A KM Implementation and Recommendation Framework using CBR and Semantic Web Technologies

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Abstract

This document describes our current work on developing a web-based system supporting organizations in the successful implementation of knowledge management by providing to them recommendations based on Case-Based Reasoning techniques and Semantic Web Technologies. The described framework follows the holistic approach of a KM introduction by considering technological, organizational and human aspects as well as the organizational culture in equal measure. The framework to be developed is based on the CBR-cycle after Aamodt & Plaza. The best practice cases for a successful KM implementation are structured using an ontology.

1. Introduction

Nowadays, most companies are aware of the importance of knowledge management for their daily business [Davenport, Prusak, 1998]. But to be aware of knowledge management is very different from introducing and using it. KM introduction is not easy at all and has to overcome several technical and organizational barriers. Moreover the introduction of KM necessarily has to focus on organizational, technical and human aspects and should in no case be regarded isolated for one specific aspect. But unfortunately, many companies regard KM as a purely technical discipline. Furthermore, the introduction of KM into an organization should consider already existing organizational structures, technical infrastructures and processes [Mentzas, Apostolou, Abecker, Young, 2003].

Therefore it is very important to have a strategy showing the way how to proceed, because many KM projects fail as a result of an insufficient know-how about conceptions for KM strategies.

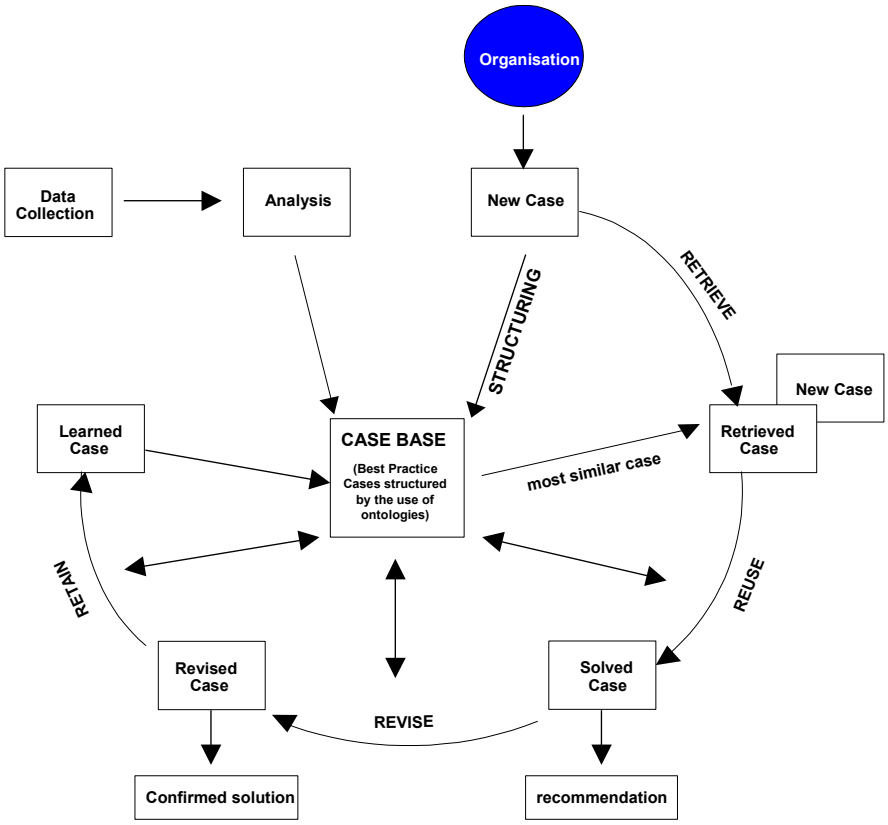
One way to deal with that fact is to learn from the KM implementation experience of others. This can be done by analyzing best practice cases for successful implementation of knowledge management and to assign those experiences to the own organization. The problem of this approach is, that the existing best practice cases are not well structured or not directly adaptable to the own organization's needs. Furthermore there is no existing public available computer-supported knowledge base for the introduction of KM which can easily queried for typical KM implementation problems. The holistic and integrated approach of the KM implementation and recommendation framework described in this paper will cover the above mentioned problem fields by supporting organizations in the successful introduction of KM by the use of Case-Based Reasoning. This will be realized by a web-based self-auditing tool providing organizational and technological recommendations based on best practice cases with regard to a successful implementation of Knowledge Management. The best practice cases are structured by the use of an ontology. The paper is structured as follows: Section 2 gives an overview on the components of the framework to be developed. Section 3 describes the components of the KM Implementation and Recommendation Framework (KMIR) to be developed in detail along the processes of the adapted CBR-cycle. Finally the paper concludes with a summarization and an overview on related work.

2. Working Agenda

In order to support organisations in the implementation of knowledge management we intend to develop a holistic and integrated recommendation framework based on the Case-based Reasoning Cycle from Aamodt & Plaza [Aamodt & Plaza, 1994] which has been adapted with regard to specific needs. The framework to be developed will consist of the following components which are later described in detail in the following section along the adapted CBR cycle (cf. Figure 1):

1. a **case base** containing KM best practice cases structured by the use of an ontology
2. a **web-based self-auditing component** supporting the organisation to describe itself the company profile, strategic normative and operational goals, as well as organisational, technological or human based knowledge problems which they would like to solve in the context of implementing KM
3. a **matching component** for retrieving most similar cases with regard to the described profile of the auditing organization
4. a **recommendations component** providing recommendations about how to introduce KM based on etrieved most similar cases

5. a **learning component** capturing new best practice cases and refining existing cases
6. an **expert interface** for importing current research results into the case base, i.e. new technical solutions and methods



3. The KMIR Framework

3.1 Data collection Analysis and Structuring

In order to create a first version of the case base this preliminary step is concerned with on the one hand collecting episodic best practice cases of a successful KM introduction from different information sources, describing real events (i.e. [Davenport, Probst, 2002], [Abecker, Hinkelmann, Maus, Müller, 2002] or [KluG, 2001]) and on the other hand with designing prototypical cases by experts in order to have practicable and innovative cases in the case base. After that, the best practice cases are analyzed considering organisational, technical and human aspects and finally structured and stored in an ontology using the OI-Modeler, which is a tool for visually creating and maintaining ontologies. The OI-Modeler is a module of the open-source ontology management infrastructure KAON[1] which includes a comprehensive tool suite allowing easy ontology creation and management, as well as building ontology-based applications. This "interface" can also be used for modeling advanced technical solutions, new methods and practices into the case base, that are not widely used in organizations in order to guarantee the timeless and reusability of the whole framework

The following picture depicts an excerpt of the KMIR ontology's conceptual level, which is used for structuring the best practice cases in the case base.

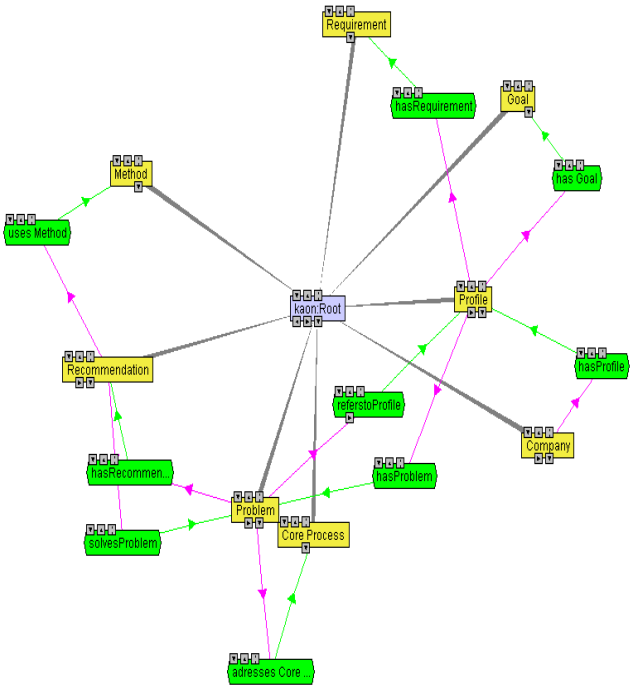


Figure 1: Excerpt of the KMIR ontology

[1] cf. http://kaon.semanticweb.org

Each best practice case describing a successful KM introduction is modeled as a "profile-instance" of the ontology. It consists on the one hand of a general description of the organization that has implemented KM, including the number of employees, the industrial sector, the organisational and technical infrastructure as well as general financial ratios and information about KM implementation costs and implementation time. This will be realized by modeling on the conceptual level the two main concepts "company" and "profile" that are linked together using the property "Company has Profile" as well as by further sub-concepts of these two concepts that are faded out in figure 2. On the other hand the case base structures problems and barriers, which the companies had to solve while introducing KM and how they managed to solve them. Therefore each modeled problem is linked to the profile by using the property "Profile has Problem" as well as to a recommendation by using the property "Problem has Recommendation" and the inverse property "Recommendation solves Problem". Problems and requirements can also address a specific core process of the Probst-Model (i.e. knowledge acquisition, knowledge sharing, etc.) [Probst, Raub, Romhardt, 2003].

Moreover the modeled problems can be divided into sub-problems (by modeling sub-concepts of the concept "problem" and "recommendation") because KM approaches are of course never identical, and the organizations have sometimes already existing partial solutions with regard to a specific knowledge problem, that can then be extended. Another important point for dividing the problems into sub-problems is that the assigned recommendations of different profiles can individually combined to new recommendations.

The modeled recommendations follow the above-mentioned holistic approach, meaning that a recommendation considers technical, organizational and human aspects which are additionally linked among each other by modeled properties for each link. This is necessary because the implementation of a KM system depends for instance on a specific technology and furthermore requires a methodology for the successful introduction as well as a cultural change in the organization. KM solutions, which are implemented in the context of the KM introduction are linked to the technology on which they depend, can consist of or depend on further solutions or just be a part of a larger solution. Several other concepts of the ontology are furthermore divided into sub-concepts in order to have the possibility for more precisely specifying the top concepts which are viewable in figure 2.

3.2 Auditing Process

A web-based self-auditing component (cf. figure 3) supports an organisation in describing its profile (size, industrial sector, organisational and technical infrastructure, economic aspects, etc.) as well as normative, strategic and operational knowledge goals and target costs for the implementation of KM. Furthermore the organisation is able to describe general knowledge problems/ requirements and furthermore technological, organisational and human problems and requirements and to assign them to the KM core processes from Probst. The auditing component will be realized by Java Server Pages and tag libraries which are directly connecting to the API of the above-mentioned KAON Toolset. This means that the created profile during the audit is directly stored as a set of instances into the ontology structuring the case base.

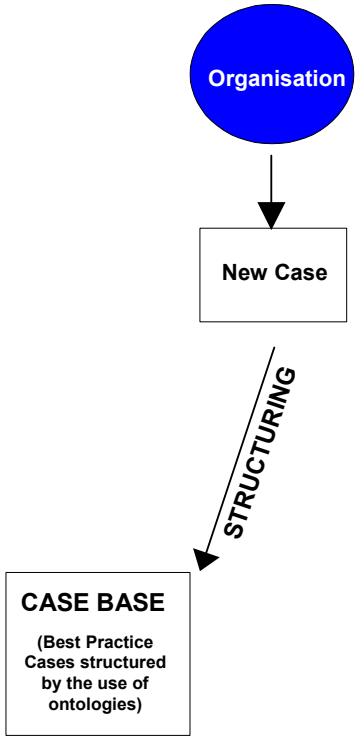


Figure 2: Auditing Process

3.3 Case Retrieving Process

For retrieving cases similar to the profile, which has been achieved from the auditing process, a matching component matches the new profile against already existing best practice cases from the case base. This will be done in a two step process consisting of weighted averages and ontology-specific similarity measures. Starting with a pre-selection using weighted averages, the auditing organization has to associate weights to the defined problems, which it would like to solve as well as to requirements and short- /long-term goals. Furthermore the matching component automatically identifies weights from the general profile description (size, number of employees, etc) of the organization. Table 1 shows an example for the pre-selection using weighted averages.

Case 1 (from Audit)	Weight	Similarity	Case X (from case base)
Sector: IT	**6**	**1**	**Sector: IT**
Size: 50	**4**	**50/100 =0.5**	**Size: 100**
Processes: defined	**2**	**1**	**Processes: defined**
Identified knowledge intensive activities: no	**1**	**0**	**Identified knowledge intensive activities: yes**
Planned implementation costs: 2000 €	**3**	**2000/10000 =0.2**	**Implementation Costs: 10000 €**
Similarity: 1/16*[6*1+4*0.5+2*1+1*0+3*0.2]=0.6625			

Table 1: Similarity Computation by Weighted Average, adapted from [Bergmann, 1998]

In the second step of the matching process the created profile from the organisational audit is matched against the pre-selected profiles using ontology-specific similarity measures. That is to compute the similarity between two instances on the basis of their corresponding concepts and their position in the concept taxonomy (**Taxonomy similarity**), relations to other objects (**Relation similarity**) and attribute values (**Attribute similarity**) [Maedche, Zacharias, 2002]. A concrete example is an organization that would like to extend an existing groupware system with regard to advanced KM technologies. The matching component identifies a similar technical solution in the case base, which served as a basis for an advanced KM solution by checking if a solution is structured by the same concept or sub-concept and if it has similar attributes and relations to other instances. Figure 4 shows the general matching process.

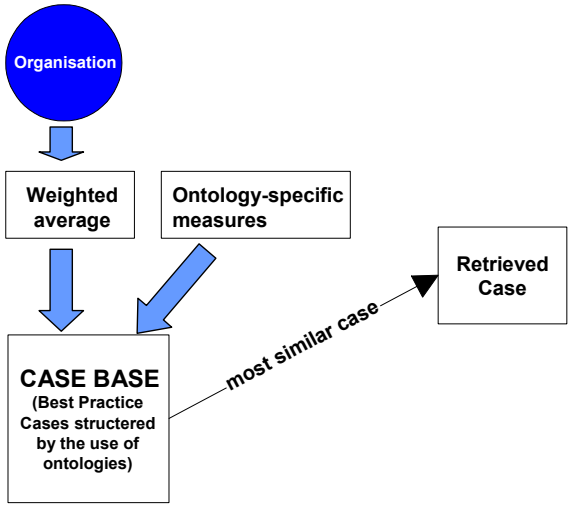


Figure 3: Case Retrieving Process

3.4 Recommendation Process

A recommendations component automatically provides recommendations to the auditing organization according to its defined problems, requirements and goals based on the identified most similar case(s). This will be done on the one hand by presenting to the organization one or more retrieved profile(s) from the matching process, that correspond to the profile from the self-audit, including similar problems as well as associated recommendations to solve these problems. On the other hand the framework is able to present recommendations to the auditing organization that are combined of different similar cases to one general recommendation. In addition the recommendations component checks for each problem-recommendation pair further relations to other KM aspects using the structure of the ontology and generates from them additional recommendations to the auditing organization. Furthermore the system combines the recommendation with an estimation of implementation costs and time.

An example for a so called "holistic recommendation" would be, that the recommendations component recommends the auditing organization the implementation of a KM tool X and furthermore combines it with a specific organizational method for a successful introduction of this tool, as well as with a required organizational culture and all other aspects that have to be considered in this context.

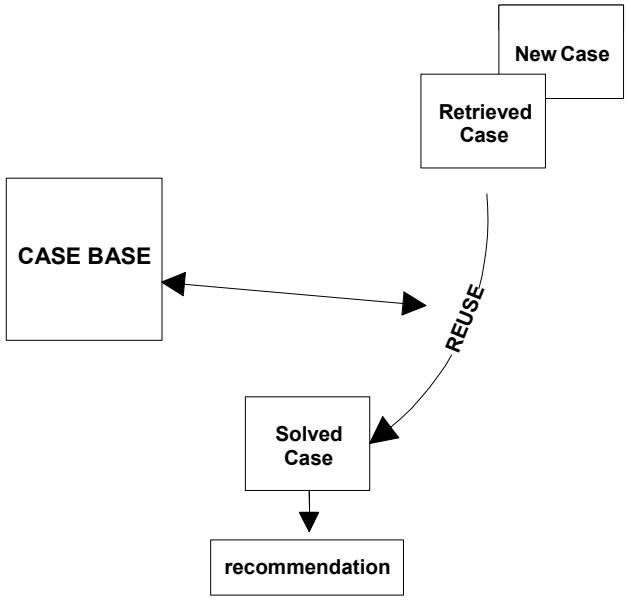


Figure 5: Recommendation Process

3.5 Feedback Loop and Learning

In the Feedback Loop successful completed KM implementations of an organisation are added as a new best practice case into the case base. This will be done by structuring and capturing the adapted and reused best practice case(s) as a learned case into the case base. Therefore the Feedback Loop guarantees the timeless and reusability of the case base.

A Learning Component will collect lessons learned regarding successful or inappropriate given recommendations in order to refine or extend the best practice cases as well as the general structure of the case base. This will be done by

- a web-based questioning of the auditing organisations concerning the experiences they made with the recommendations
- a tracking of the user behaviour using log files and from that changing the structure and content of the ontology representing the case base [N. Stojanovic, L. Stojanovic 2002]

Using the web-based questioning, the user has the opportunity to evaluate the recommendations with regard to their correctness and capability to solve a specific problem. The evaluation results directly flow into the learning component. The learning component uses the achieved results of the user feedback as well as the data from the user log for an internal ranking of the best practice cases in the case base. Based on ranked cases, the recommendations component is able to provide better recommendations to the auditing organisation (i.e by providing recommendations that were evaluated better than other ones in terms of solving a specific problem). On the other hand, worse evaluated recommendations with a low ranking can be either optimized or thrown out of the case base.

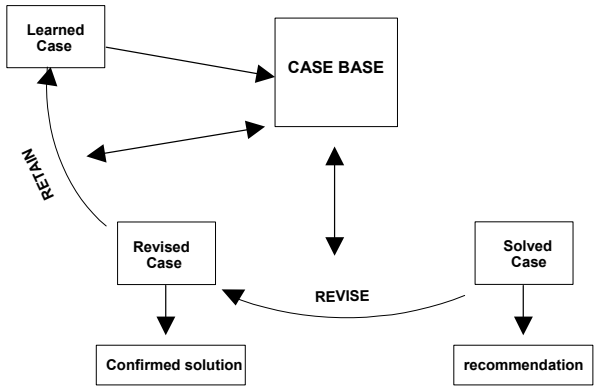


Figure 6: Feedback Loop and Learning

4. Conclusion and Related Work

In this paper we described our current work on developing a web-based system which supports an organization in the successful implementation of knowledge management by providing recommendations based on Case-Based Reasoning techniques and the usage of Semantic Web Technologies for storing the best practice cases into an ontology. For the development of this framework an extensive collection, analysis and structuring of best practice cases from different information sources is necessary. The analysis but also the structuring of the best practice cases directly focuses on human, technical and organizational aspects in order to consider a holistic knowledge management approach.

For the future we intend to validate this implementation and recommendation framework under real-life conditions which might be realized in the context of a concrete KM project. Moreover we will include a component for determining the current KM maturity level of an organisation in order to better focus on the organization's needs with regard to a successful introduction of Knowledge Management. Furthermore we intend to combine the best practice cases with further financial ratios like for instance the Return on Investment (ROI) that the organization has a better possibility for evaluating a KM introduction and for comparing different KM introduction alternatives from a more economic point of view.

References

[Aamodt & Plaza, 1994] A. Aamodt, E. Plaza. Case-based reasoning: foundational issues, methodological variations, and system approaches. AI Communications 1994, 7(i):39-59

[Abecker, Hinkelmann, Maus, Müller, 2002] Andreas Abecker, Knut Hinkelmann, Heiko Maus, Heinz J. Müller. Geschäftsprozessorientiertes Wissensmanagement, 2002

[Bergmann, 1998] Ralph Bergmann. Introduction to Case-Based Reasoning, 1998

[Davenport, Probst, 2002] Thomas H. Davenport, Gilbert J.B. Probst. Knowledge Management Case Book. Best Practices, 2002

[Davenport, Prusak, 1998] Davenport T. and Prusak L. (1998). Working Knowledge. How Organizations Manage What They Know. Harvard Business School Press.

[KluG] KluG - Kenntnisse leiten zu unternehmerischem Gewinn. Einführung von Wissensmanagement in KMU, http://www.iw-klug.de, 2001

[Maedche, Zacharias, 2002] Alexander Maedche and Valentin Zacharias. Clustering Ontology-based Metadata in the Semantic Web, 2002

[Mentzas, Apostolou, Abecker, Young, 2003] Gregoris Mentzas, Dimitris Apostolou, Andreas Abecker, Ron Young. Knowledge Asset Management. Beyond the Process-centred and Product-centred Approaches, 2003

[Probst, Raub, Romhardt, 2003] Gilbert Probst, Steffen Raub, Kai Romhardt. Wissen managen. Wie Unternehmen ihre wertvollste Ressource optimal nutzen, 2003

[N. Stojanovic, L. Stojanovic 2002] N. Stojanovic, L. Stojanovic. Usage-oriented Evolution of Ontology-based Knowledge Management Systems, Proceedings of the 1st Int'l Conf. on Ontologies, Databases and Application of Semantics (ODBASE-2002), Irvine, CA, 2002