A Knowledge-Based System for Knowledge Management Evaluation

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Abstract: - High quality knowledge management programmes usually lead to competitive advantages for the organizations that implement them. Several knowledge management maturity models have been proposed with the aim of evaluating the quality of knowledge management programmes in organizations, among which the Knowledge Management Capability Assessment (KMCA) model. Even so, the acquisition of a knowledge management level by means of those maturity models may imply a considerable economic burden because of potentially necessary audits. It is therefore very interesting to minimise the costs by paying only for the truly indispensable audits. This article proposes a Knowledge-Based System that makes it possible to evaluate an organisation at a determined KMCA knowledge management maturity level and thereby limit the services of an auditor to those cases in which the system’s response complies with the requested knowledge management level. This clearly implies an important cost reduction for audits with a negative result. The design of this system is based on the CommonKADS methodology, and its implementation was carried out with the Clips tool.

Key-Words: - Audit, Clips, CommonKADS, Knowledge-Based System, Knowledge Management, Maturity Model.

1 Introduction

It is now commonly accepted that an important share of the real value of an organisation resides in its own knowledge, in particular the one that comes from experience. This situation has lead to a new discipline, known as Knowledge Management (KM), whose aim is the collection and optimal application of all the knowledge and experience that is latent in every organisation [1]. This commonly accepted situation and the growth of the KM discipline have caused organisations to dedicate numerous efforts in order to retain and to institutionalise the knowledge they possess [2].

In recent years, investments in KM initiatives have grown and the related literature counts a fair number of success stories [3]. Principles and practices for the implementation of KM programs have been developed, and researchers have proposed maturity models as the main way to represent the KM programmes development process.

As a result, there is a growing number of the so-called Knowledge Management Maturity Models (KMMM). Examples of these initiatives are: the KMF and KM3 models [4], the KPMG Knowledge Journey [5], the model proposed by Gabor Klimko [6], the Knowledge Management Capability Assessment (KMCA) [7, 8], the Tata 5iKM3 [9] and the model proposed by Infosys [10].

The satisfaction of a high KM maturity level by an organisation tends to increase its prestige and competitive advantages. It may however be very expensive to evaluate whether or not an organisation disposes of the necessary conditions to obtain a given KM level: this implies the repeated services of an auditor before and after the correction of any detected insufficiencies. Also, once the necessary conditions are acquired, the auditor must intervene once more to evaluate the organisation at the desired KM level. The entire process may turn out to be very costly.

This article proposes a Knowledge-Based System (KBS) for the evaluation of an organisation at a specific KM maturity level. The application of this system will substantially reduce the need for expensive audits because these will only take place after the system has issued a positive report on compliance with the level—a report that has many possibilities to coincide with the auditor’s review but is not necessarily identical, since the auditor may weigh certain aspects that are not considered by the KBS. These differences between expert and KBS can actually be exploited, since the inclusion of new knowledge will lead to the improvement of the system.

We selected the KMCA model, proposed by Uday Kulkarni and Ronald Freeze [7, 8], because its structure and evaluation process are well detailed.
This model is an adaptation of the well known Capability Maturity Model (CMM).

The purposes of the CMM are twofold: on the one hand, to evaluate how organisations develop software (i.e., the quality of the processes they follow and the mechanisms they use), and on the other hand to serve as a guide towards continuous improvement [11]. This model contemplates five maturity levels that represent the quality of the software development process in the organisation.

Each maturity level, with the exception of the first, defines a series of Key Process Areas (KPAs) with which the company must comply in order to be positioned in that level.

The KMCA model also contemplates five maturity levels. These levels are, ranged from minor to major, the following: difficult, possible, encouraged, enabled, and continuously improved, with a major KMCA level implying more KM quality.

Each maturity level implies the following Knowledge Capability Areas (KCAs): expertise, lessons learned, knowledge documents, and data. Each KCA has its own properties, but all imply the same management steps: creation/acquisition, storage/recording, recovery/transfer, and application/reuse.

Thus, for each maturity level in the KMCA model, the evaluation process implies the evaluation of a set of general objectives and a set of KCA-specific objectives. Each objective is related to specific KM practices, which are represented by concrete questions in a maturity form.

The design of the proposed KBS is detailed in Section 2 of this paper, section 3 shortly describes the system implementation, and Section 4 sets out the conclusions.

2 Design of the proposed system
The quality of KBS design depends on the knowledge engineer’s programming skills, and on his ability to devise, remember, and dynamically update a design specification. This is a difficult task for all but the smallest KBSs.

Difficulties like these can be alleviated by producing representations of the expert’s knowledge and of the design specification in the shape of text or diagrams. The best known approach towards the production of such documents is the CommonKADS methodology [12, 13, 14, and 15]. It now is the European de facto standard for knowledge analysis and knowledge-intensive systems development, and it has been adopted as a whole or has been partly incorporated in existing methods by many major companies in Europe, as well as in the US and Japan [12]. We apply CommonKADS to elaborate a list of potential components of the model for the KBS, select the adequate template for the task, and construct the initial domain scheme. The last stage is a complete specification of the knowledge model. The following sections describe how each of these activities was carried out.

2.1 List of potential model components
The task of the proposed KBS belongs to a highly specialized field, i.e. a concrete and classified theme within Quality Management. It is perhaps for this reason that we dispose of reliable information on how to carry out audits [16]. Consequently, the knowledge of the domain can be said to be formal.

On the one hand, there is evidence of the existence of a commonly accepted structure in the sphere of the KMCA model—shown in Figure 1—that represents an initial candidate for the domain model. This structure reflects the existence of five maturity levels and four KCAs. Also, a maturity level requires a certain level of compliance with each KCA, and each KCA contains a series of questions in a maturity form; consequently, the compliance of all of these questions implies the compliance of the KCAs as a whole.

On the other hand, it is fundamental to record the performed audits and their results in, for example, a database: when we consult the system with respect to the convenience of an audit of KM maturity level $n$, we must be able to check whether the organisation was successfully audited in KM maturity level $n-1$. If the answer is negative, there is no possibility whatsoever to compete for the desired level, because neither in the system, nor in reality, it is good practice to “skip” KM maturity levels. For example, in order to reach level 3 we must previously have obtained level 2.

2.2 Selection of the task template
The final purpose of the proposed KBS is to provide an organisation with the possibility to fill out a form for a given KM maturity level and consult the system regarding its viability: “Given the data contained in

![Fig. 1. Initial relationships structure.](image-url)
this form, is it possible for the organisation to successfully pass an audit for KM maturity level x?"
In this context, and from the point of view of the task, this is an activity that fits into the category of assessment. These activities are provided with various templates, from which we have selected the one mentioned in [13].
The main motive for this choice is that the associated inferential structure matches the purpose of the application. A good technique to establish this adequacy to the problem consists in building an annotated inferential structure in which the dynamic roles are annotated or made to correspond with specific elements of the domain. This inferential structure is shown in Figure 2.

2.3 Construction of the initial domain scheme
As recommended in [13], this activity was carried out in parallel with the previous one. The result is a set of domain-specific conceptualisations—shown in Figure 3—and a set of method-specific conceptualisations—shown in Figure 4.

We detected two main concept types in the problem domain: Form and Section. We also need some historical information, such as the last KMCA level that was reached. To this effect, we model a concept Record with the attribute that represents this need. The concepts Form and Record constitute the initial reasoning case. A Form refers to a specific KMCA level and consists of a series of sections that each refer to a KCA. This fact is reflected by modeling an aggregation relationship between the concepts Form and Section. The concept Form has an “associated-level” attribute that indicates the KMCA level to which it corresponds. The concept Section presents four attributes: “name”, “total-questions”, “positives”, and “category”. The first refers to the name of the section—e.g. Lessons Learned—, the second indicates the total number of questions in the section, the third represents the total number of questions that were answered positively, and the last attribute refers to the organisation’s level of compliance in the section.

Once it is determined how the domain concepts will be used, we must establish the criteria that will be applied to the data in order to determine the compliance with a given KMCA level. In this concrete case, we considered two different criteria, each with a truth-value attribute that determines whether or not the criterion was fulfilled:

- If the positive answers represent less than 25% of the total, the level of compliance is considered “none”. This means that the organisation does not comply with the KCA represented by the section.
- If the positive answers represent between 25-50% of the total, the level of compliance is considered “low”.
- If the positive answers represent between 50-75% of the total, the level of compliance is considered “medium”.
- If the positive answers represent between 75-100% of the total, the level of compliance is considered “high”.

Fig. 2. Annotated inferential structure.

Fig. 3. Domain-specific conceptualisations.

Fig. 4. Method-specific conceptualisations.
• Last-level: Was the organisation successfully audited in the level previous to that at which it aspires? In other words, does it meet the requirement of having been successfully audited at a KMCA level that precedes the desired level?

• Concrete-level: Does the organisation meet the specific requirements of the level for which it wants to be audited? If the organisation wishes to be successfully audited for a specific KMCA level, it must meet the KCAs at certain rates or levels (many possibilities are accepted).

Finally, we wish to emphasize that the system only offers a positive response if all the criteria present the value “true”.

2.4 Complete specification of the knowledge model

As explained before, the activity to be modelled is an instance of the task type assessment. Also, the selected template shows an adequate inferential structure for the purpose of this KBS, in which the inferences present sufficient detail.

The task that must be carried out is decomposed into two subtasks, which means that the “task method” structures the reasoning process in two steps:

• Abstraction: the purpose of this step is to obtain the level of compliance for each section (KCA). As explained above, this level of compliance can be “none”, “low”, “medium” or “high”. The motive for this abstraction is the fact that what matters in a decision is not so much the number of positive answers by the user, but rather the meaning of this number. In other words, the reasoning of an expert auditor will be as follows: “The organisation complies with all the sections at a medium level, but the section Knowledge Documents is indispensable (must have a high level of compliance) and I therefore consider that improvements must be made in that area”.

• Matching: the abstractions are matched in order to take the final decision on whether or not there is compliance with the established criteria.

Figure 5 shows the template that was chosen for the modelling.

On the other hand, the knowledge scheme that was finally obtained is shown in Figure 6. We can observe that the final domain scheme incorporates three rule types:

• “case-abstraction”: the abstractions that are required for the application refer to the obtention of the Section compliance level by using the “total-questions” and “positives” attributes as previously mentioned. Even though the abstraction really refers to the Section concept, it is modeled in the Case concept as it possesses an aggregation relationship with Section.

• “form-requirement”: this type of rule aims at offering truth values to the norms “Last-level” and “Concrete-level”. Their instances therefore indicate the compliance with the previous KMCA level and the acceptable compliance levels of the maturity form’s sections for a determined level.

• “level-decision-rule”: we need some type of knowledge that refers to the final decision offered by the system to the user. This decision is represented by a “Level-decision” concept with a “value” attribute that indicates whether or not the organisation has real possibilities of successfully passing an audit for the desired KMCA level. Also, this type of rule expresses the relation between the different criteria and the final decision taken by the KBS.

Fig. 5. Decomposition of the task

Fig. 6. Final knowledge scheme.
3 Implementation of the proposed system

The system was implemented according to the above design and by means of the Clips tool [17]. In order to provide the application with modularity and simplify the development and depuration processes, we defined the following knowledge bases:

- **General**: This knowledge base contains all the definitions of classes, objects, and properties. Since it also contains the operative knowledge of the system, it is the base that must be loaded first.
- **Abstract**: This knowledge base contains the abstraction rules needed to obtain the compliance level of each KCA. As explained in the knowledge model, each KCA entails a series of questions that the organisation must answer. Relevant to the system are not the questions themselves but rather the number of affirmative answers with respect to their total amount. The abstraction of the incidence probability is then calculated.
- **Level1, Level2, Level3, Level4, and Level5**: This knowledge base contains the rules for the evaluation of the criteria “Last-level” and “Concrete-level”.
- **Decision**: The rules contained in this knowledge base refer to the final assessment decision according to the values of the criteria specified above.

The Clips inference engine is started and the corresponding knowledge bases are loaded. Once the graphic interface is initiated, the inferential process begins. Figure 7 shows an execution example in which a company wishes to be evaluated at KMCA level 4 after having been successfully audited at KMCA level 3, but the organisation lacks an acceptable level of compliance with the KCAs.

![Fig. 7. An execution example.](image)

4 Conclusion

A high quality KM program undoubtedly implies prestige and competitive advantages for an organisation. This is precisely the reason why organisations dedicate numerous resources to the adaptation of their processes to the requirements of the KM maturity models. One of these models is the KMCA. However, until it reaches the desired KM maturity level, an organisation usually needs to pass a series of audits. This article proposes a KBS that considerably reduces the economic burden of such audits by limiting their number in function of the compliance with the desired KM level (KMCA level).

Finally, the developed KBS is currently being installed and tested in various companies at A Coruña, Spain, with which the authors have collaborated in previous occasions.

References:


