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Knowledge Management for Competence Management

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Abstract: In companies, competence management involves several heavy processes that we have categorised in four classes: competence identification, competence assessment, competence acquisition, competence usage. Competence management, being the management of knowledge about competence, can also take advantage from the *knowledge engineering techniques* to support the mentioned processes. The paper classifies the knowledge engineering techniques proposed in the existing literature to support the competence management according to its processes. According to the performed classification and based on the authors' previous work on competence management information systems *(CRAI approach*), the paper provides a critical discussion of the mentioned knowledge engineering techniques: their strengths and benefits in the context of the processes carried out.

Keywords: Knowledge Engineering Techniques, Individual Competence, Competence Management Information Systems, CRAI Model
Categories: E.2, H.3.2, H.1.1

1 Introduction

Broadly speaking, *competence management* is the way in which organizations manage the competencies of the *corporation*, the *groups* and the *individuals*. It has the primary objective to define, and continuously maintain competencies, according to the objectives of the corporation. A competency is a *way to put in practice some knowledge*, *know-how* and also *attitudes*, inside a *specific context*. Competence management is becoming more and more important: competence has been well recognized as extremely important for the achievement of company goals, complimentary to, for instance, core business processes, customer relationships, financial issues and so on [Hamel, 94], [Norton, 96].

Our current thinking is that competence management can be organized according to four *kinds of process* (i.e. inside each one, several processes may run) (figure 1):

- *Competence identification*, i.e. when and how to identify and to define *competencies required* (in the present or in the future) to carry out tasks, missions, strategies; how competence is represented is included here.
- *Competence assessment*, i.e. (i) when and how to identify and to define *competence acquired* by individuals and/or (ii) when and how an enterprise

can decide that an employee (or an individual) has acquired specific competencies; how the relationships between individuals and required competencies are represented is included here.

- *Competence acquisition*, i.e. how an enterprise can decide about how to acquire some competencies in a planned way and when;
- *Competence usage*, i.e. how to use the information or knowledge about the competencies produced and transformed by identification, assessment and acquisition processes; for instance, how to identify gaps between required and acquired competencies, who should attend required training, how finding key employees (i.e. holding key competencies) and so on.

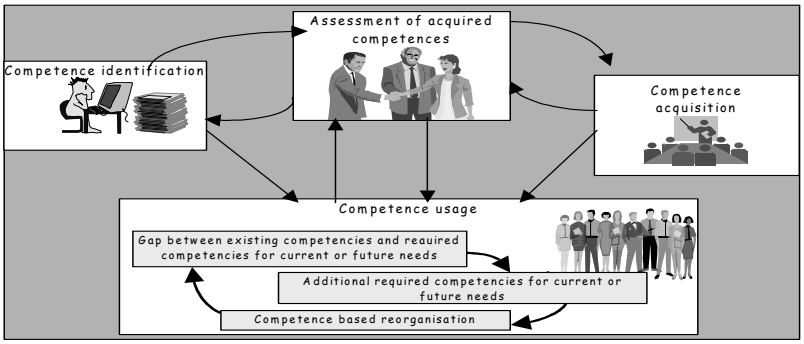

Figure 1: Competence Management Process Architecture

To support these processes, in our previous work (Section 2) on competence management (*CRAI approach*), we have used the classical techniques for the design and the implementation of *information systems* (i.e. mainly *database technologies* and *related design methodologies*).

The current work should allows us to move to *knowledge engineering techniques and technologies* in order to increase the flexibility (changes in competencies), the usage (usage of the represented competencies) and the implementation (for instance, with some *web technologies* related to *ontology* [Guarino, 95]) of a *competence management information system*. To this aim, on one hand, we have analysed the existing literature about competence management tools and approaches applying knowledge techniques (that we are classifying in *knowledge acquisition, knowledge extraction* and *reasoning techniques*). On the other hand, we are investigating knowledge techniques that can be used towards our objective.

Most of the reviewed knowledge techniques seem to be useful for improving ***heavy tasks*** (such as to find the competencies, required or acquired) in the various competence management processes and for integrating much better the supporting information system (reducing the need to perform several times the same or similar tasks). Therefore, knowledge techniques are generally useful for improving the performance of competence management processes (as any tool for supporting the enterprise activities).

In this paper, Section 2 provides an overview about our previous work, its objectives and its main outcomes. Sections 3, 4, 5, 6 discuss, according to competence

management processes, the results of the literature analysis (pointing out strengths and weaknesses). Section 7 provides a synthesis of this analysis.

2 Background

Our previous work [Harzallah, 02], [Harzallah, 04] has been concentrated on *competence of individuals*: other kinds of competence, referred in the literature as *group* and *core (or strategic) competence* have not been approached because they are difficult to be identified. However, they eventually include individual competence and the way in which they can be represented is similar to the way for representing individual competence. Our work was mainly concentrated on how to represent *competencies acquired* by individuals (concerning *Competence Assessment*); how to represent required *competencies* and guidelines for their identification (concerning *Competence Identification*); and how to use represented competencies for reorganization purposes (concerning *Competence Usage*); the aim was to provide a base for the development of *competence management information systems*. The results of this previous work are organized in three components (*CRAI approach*):

- The *CRAI model* (*Competency Resource Aspect Individual)* which provides a formal representation of individual competencies, both acquired and required (figure 2);
- A *set of guidelines* (i) to deploy the CRAI model into a specific organization for building its competence information system and (ii) to evolve the represented required and acquired competencies;
- A *set of enquiries* that can mainly be used for evaluating various differences, including the gap, between required and acquired competencies.

These results were applied to a real industrial case concerning the reorganisation of the department for the maintenance of a production system.

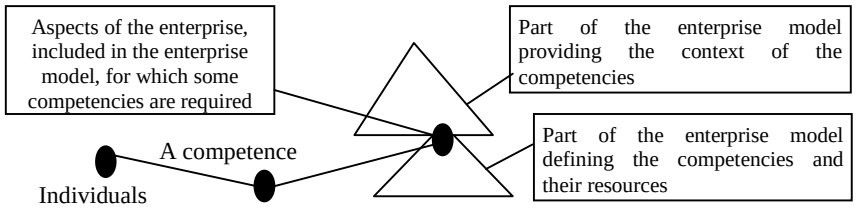

Figure 2: The structure of the CRAI model

As stated in the Introduction, we would extend the three original components by looking at the existing *knowledge management techniques* for making *competence information systems* to support competence management processes. Specifically, we are thinking that it should be interesting

- To move from the *set theory* used to formalise the CRAI model, to some *knowledge representation language*;
- To move from specific guidelines, to some knowledge acquisition, elicitation, reasoning and extraction techniques;

- To move from the enquiries formulated in the *set theory*, to enquiries over the knowledge (or knowledge base).

It should be pointed out that, as any other tool for supporting enterprise activities, competence management information systems should be useful for improving the *performance of the enterprise*. This usefulness is difficult to be justified *a-priori* (while it seems that *a-posteriori* is, at some extent, justified by *empirical thinking* cited in the Introduction). In our original work, we partially approached the problem of this relationship and we found the following two main conditions (which are also part of the developed guidelines):

- There is an *explicit link* between the competencies and the objectives to be achieved by the enterprise; this link should explicitly be represented to justify the name of *required competencies*;
- The *acquired* and *required competencies* should be correctly and completely described and it should be possible to assess acquired competencies in a robust way.

Under these conditions, competence management is becoming a well-structured framework that, for instance, allows to optimise medium and long term decisions (such as how to associated employees to their jobs, how to reorganise a set of organisation units and so on).

Whenever some of the mentioned conditions above do not happen, it might be possible that competence management assumes less structured forms in which competencies are poorly described and their assessment is becoming less sure. In this case, competence management is becoming less precise; nevertheless, it might improve the *enterprise knowledge asset* by grouping together individuals who share *domains of competence* (according to the *CRAI model*, a domain of competence corresponds to the enterprise aspects relevant to the definition of some competencies).

3 Knowledge techniques for competence identification

The CRAI model suggests that there are two main elements for modelling required competencies: the enterprise model [Vernadat, 96], which provides the reason to require a competence and the definition of the competence itself. The definition of the required competence can be approached by using ontologies, i.e. by introducing an explicit competence ontology of the required competencies [Posea, 04], [Vasconcelos, 03], [Colucci, 03]. This competence ontology can further be composed of a specific *ontology* and a *reference ontology* (for instance, [Vasconcelos, 03]). To define the required competencies various ways can be used. The most practical is related to the use of Interview (structured or unstructured, automatically collected) [Ley, 03]. However, especially whenever new required competencies are unknown, a *goal-oriented modelling* may be envisioned [Yu, 99]. Goal oriented modelling focuses on the reasons of a competence (i.e., in this context, why a competence is required): this aspect characterises the required competences according to the mission or to the objective to be achieved. Ontology is often represented in some *description logics* even in the context of competence modelling [Colucci, 03]. This logic representation enables the usage of competencies and provides a support to competence evolution

through, for instance, automatic classification mechanism. Description logics can also be suitable for modelling incomplete definition of competencies [Colucci, 03].

4 Knowledge techniques for competence acquisition

One of the main way in which competencies can be acquired is through learning processes. Therefore, because we are analysing the knowledge techniques for competence management, advanced e-learning systems (for instance, [Baldoni, 04] and [Garro, 03]) are relevant to our study. Over an e-learning system, two scenarios should be implemented in a competence management system:

- A competence management system should help the enterprise to decide and to plan the overall *trainings*, given a set of possible *learning resources*;
- A competence management system should help employees to decide and to plan the his/her own learning, given a set of possible *learning resources*.

The consequence is that a competence management information system can be integrated (or coupled) with an e-learning system. This e-learning system provides fully the definition of learning resources and their relationships with the required competencies.

Under the competence acquisition umbrella, we found relevant techniques that can be useful for recruiting the personnel. As an example, agent-based systems such as recommender systems, seeking relevant individuals over a set of interrelated archives (including databases, files and documents).

5 Knowledge techniques for competence assessment

According to the Introduction, *Competence Assessment* concerns the acquired competencies. We are currently thinking that these processes concern both employees and candidates. We carefully distinguish between identification of competence acquired and its evaluation: the first one is about when and how to identify individual potentially related (with an "high score") to some competencies; the second one is about how to perform direct evaluation of individuals.

Under this kind of processes, we found very useful the definition of a *competence management ontology* (distinct from the competence ontology) for identifying and updating the acquired competencies. This competence management ontology can be related to

- E-learning systems [Garro, 03], if available, that store the learning history of employees (or candidates, if an interoperability scenario is put in place),
- Some enterprise (real) data (for instance, documents or traces describing performed activities) [Sure, 00],
- Some "expert rules" as in [Blanchard, 04], [Sure, 00] (an example of "rule" is "if an individual has participated to several projects dealing with Java, then this individual can be considered competent on Java").

Whenever real data (i.e. data produced and transformed by the enterprise activities) are used, we found interesting in [Sure, 00], the *semantic annotation techniques* (i.e. meta-data) for documents. Moreover, some *information retrieval*

techniques [Becerra, 00] can be applied for establishing the relevance of the documents in relationship with some individuals.

Because both the identification and evaluation of acquired competences are very heavy tasks, some techniques envision the usage of the "interests" of employees through a *recommender system* [Lindgren, 03]. These "interests" are close to the domains of competence (Section 2) than to the concept of competence itself. Some other proposals envision a *guided self-assessment* through a *competence reference ontology* [Trichet, 02].

Concerning the evaluation of acquired competences, e-learning systems constitute the most important reference. In fact, e-learning systems comprise software modules for putting in place *test methods* [Baldoni, 04]. Accordingly, because already provided by e-learning systems, we are not interested in further investigating knowledge techniques used for realising these modules. Indeed, as also pointed out in the Section 4, a competence management information system can be integrated (or coupled) with an e-learning system.

6 Knowledge techniques for competence usage

The competence usage processes are all the processes which are not specific to the previous three ones. They are tightened on *specific objectives* to be achieved. For instance, we are using the competencies for re-organising the enterprises or we are using the competencies to find relevant individual for a specific task (taking into account time and location constraints) and so on.

The usage of competencies is closely related to the possibility to inquiry the acquired and required competencies. It may concern simple and quantitative queries [Harzallah, 04], [Becerra, 00] or semantic queries. In the second case, the *logic approach* seems to be the most suitable for that. The specific feature that has to be integrated is a *similarity measure* [Colucci, 03] between competencies or *approximate search* [Corby, 2004] because finding exact matches seems to be too much restricted. Therefore, *semantic matchmaking* is a valuable contribution to the competence usage processes.

7 Conclusions

In the literature, many research works have interested on applying knowledge techniques to competence management. These works concerns the various processes of competence management. They often use a formal language (LD, F-Logic, XML, etc.) to define a *competence ontology* and to reason on it. To simplify competence assessment, they use methods to extract *acquired competencies* from documents related to individuals, their interests or the tasks they perform. Finally, to retrieve a semantic correspondence between required and acquired profiles, they propose algorithms based on *semantic distances*. However, they prioritise one kind of processes among, identification, assessment and acquisition. They are sometimes poorly modular with respect to the competence modelling; for instance, they do not distinguish between competencies and qualification, or availability and competencies; they poorly distinguish between required and acquired competencies.

As a main conclusion, based on the performed classification and analysis of the existing works, it seems interesting to us to provide an unified representation of a conceptual architecture supporting the various competence management processes. This architecture integrates both the reviewed literature (competence reference ontology, competence management ontology, e-learning system, etc.) and the CRAI model (the relationships between competence, individual, c-resource and enterprise aspect) (figure 3).

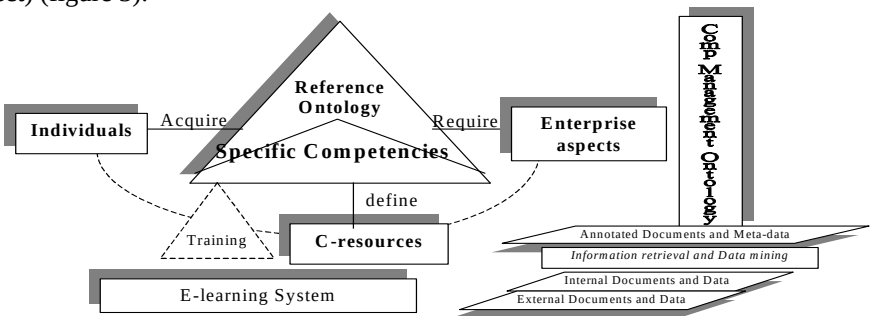

Figure 3: Towards an integrated architecture for competence management

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