valuable to carry out the study of this activity, with respect to the size and complexity of the Company. We have thus decided to confine ourselves to targeted knowledge by selecting a structure which constitutes a nodal point and an inevitable upstream activity, involving strategic and critical know-how.

[2] http://www.club-gc.asso.fr

[3] Group of Research in Knowledge Acquisition in France, http://www.irit.fr/GRACQ/

Thus, the PED division (Petroleum Engineering & Development) was selected for the test domain of our study.

This research project, within the PED, consists in designing and testing the KM methodology, based on the concepts mentioned above and directed by the strategy in Sonatrach, whose aim is to ensure sharing and transfer of the most critical knowledge. During the initialization phase, we presented our project in order to make the actors at various levels aware of the importance of this research work and to ensure their active participation in this project.

The phase which is currently underway consists in designing, then implementing devices (knowledge servers and computer assisted human learning, E-learning) by capitalizing knowledge with a knowledge engineering method and carrying out, thereafter, a pedagogical observation based on the acquired knowledge models. The groups of learners involved in the learning apparatus presented here, when sharing knowledge will evolve into communities of practice [24].

2 The Method

The general principle of the method is to identify the best professional knowledge and practices, to formalize them into models and to ensure the transfer of know-how. This requires the design of a knowledge repository (knowledge mapping), a strategic analysis and alignment of knowledge, then choosing, designing and implementing the most suitable modes for the diffusion, the sharing and the acquisition of this knowledge.

The objectives are to select the processes of collective learning, that have a capitalized set of know-how available, and which have been recognized as crucial by this analysis. Figure 1 summarizes the main steps of our method which, in addition to its strategic dimension, puts the knowledge holders (Knowledge Workers) at the centre of any process of thinking / acting.

FIG. 1 – Main Steps of the Method

The practical work has been carried out on the basis of four steps: group working sessions involving those concerned with discussion on a particular issue, individual interviews with nearly twenty people concerned in various processes (actors of knowledge/experts), interviews with managers to explain the strategy and finally readings of reference documents. 80% of the interviewed knowledge actors have an average of 20 years experience in their domains of competences with highly qualified professional profiles. The interviews and group working sessions took place at the PED and Sonatrach Top Management.

During the interviews, some support tools have been used (such as evaluation grids for criticality of the KM club, profile cards, recordings, etc.) as well as interviewing techniques. The fact that the interviewees worked for the Company have facilitated the contacts and the interviews. During group working sessions, we used facilitation techniques (brainstorming) and projections (video projector) to help the group to make their ideas converge for a better knowledge sharing. Once formalised, all the results have been validated with the participants

3 Strategic Analysis

3.1 Strategy Mapping

The strategic orientation of a company is a crucial factor for its performance [1]. In fact, whatever the type of strategy to be opted for, as it may be in the case for generic strategies or development strategies, the company may win a competitive advantage that results in a sale increase, profits or outputs [13]. The mapping of the strategy of the Company was carried with the objective of strategic alignment. This alignment aims at matching the needed strategy for knowledge management with that of the company, specifically in terms of professional knowledge.

After some working sessions, interviews and readings of reference documents, we have extracted a number of contextual factors that represent parameters for the strategy in Sonatrach. The current context involves a situation that is increasingly competitive but it also offers various opportunities: as the possibility of exploiting the convergence gas–electricity, the possibility of export of gas towards markets where the price level is high and/or towards markets where there is reserves depletion, etc. Therefore, this constitutes both elements of strategy for the Sonatrach Group (aiming at improving the strategy of exploration and the consolidation of its reserves potential) as much as it constitutes assets (competitive attitude, exploitable NG/LNG flexibility, possibility to increase production rapidly, etc).

FIG. 2 – Strategy Sonatrach

At the end of this first phase, we have obtained a consolidation of the strategic objectives of the Sonatrach Group. This analysis is represented as a Kaplan-Norton's "strategy map" [14] which may be summarized as follows:

1. Development of the level of the reserves (discoveries and re-estimation),
2. Production targets of 1,5 MMbbl per day in 2010,
3. Exports previsions of 85 bcm per year of natural gas bcm by 2010,
4. Improvement of the LPG and Condensate,
5. Optimal exploitation of refining assets, distribution and petrochemistry,
6. Encouraging partnership to reduce risks,
7. Development at the international level on all the links of the chain.

3.2 Impact of the Strategy of Sonatrach on the PED Division

3.2.1 The PED, a significant reservoir of strategic know-how

The PED (Petroleum Engineering & Development) is a division that deals with upstream activity within Sonatrach Company. As a structure involved in nearly the complete value chain E&P (Engineering and Production), the PED is the division of upstream activity that handles the largest variety of petrotechnical data. One of the major roles of the PED is to gather and store the relevant data

generated by other divisions. This position puts the PED at the centre of the interactions with various structures of upstream activity. Thus, the PED has to fulfil missions such as:

- Basic engineering studies and definition of the options for development in each domain,
- Planning and following operations (drilling and workover) and production,
- Technological survey and implementation of new technologies (shorts radius, horizontal drilling, etc),
- Design and definition of development plans and reserves exploitation (operated by Sonatrach and in association or combined actions),
- Realization of technical and economic studies following the policy of improvement of existing reserves or discovered reserves,
- Evaluation of the reserves in all oilfields throughout the Algerian territory, setting production and injection previsions on the basis of the situation of the reserves, of the level of development of oilfields and installation capacities,
- Estimation of opportunities as to the acquisition and development of assets through personal effort and/or joint projects in Algeria and Overseas.

Thus, the PED is a nodal and inevitable structure for upstream activity within Sonatrach. It constitutes a significant bank of strategic know-how. This justifies in fact the choice of this department for testing of the research project.

3.2.2 Strategic Competences for PED

The mapping of Sonatrach strategy (FIG. 2) has been instantiated on the particular case of the PED. Using these results, we have tried to highlight the competences which fit the vision of PED managers. We thus performed several working sessions and interviews to carry out the mapping of strategic competences in the PED. Figure (FIG. 3) illustrates the results.

FIG. 3 – Strategic Competences in the PED

This set of competences is attached to the strategy of the domain and it identifies “core competences” as exemplified in [18]. The strategic analysis has put forward the strategic and necessary competences that allow reaching the corporate objectives.

One of the main factors for success in a knowledge management method is the active participation of the knowledge actors, who remain the fundamental resources of any operational device of knowledge processing [20]. The strategic vision is not thus sufficient to ensure the success of the method. It is imperative to match this strategic vision with that of the operational knowledge workers. This is the objective of the following step, i.e., that of the professional knowledge analysis. The purpose of this analysis is to identify know-how which is critical, according to the professionals.

4 Professional Knowledge Analysis

4.1 Knowledge Mapping and Criticality Analysis

Building a map and carry out a criticality analysis require a methodological process ([2] and [3]). The method for knowledge mapping used here is defined in [8].

The criticality of a domain is defined as a risk/opportunities estimation in a given sector of the company [2]. We have chosen a grid of criticality elaborated by the French Knowledge Management Club.[4] Figure (FIG 4) represents an overview of these criteria.

FIG. 4 – Criteria for the Evaluation of Criticality

Once the mapping of the knowledge domains has been set up, we carried out the estimation of these criteria for each knowledge domain.

4.2 The Results

During this phase, our interlocutors were professional experts (knowledge workers) at the PED. The adopted principle was to gather the various activities in the knowledge domains, to elaborate them by means of a critical representation, then to supplement and validate the resulting mapping produced by these experts, in an iterative way.

A map started to be elaborated as the interviews were on-going. An appropriation of the problematic by the interviewees strengthened progressively. The various map versions were validated. This iterative validation took the form of a co-building in order to guarantee a maximal implication and appropriation by the interviewees. Once this stage has been finalized, we obtained the map given in figure (FIG. 5).

FIG. 5 – Map of PED knowledge

This map represents a description of PED know-how at a supra (meta) level [19]. It provides an addressing system of know-how which facilitates access .to knowledge

On the basis of this map, a criticality study was carried out. The evaluation of the criticality of a domain consists in attributing a grade according to each criterion of the grid of analysis for each domain. The more critical the domain is, the higher the grade is. Each domain was evaluated independently from the others. The restitution of the results relating to each domain is synthesized graphically in a radar diagram.

FIG. 6 – Radar Diagram of Criticality for Modelling Reservoir

[4] http://www.club-gc.asso.fr

The results of this criticality study allowed us to establish a map where the most critical domains are identified. The critical domains in figure (FIG. 5) are highlighted according to their colour : red, orange and green.

This visualization was very useful when we presented it to the managers. It has the advantage of being simple and easy to trace, in the sense that any element can be justified by a complete analysis file (interviews verbatim, notational system, synthetic leaflets, radars, etc).

At this stage of the KM process, we have obtained two results:

- A map of strategic competences, obtained on the basis of a strategy analysis of the company and involving the management,
- A map of critical knowledge, obtained by an analysis involving the knowledgeable professionals.

Without being contradictory, these two mappings represent different points of view. The next step, strategic alignment, aims at synthesizing these points of view.

5 Strategic Alignment

At this stage, there is a need to compare critical knowledge and strategic competences. In other words, we have to match the results displayed in Figure (FIG. 3) with those displayed in Figure (F IG. 5). To achieve this, we suggest a cross analysis on two levels.

- A first filter on the main branches of the two maps (FIG. 3 and FIG. 5) allows us to link knowledge domains to strategic competences. The table in Figure (FIG. 7) illustrates this first level of our cross analysis.

FIG. 7 Cross Analysis of Knowledge domains

- In the second step, each identified link (highlighted by an X in (F IG. 7)) is identified by decomposing the main branches in the mappings. Below is an example of the analysis of the links between "Engineering Reserves X Hydrocarbons Reserves" and which is summarised in the table of Figure (FIG. 8).

From qualitative point of view, the results represent a set of identified knowledge which is considered at the same time as critical by the professionals and which responds to the required competences of the strategy.

FIG. 8 Link Analysis for «Engineering Reserves X Hydrocarbons Reserves"

Let us recall that we are concerned here only with the most critical knowledge. It is thus necessary to weight the analysis with the criticality factor of the knowledge. Thus, in this example, the know-how appearing on the last line will not be considered because it is not critical. Lines 1 to 4 represent know-how which is both critical and responds to strategic competences, but it is only line 2 which represents a critical know-how involved in the maximum of strategic competences. Our analysis, then, makes it possible to select this know-how, "simulation of reserves" as the most critical know-how and the one that responds most to strategic requirements.

The whole set of critical know-how that has been selected is reliable and provable because it is the traceable result of a global methodology (Mapping of the strategy, mapping of knowledge, criticality analysis, strategic alignment, etc.) that involves every kind of actors of the company. It allows discriminating knowledge domains within a very important initial knowledge capital (in that case, only 15% has been retained from initially identified knowledge), on the basis of objective criteria that are open to debate.

The result of this strategic alignment of critical know-how constitutes the basis for the next step (currently in progress). This critical knowledge is characterized by professional skills and logics and they are using a great number of knowledge sources within the division. The criticality analysis has revealed the very tacit nature of a great number of know-how. In order to test the next step of our methodology, we have decided to focus on this tacit know-how, though this does not represent in itself the only problem that has been identified. A domain has been selected, experts have been identified and capitalisation has been initiated.

6 Capitalization of tacit know-how

Knowledge codification is a method which is often used for knowledge processing, acquiring it, designing learning environments and setting up the processes by which a knowledge based organisation becomes a learning organisation. This can be achieved by knowledge modelling methods, which identify and structure knowledge in a diagrammatic representation in order to make it visible, easy to handle, comprehensible, and transferable [17].

The capitalization process includes several stages centred on the notion of strategic knowledge which involves the location or identification of the sources of knowledge, their formalization, their organization and their storage, their distribution and maintenance. For each one of these stages, there are methods, tools, computerized products, besides or in lieu of less industrial and more traditional techniques.

Knowledge capitalization is not a goal in itself. It is a permanent issue that is omnipresent in the activities of each employee. This process is well illustrated on the diagram proposed by Grundstein [11]. As a method of capitalization, we have chosen the MASK method ([6] and [7]). This method for knowledge management is currently in its third generation. For nearly 15 years, it has been continuously refined and improved through very numerous projects that have been carried out in companies of various sectors and different sizes.

The result obtained initially in a MASK project is a set of models that formalize knowledge and which were elaborated through interviews with the knowledge holders. These are sufficient enough if

one wishes to proceed to an immediate data-processing application (a computerized decision-making system, a database …).

The MASK models, supplemented by full information and documents, cards, files … which are relevant, constitute the "Knowledge Book" of the given domain. The concept of Knowledge Book is a continually growing notion within the knowledge management framework and it has come to be a very important notion. It capitalizes and diffuses a whole set of knowledge in a given area, it represents knowledge structure and it indexes the documents concerning the activity (descriptive cards, memos, publications, hyperlinks,…) together with multi-media contents (video, images, sounds…). It also provides a strong basis for any operational project on knowledge processing. [7].

The first possible use of a Knowledge Book is its access by the knowledge workers in a given intranet "knowledge space", which is dedicated and integrated into the information system of the company. It is what we also call a "knowledge server" or "knowledge portal".

In addition, the MASK models represent a strong interest for teaching scenarios in order to describe the steps for the sharing and the acquisition of the modelled knowledge. This allows determining the contents of the learning devices [4].

Knowledge servers and computer assisted human learning environments, E-learning, represent in fact the technical devices we are suggesting in our methodology for the transfer of know-how. The designing and application of these transfer devices and the definition of their contents is the next issues related to our current research.

In the objective of professional training, we are interested in the Knowledge Book representing know-how and best practices, as provider of the essential content for training devices. Hence, we distinguish ourselves from the classical methodology on traditional training [5], [9], [21] and [22], which is centred more on the learner than on expert knowledge. In what follows, we shall indicate some hints for future research and developments in the KM process in the company.

7 Designing Transfer Devices

We are currently focussing on the most critical domains and aiming at establishing a coherent set of methods and tools in order to ensure the transfer. Rather than considering disparate devices, which would look more like a panoply of tools than a concerted methodology [7], our target is to develop a complete and coherent working plan.

Several solutions are being investigated: sharing devices under the form of collaborative spaces, online discussion, knowledge and transfer servers, especially through training of this know-how by using E-learning technologies according to clearly defined norms and standards, that can later on be deployed (scalability).

In that purpose, we will exploit and re-use our already completed work [4] for the definition of learning contents, starting from the knowledge included in MASK models ([6] and [7]). This work articulates knowledge engineering techniques , that the MASK models encapsulate, and those of teaching management that can be exploitable through teaching scenarios. Once the targeted know-how has been made explicit and capitalized, we suggest ways for moving from these MASK models to

teaching scenarios whose elements are described according to the description language IMS - Learning Design. This use of normalisation reinforces the setting of scenarios and responds to a vision of standardization and re-investment of the contents of the transferring by learning devices .

This is a new approach which appears to be effective and with gives the possibility to develop realistic learning activities within the professional context. Indeed, knowledge to be learned corresponds to practices deriving directly from the concerned professional activities. Figure (FIG. 9) describes the principle for the elaboration of learning contents, starting from the knowledge encapsulated in the MASK models and other complementary sources. This allows pointing the contribution of the Knowledge Book to the definition of learning devices, and particularly the central role of the models, supplemented by other elements.

FIG. 9 – Principle of Elaboration of Learning Contents

The teaching design must take into account not only the contents and the tasks to be achieved but also the "learning relations" which will bring up to date (update) learning, as advocated in Mayes [16]. The importance of online supervision, which is based on the suggestions in the works by Fowler and Mayes [10] on the importance of the dialogical communication in the building of knowledge, will be examined.

Synergies between these tools and the process of capitalization and sharing constitute the basis of our research. This study will also have to consider the emergence of a learning community that activates around the designed devices and its progressive evolution towards a community of practice as defined in [24].

8 Conclusion

Both from a scientific and industrial point of view, the objective of the project is to design and test a complete knowledge management method for the transfer of professional know-how. On the basis of what has been achieved so far, the method is articulated in six steps:

- Stage 1: Strategic Analysis,
- Stage 2: Critical knowledge Analysis,
- Stage 3: Strategic Alignment,
- Stage 4: Capitalization of Tacit Know-how,
- Stage 5: Design of Knowledge servers and Computer Assisted Human Learning Environments (CAHLE), E-learning.

Each stage is based upon established theoretical bases (see Introduction). Those bases are classical in management science and knowledge engineering, and have been improved and adapted to the issues raised by the research project.

The project is currently in the middle of the way. Stage 4 is now classical. For a substantial part of Stage 5, the theoretical framework has already been conducted in [4]. Research in progress will thus lead us to develop knowledge models and learning models as well as to design knowledge servers and Computer Assisted Human Learning Environments and E-leaning.

We have particularly stressed the fact that the project proceeds in the most possible participative way, as this is a key factor of success. The professionals are indeed the main producers and consumers of know-how. Their participation as co-designers is a must for the appropriation of the methodology. This active participation approach for the pilot project which is currently undertaken, involving both top managers and operational knowledge workers, has largely reduced resistance to sharing and elicitation of knowledge.

In our mapping approach, we aimed at the location of knowledge (review of knowledge areas, identification of expertise holders, etc), evaluation and analysis of criticality of the knowledge capital(audit) and the visualisation of critical knowledge and its alignment with Sonatrach strategy. This made possible to identify know-how on which this strategy had some impact and therefore to identify the knowledge domains which have to be sustained and or developed by actions of transfer via capitalization and learning in particular. The next step is to demonstrate how the technology can support this transfer.

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