Extension of CommonKads for Virtual Organizations

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Abstract: In this paper, we describe knowledge acquisition for the construction of an extended enterprise memory. Our purpose is to verify the applicability of an existing knowledge acquisition method (commonKads) for the case of virtual organisations. The case study presented is chosen in the building domain. The organisation studied would like to preserve knowledge of post-seismic evaluations of damages caused to structural elements (beams, columns). The limits of commonKads for virtual organisations are then presented with propositions to extend it. We also focus on the tacit dimension of knowledge and propose to accept a margin of error in the acquisition process.

Keywords: Virtual enterprise, enterprise memory, knowledge management.

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1. Introduction

In many enterprises, information systems (IS) have acquired capital importance. Numerous tools of IS management have been developed. Beyond information management, currently we speak more about knowledge management. The factors of productivity are not solely physical capital and work forces, but also, knowledge capital. This capital must be "captured", stored and used at the right moment. The importance of this reality is twofold for big organizations, especially those integrated into networks. In fact, in order to respond to a complex and competitive economical environment, enterprises opt for networked systems. However, in the extended or virtual enterprises, management of experts and knowledge holders is a difficult task. The management of the knowledge allows them to master competencies and avoid "reinventing the wheel".

By realizing the above fact, we construct the base of our present work. Our main objective in this paper is to present a part of a project of corporate memory and knowledge capitalisation in virtual organizations; we take the construction industry as the illustration. The organization presented would like to save and capitalize its knowledge and its know-how concerning post-seismic evaluations of damages caused to elements of structures (beams, columns). In fact, if engineers have corporate memory at their disposal, they will be able to establish post-seismic evaluations efficaciously and confidently.

In order to capitalize on expert knowledge, we have first analysed the applicability of an existing knowledge acquisition method (CommonKads) for the case of a virtual organization. Since we found that this method presented some limits due to the fact that it did not consider virtual organization characteristics. Some propositions were made in order to extend CommonKads for these types of organisations. These propositions are followed by a discussion, which covers the limit of our new model. The last section summarises the knowledge acquisition process and the possibility of CommonKads' utilisation in this process.

2. Virtual organization: Definition

Today's organisations are faced with a dynamic and turbulent environment. Many of them have responded by adopting a new structure, which permits them to be lighter. In fact, this new structure allows every one to choose the suitable partners, with the ability to remain autonomous. These enterprises join their IS departments in order to cooperate more closely and more efficiently. For *Ahuja* and *Carley* [1]: A virtual organisation (VO) is a geographically distributed organisation whose members are bound by a long- term common interest or goal, and who communicate and coordinate their work through information technology. Several classifications of VO exist in the literature. For the purpose of our study, we will retain two types of VO [3].

- Stable networks of organisations: The links between the nodes of this network are perennial; for example, the cooperation between a cars' constructor and his subcontractors.

- Dynamic networks of organisations: The nodes of this category are formed by persons or teams having complementary competencies needed to achieve a project. The links between the nodes are purpose-oriented, like in a building project. The cooperation between the architect, the mason, the painter etc. will end once the construction of the building is finished.

3. The study problem

A corporate memory is the explicit and persistent representation of the collective knowledge of the extended enterprise [17]. In this study, we will adopt the same definition. We will focus on the problem of the VO memory constitution. More exactly, our project concerns the building field. The organisation of the case study is the CTC (*Controle technique de la construction*). This organisation would like to preserve knowledge of post-seismic evaluations of damages caused to existent buildings. This knowledge concerns the structural elements made of concrete (beams, columns).

After a seism, inspection of the damages caused to structures is fundamental in order to determine urgent actions and other ones, which can be done later. This will reduce the risk of collapse of buildings which are still alive and which need to be strengthened.

The first action is an inspection, which allows an evaluation of the structural damages. Often, the CTC appeals to experts working in other organisations and even to experts from other countries. However, in emergency situations and in view of the scope of the disaster, the number or capacity of experts can be insufficient. In addition, the strain, the stress, the emotion generated by such situations affects the capacities of the engineer responsible for the assessment.

Thus, faced with these problems, the CTC wants to preserve expert knowledge. This knowledge will help the inexperienced engineers so as to guide them in assessing any structural damages. This memory will be both diagnostic, in post-seismic damages, and helpful in formulating recommendations. These recommendations concern the urgent measures (reparations and restorations of the structures) with the aim of providing security and protecting human lives.

4. Knowledge acquisition process

In the enterprise, different typologies of knowledge exist. These typologies can be helpful in determining which type of knowledge an organisation must capitalize, and especially, which are the mean types of knowledge to be capitalised [5]. In fact, the kind of knowledge to be stored depends largely on the sources of this knowledge. It depends also on the methods needed for their acquisition, modeling and storage. In our article we have followed *Polany's* [11] typology, which distinguishes between explicit and tacit knowledge.

- Explicit knowledge: It corresponds to knowledge that can be transmitted via a language. It can be expressed, communicated and captured in a speech/report, databases.

- Implicit knowledge: This knowledge is acquired without being aware. It is subjective, experience-based knowledge that cannot be expressed in words, sentences, often because it is context specific.

In order to constitute the CTC memory, we had to acquire both explicit and tacit knowledge. We then analysed the applicability of these knowledge acquisition models for the case of VO. However the analysis reported in this paper is not all-inclusive.

Since several methodologies dedicated for knowledge capitalization exist such as (MKSM [7], KOD [16], CommonKads [12], REX [9]) only three methods are presented here.

KOD (Knowledge-Oriented Design): It is a methodology for designing knowledge-based systems (KBS). Its capitalization and modeling process is based on three models (The practical model, the cognitive model and the data processing model) and on three paradigms (the being, the doing and the telling). KOD describes the world in objects, actions and reasoning.

MKSM (Methodology for Knowledge System Management): MKSM proposes models enabling, the analysis, the modeling of organizations knowledge, and projects development cycle. MKSM models are based on two hypotheses: The systemic hypothesis and the semiotic hypothesis.

CommonKAds: KADS (Knowledge Acquisition and Design System) was born in 1985 as part of a European programme Esprit I. The project was continued in1990, and named KADS II. In order to be a commercial standard, this methodology has been improved and named CommonKads. For analysis of any knowledge-based application, CommonKads recommends the development of six models: The organisation model, the task model, the agent model, the communication model, the expertise model, and the design model.

In our project, it was decided to use CommonKads for modeling organisational and expert knowledge. This choice was motivated by two factors:

- CommonKads is one of the most used methodologies in the knowledge management field. It has the advantage of being used in several enterprises' projects, which has contributed to its maturity.
- The organization studied is not classical. Its structure and the means of communication between its actors constitute its originality. Therefore, we looked for a methodology that underlines the organisational and communication aspects explicitly.

After the choice of methodology to be used, the process of information collection was initially carried out using interviews. However, we were obliged to use different means of communication (telephone, fax, e-mail, etc.) to reach the experts who are geographically dispersed. We have to note that the process of collecting information took longer than we expected because some experts were strained while we used these means of communication. The lack of face to face created an uncomfortable atmosphere. We were then obliged to use videoconference with these experts who were more co-operative when using both audio and visual channels. These interviews provided much useful knowledge, and highlighted the existence of a number of relevant technical forms. We have to say explicitly that the processes reported here do not address the semantic level of knowledge acquisition, which could be difficult to measure.

5. CommonKads models applied to CTC

The CommonKads methodology follows an approach to KBS development as the building of separate models that capture salient features of the system and its environment. Every model of CommonKads has been studied for the case of CTC. A brief description of these models is proposed.

Organisation model: It is a tool for analysing the organisation in which the KBS is going to be introduced. The CTC structure can be divided into two levels:

- The first level is made up of the general and technical directions. The general direction manages the administrative work of the CTC. The technical direction establishes regulations, proceedings, technical forms, etc. In case of a seism, these directions contact the second level and give the instructions that must be executed.
- The second level is made up of several agencies. These agencies employ civil engineers who are experts in seism. These engineers are responsible of post-seismic evaluations. They use civil engineering materials (sclerometer, acoustical sounds, etc.). However, in many cases the number of

these engineers is insufficient. Consequently, the CTC has opted for a virtual structure of dynamic type. It calls, as the case may be, on external expert services. Some experts are from other countries (France, Italy, Turkey, etc.)

Task model: It is used to describe, at a general level, the tasks that are performed in the organisation environment where the proposed KBS will be installed, and provides the frame for the distribution of tasks over agents. The analysis of the CTC processes allows the evaluation of the different tasks accomplished, in order to evaluate post-seismic damages. These tasks can be summarised in five functions:

- The identification and damages observation: to identify damages on the seism site.

- The damages estimation: to appreciate the severity of the damages.

- The establishment of breaking modes: to determine if an element of structure has broken because of a shearing, a crushing, a buckling, etc.

- Formulation of necessary recommendations: It includes all the tasks allowing proposing recommendations and emergency measures.

- Estimation of the global damage of each storey of the building: to classify the columns and beams according to the severity of their damages (very severe, severe, moderate, weak, very weak, no damage). This allows calculation of a severity factor, which gives an idea on the global damage of each storey.

Agent model: An agent is an executor of a task. It can be human, computer software or any other entity capable of executing a task. This model describes the capabilities and characteristics of the agents. In our case, we have two categories of agents.

- Human agents: These agents can be divided in two categories too. The first one is composed of agents who go on the seism site in order to identify and observe damages. They must be at least, civil engineers. The other category is formed of decision-maker agents. They must be civil engineers too, but they must also have experience in the seism field. They estimate the damages and propose recommendations. The decision-maker agents can work with the virtual or technical forms of information (when they can not be present on the seism site).

- **Artificial agents**: These agents can help human agents supporting retrieval of the relevant information from the corporate memory. They can be divided into four categories: corporate memory management, ontology and dictionary, user management, agents' interconnection.

Communication model: It details the exchange of information between the different agents involved in executing the tasks described in the task model. In VO, communication is an essential component. It allows the reconstruction of a social space, missed by the dispersion (geographical or temporal) of the different participants.

In the CTC human agents have access to the information in a traditional way: telephone or fax. In order to exchange technical forms and reports they use also electronic mail and the World Wide Web. The use of the Internet to deploy the system allows for a great deal more openness. Furthermore, because the agent interface is presented on a web page, it allows the system to be available on any platform that can run a web browser.

The expertise model: At this level, we have done delicate work to create the domain ontology. The aim of ontology is to define the concepts, which are used. These concepts permit organization and structuring the knowledge elements of the enterprise memory. In fact, our enterprise's agents are from various countries (they don't speak the same language, they haven't the same experience). In view of the uncommon languages, ontology helps to reduce the language-specific characteristics.

The expert process can be summarized in two steps. Step A involves a global evaluation of the damages. During this step, the engineers fill the technical forms and prepare a report, which estimates the damage levels. These levels vary from 1(no damages) to 5 (demolition). The aim of the step B is to further define the first step and to define the different reconstruction programs.

The estimation of the damages with a factor (1 to 5) is based solely on the visual observation of the damage. This know-how is the result of several years of experience and training. The expertise model is then composed of three sets of knowledge which can be integrated in our enterprise memory.

- Basic civil engineering knowledge: It represents the minimal knowledge that a civil engineer must have (Structure analysis, materials resistance, structure dynamics, etc).
- The knowledge about damages caused by a seism: In our study context, we have considered the damages of concrete structures, the causes for each element, and the different breaking modes.
- The knowledge about techniques of building repair and reinforcement.

Design model: It concerns the design of the KBS in order to make the modeled knowledge operational. Our organisation memory has been represented using a collection of cases. This choice was motivated by the following elements.

The CTC has at its disposal a collection of past experiences for which the solutions are known and which can be easily transformed into cases. Moreover, an organisation memory always evolves; consequently it can never be built at once. A representation in terms of cases allows an incremental design by adding progressively new cases. Finally, a third characteristic of this kind of system is the scattering of experience. Representation of an extended organisational memory using a collection of cases allows clarification of this characteristic, because it ensures the locality of the memory' s modifications.

This model has enabled us to produce the first version of the prototype, which contains an organisation memory composed of 19 cases of evaluations and an exploitation module enabling post seismic evaluations. It includes also an interface, which permits the expert to interact with the system.

In the exploitation module the knowledge is represented according to different levels. More precisely, the damage concept is represented at three different levels. Within the case model, there exist two levels: The level called "General description" and the level called "Causal description". The first one describes the damage at a very general level, the general conditions under which it has occurred and its physical appearance. The second level presents the damages from the formation point of view and gives the classification of the damage. At this level, knowledge is structured into objects. Finally, the third level represents the damages in the capitalisation model. This model contains further knowledge concerning descriptions of evaluations, enabling the descriptions contained in the cases more dynamic and operational.

The direct application of CommonKads to the CTC has revealed some restrictions. These restrictions can be summarised as follows:

- The organisation model presents the context of the focal organisation, in the case where the other partners are individuals or experts (like in the case of the CTC), the problem is not serious. Therefore, when the partners are organisations, the organisational context of the VO must be analysed from each angle.
- Absence of a coordination model: The knowledge analysis in a VO concerns not only problem-solving knowledge but also knowledge allowing co-ordination between partners. So it is necessary to have a model which analyses the knowledge needed to manage this co-ordiantion.
- The geographical dispersion of VO actors implies several speech communities. The speech community refers to the different language groups. This may generate a loss of time during the knowledge analysis process. In order to remedy this we propose the design of a dictionary to translate the basic concepts of the knowledge domain.

We admit here that the above restrictions are the deficiets of CommonKads, however peripheral to the VO.

The following section proposes to cover up these limitations and to expand the CommonKads model.

6. Propositions for extending CommonKads

The process of knowledge acquisition has been easier to set up, thanks to decomposition in models. However, some limits have been found in applying the CommonKads method. These limits are due to the fact that this method has been designed for traditional enterprises; it does not consider the virtual enterprises characteristics. In order to fill these gaps, we have made some propositions:

6.1 **Splitting of organisation model**: The VO cannot be considered as a single organisation. It is formed by several entities. Each entity has its structure, mission, knowledge, power, resources, and constraints. The analysis of the VO knowledge must focus on two categories of knowledge:

- The shared knowledge of each partner: Each organisation, which forms the VO, has its own activities. These activities generate knowledge; this knowledge can be either private or public. The first category is not interesting for the VO KBS, because it is internal to and part of the company's strategy; it is not revealed outside. The second category is public knowledge, which may be accessed, for example, in the partners' external communication web sites. This shared knowledge can include last cooperative experiences, future projects, etc.
- The cooperative knowledge: In the CTC, the cooperative knowledge consists of expert knowledge needed in the evaluation of post-seismic damages. So, capitalizing cooperative knowledge consists essentially in the structure and memorization of common objectives, cooperation contexts and problem solving.

In order to collect these two categories of knowledge we have to analyse the structure of each partner and the relationship between them. In order to do that we split the organisational model into two sub models:

6.1.1 The macro organisational model: It gives a general description of the VO. This description includes:

- The structure of the VO: It describes the different nodes (actors) which form the organisation (The core partner organisation, teams, individual, etc)

- **The problem to be resolved**: A cooperative activity, whether centralized or distributed, requires the definition of an objective which is common to both agents engaged in this activity to obtain the best performance. Its execution presupposes the existence, as a shared resource, of an ensemble of knowledge.

- The type of the VO: It specifies if the organisation is stable or dynamic. This is important because in a VO of dynamic type, the cooperation between the different actors is ephemeral and members are often part of multiple teams at the same time. This temporal constraint must not be ignored. In point of fact, the process of knowledge capitalisation must be finished, preferably, before the end of the cooperation contract. In the opposite case, the expert may undertake another enterprise, and it would be difficult for him to restore the knowledge concerning his previous project.

- The power: People derive power from their role in the organisational structure and from the knowledge they possess. For that reason, the analysis of the organisation context in which a SBC will be integrated must consider the power of the people concerned. This component helps to locate the knowledge holders.

- The resources: Resources in VO are dispersed among the different actors. The acknowledgement of these resources leads to a description of the activities and the knowledge needed to manage the VO resources.

- The environment: Even when organisations are centered on their own know-how, they are extremely dependent on the surrounding organizations, with regards to adjusting their production and innovation processes. These organisations must always be up-to-date with the evolution of their environment in order to anticipate new needs and future constraints.

- The relations between the different actors: These relations must emphasise the interest of the co- operation between the partners. In the case of commercial transactions, the exchange of goods or services must be specified. In the same way, the co-operation of informational nature has to be specified, as an information flow will show the informational exchange between the partners.

6.1.2 The micro organisational model: This sub model allows an understanding of the functioning of each actor. This analysis is especially relevant when the actor is itself an organisation. It gives a detailed description (the activities, resources, constraints) of the organisation. On the other hand, where the actors are individuals, this micro organisational model will describe the experts' activities, their competencies, and resources. The description of the profile of the experts would help in exploiting the knowledge of them to the organisation.

6.2 The addition of a coordination model: Malone and al. [9] define coordination as the act to manage the interdependencies between tasks which are executed, with the aim of reaching a common goal. The interdependencies may be precedence relations between tasks, resources sharing, or synchronization. The coordination between VO actors implies the transfer of competencies and resources, and tasks sharing; that is why, it is important to introduce a coordination model. This model will represent the actors' interactions and will assure the tasks distributed have a common connection. It will permit the analysis of knowledge necessary for managing different organizational actors who have their own particular interests. In our case, a "human actor" ensures the tasks coordination between the CTC and the different experts. In case of a seism, he has to:

- List of actors with the required competencies.
- Send announcements to all the actors on listing..
- Receive the actors' recommendations and reports.

To do that, he needs:

- A database that contains information on actors and tasks realisation.

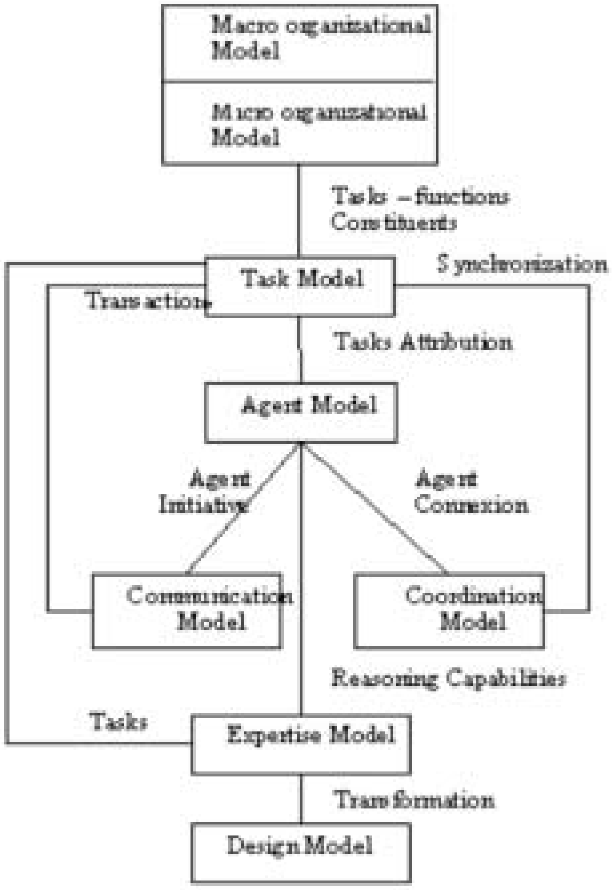

Figure 1. CommonKads model for VO

- A communication module that permits him to store messages, to interpret them, and to contact the other actors.

In the case of the CTC, the actors do not have to share physical resources. Their capital is an intellectual one. So the coordinator actor does not have to manage the sharing of resources. In other cases, i.e. other virtual organisations, the actors may use resources when they perform activities, which may be machinery, materials, etc. The coordination model will specify how the coordinator agent maintains and improves the collaboration. This model will explain:

- How resources are allocated among the different actors.
- How the overall goal is subdivided into tasks.
- Which criteria have been used to select the organisation partners.
- How conflicts are resolved in case of problems.

6.3 **Creation of a basic concepts dictionary**: Several authors have been interested in ontology in the knowledge management field, Bourry Brisset [4], Tixier [14], Vasconcelos and al. [15], etc. As explained before, ontology is a vocabulary that allows the specification of the terms and the relations between them in order to facilitate agents' communication. The domain knowledge, which is a sub-model of the expertise model represents the ontological knowledge [14]. This sub-model has been studied. Nevertheless, since the actors are scattered all over the world, ontology is not sufficient because the agents do not necessarily speak the same language. It is essential to have a dictionary. This dictionary will give the synonyms of the basic concepts and the translation in an international language (English, for example).

These propositions were added to extend the CommonKads model for the case of VO. As mentioned in figure 1, the new CommonKads model is made up of eight models: The macro organisational model, the micro organisational model, the task model, the agent model, the communication model, the coordination model, the expertise model and the design model. Thus the above sections 6.1, 6.2 and 6.3 constitute the introduction of the model.

7. Discussion

Applying this new model helps to understand the knowledge acquisition process in the CTC. It has permitted us to collect the existing knowledge and to determine new requirements. However, a knowledge acquisition process needs a contact phase, which enables one to see the experts at work, and to collect tacit knowledge. While conducting our interviews, we used video recordings to have maximum details. But no seism occurred during the phase of our data capturing, therefore it was impossible to see the experts while doing their evaluations. Yes indeed! The experts described their knowledge acquisition and application using their vocabulary, and in our case, the experts do damage assessment on their visual observations (cracks, crushing, etc). The descriptions they have specified to us were not quite sufficient to understand the knowledge acquisition and application process. In fact the experts had some difficulty in explaining their reasoning because their reasoning is natural and implicit which could be not feasible to express in verbal language. In order to illustrate these difficulties, we present an example. This example concerns the damage estimation caused by deformation.

After a seism, the load-bearing capacitance of structural elements is reduced because of columns collapsing and beams bending. The deformation depends on the type of the structural element (beam, column). In fact the beams' bending is itself a severe condition of damage: Even if the resistance of the sections remain constant, damage can occur owing to a loss of stability or due to formation of kneecaps plastic mechanism. This phenomenon results from the increment of bending momentum due to the seism undulation. We consider also that beam bending is more severe when visible to the naked eye. To represent this case, the experts used severity factors, which depend upon their observations.

- If no beam bending is observed then the severity factor = 0
- If the observed beam bending is hardly visible then the severity factor = 1
- If the observed beam bending is visible then the severity factor = 3
- If the observed beam bending is excessive then the severity factor = 5

The example shows that experts assign severity factors, these factors depend upon their experience. When they were asked to explain the difference between "hardly visible" and "visible", and between visible and excessive they were not quite convincing.

In order to fill such missing, we propose to tolerate a margin of errors in the measurement of knowledge acquisition process. This tolerance can be explained by *Nonaka*'s theory.

Nonaka [10] divides the tacit knowledge into two parts: One part is constituted of cognitive elements such as beliefs, images, intuition and mental models. This part will be called in our paper "non declarable tacit knowledge". The other part is constituted of technical elements such as craft and know-how; this will be referred to as declarable tacit knowledge.

Our knowledge acquisition method extracts solely the declarable tacit knowledge. However, with the explicit knowledge and the declarable tacit one, the enterprise's memory user "can make it out". Depending on the situation, his cognitive elements, his own experience (his non declarable tacit knowledge); he will be able to re-create the whole knowledge. So even we tolerate a margin of error when acquiring knowledge, this margin will be negligible when utilising this knowledge

8. Synthesis

The knowledge acquisition is the first phase in a KBS, other phases are necessary to transfer the expertise from experts to abstract structures reflecting the collective knowledge. In this section we will show how our system deals with these steps.

The first step consists of the exploitation of the structure of existing documents (technical forms). The aim of this step is to categorize the knowledge, i.e. to select which kinds of knowledge must be taken into account in the system. The support of this step is essentially the set of documents. This step produces 'Explicit knowledge'.

The second step consists of applying the extended CommonKads method to collect knowledge which is not reported on documents or which was not thoroughly understood by the knowledge engineer. This step produces ' Non declarable tacit knowledge'. The support of this step is by the set of experts.

Step one and two permit the collection of VO knowledge and its' structuring. This structuring is the first organisation of the knowledge but without any choice concerning the way it should be modeled.

Once the knowledge-structuring step is finished, the knowledge engineer can choose a technique allowing representation of the organisation memory (case-based reasoning, machine, learning, neural networks...). As explained in section 4, in our project we used case-based reasoning. This step produces a model formed of a subset of cases. The last step is called "prototyping and tests". It consists of testing the model obtained at the end of the previous steps. The purpose of this step is to verify whether the cases generated are complete, that is to say allows representing any element to be included in the VO memory. The support of this step is from the prototype (cases) and the experts. The final result of this step and of the acquisition process is a refined model.

As specified earlier part of this paper, the presentation given could not be comprehensive owing to space limitations and thus may be indicative to the readers.

9. Conclusions

The first aim of this study is to propose a knowledge acquisition model for VO. To reach this goal, we have extended the CommonKads model. This extension is added to fit to the knowledge requirements of VO.

Moreover, we have focused on the tacit dimension of knowledge. We propose that, contact with the expert is necessary for knowledge acquisition. Nevertheless, we have allowed for an imperfection threshold, because the memory's end user will perfect this knowledge when, he will use it.

However, some philosophical positions encountered in the literature have not been considered. These positions present knowledge as a paradoxical concept. For Baumard [2]: Knowledge is a paradoxical subject in itself, because it cannot be reconstituted in a retrospective manner, no one can really be witness to his own knowledge. In the same way, for Snowden [13], knowledge is seen paradoxically, as both a thing and a flow requiring diverse management approaches.

Our prototype is an experiment, which has produced favorable results, until now. The database, which constitutes the experts network, has been implemented; it is the kernel of the coordination model. Furthermore, the enterprise's memory has been represented using a collection of cases. This representation allows an incremental design of the memory by adding progressively new cases. It permits us also to integrate different memory exploitation tasks.

We think that our acquisition model is appropriate to any VO, both in project fields and electronic commerce.

References

Ahuja, M.K, & Carley, K.M. (1998). Network structure in virtual organizations, JCMC 3(4), 15-19.

Baumard, P. (2002). Les paradoxes de la connaissance organisationnelle. In: Emmanuel Josserand et al. Veronique Perret, Paris: Ellipses.

Bouarfa, H. (2000). L'entreprise virtuelle: Dimension ou structure organisationnelle, RIST 10(2), 20-27.

Bourry-Brisset, A.C. (1999). Gestion des connaissances d'une memoire corporative construite autour d'ontologie , IC'99: Ingenierie des connaissances, Plate forme AFIA.

Combet, V. (1998). Enterprise memory: Privileged support for knowledge management. D.E.S.S dissertation, National institute of languages and oriental civilisation, France.

Dieng, R. (2002). Panorama : Methodes et outils pour la gestion des connaissances. Journee Loriatech sur la gestion des connaissances, Nancy.

Ermine, J.I. (2001). Capitaliser et partager les connaissances avec la methode MKSM. In: M.Zacklad et al. M.Grundstein (Ed.) Ingenierie et capitalisation des connaissances , Hermes.

Malone, T.W. (1990). What is coordination theory and how it can help design cooperative work systems. Proceeding. In: Bikson,T & Halasz, F. (Eds).

Malvache, P. Prieur, P. (1993). Mastering corporate experience with the Rex method. In: J.P. Barthes (Ed), Proceedings of the international symposium on the management of industrial and corporate knowledge (ISMICK'93), Paris.

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. Organization Science 5(1), 14-36.

Polanyi, M. (1969). Knowing and being. The University of Chicago Press.

Schreiber, G. Wielinga, B. & Breuker, J. (1993). KADS: a principled approach to knowledge-based system development, In:Knowledge-based systems. 11, New York: Academic Press.

Snowden, D. (2002). Complex acts of knowing-Paradox and descriptive self-awareness. Special Issue Journal of Knowledge Management.

Tixier, B. (2001). La problematique de la gestion des connaissances: Le cas d'une entreprise de developpement informatique bancaire. Research report, 019.

Vasconcelos, J.A.B, Kimble, C, Gouveia, F.R. & Kudenko, D. (2002). Reasoning in corporate memory systems: a case study of group competencies. Proceeding of the 8th international symposium on the management of industrial and corporate knowledge.

Vogel, C. (1990). KOD : une methode pour le recueil et la modelisation de connaissances. Workshop on experts systems and their applications, Avignon.

Zacklad, M, Boughzala, I. & Matta, N. (2000). Toward an extended enterprise memory in textile industry. Proceeding of the Third Int. Conference. on Practical Aspects of Knowledge Management (PAKM2000) Basel, Switzerland.