Journal of Universal Knowledge Management, vol. 1, no. 3 (2006), 235-254
submitted: 5/10/06, accepted: 15/11/06, appeared: 28/12/06 © J.UKM

Portability of Best Practice Cases for Knowledge Management Introduction

Mark Hefke
(FZI Forschungszentrum Informatik an der Universität Karlsruhe, Germany
hefke@fzi.de)

Andreas Abecker
(FZI Forschungszentrum Informatik an der Universität Karlsruhe, Germany
abecker@fzi.de)

Knut Jäger
(FZI Forschungszentrum Informatik an der Universität Karlsruhe, Germany
jaeger@fzi.de)

Abstract: This paper investigates the question which indicators are suited to characterize Best Practice Cases (BPCs) for Knowledge Management (KM) introduction projects such that the portability of these BPCs to other organisations can be estimated. We scanned relevant KM literature and web pages for generating a basic set of indicators and verified these indicators through an open internet survey (n=103). To this end, we developed a web-based questionnaire where the respondents could prioritize the proposed indicators and assign them to one or more predefined classification schemes. We distinguished between indicators for the general description of an organisation, critical KM success factors, and indicators for the transferability of KM BPCs to other organisations. The evaluated results of the survey were used as an input for the development of an ontology-based reference model for describing KM BPCs.

Keywords: Knowledge Management, Best Practice Case, Case-Based Reasoning

Categories: A.1, H.1

1 Motivation & Overview

Introducing Knowledge Management in an organization has to address organizational, technical, and cultural issues, and must overcome manifold barriers. One way to deal with this is to learn from the KM implementation experience of other companies or organizations. This can be done by scanning, collecting and analyzing best practice cases (BPCs) of a successful KM implementation and adapting those case experiences to the own organization. The practical problem of this approach is that existing BPC descriptions (normally available as success stories in text books or on Web sites) are usually not well-structured and not directly comparable. Consequently, their applicability to the own organization's needs is difficult to assess. Hence, our goal is to provide a reference model that is able to structure portable BPCs of a KM introduction – thus helping other organisations in the successful accomplishment of KM, based on structured, and therefore comparable, experiences made by others. To this end, we proceeded as follows:

(1) Identification of relevant indicators for describing and assessing the portability of Knowledge Management Best Practice Cases (KM BPCs) [see Section 2].
(2) Verification of identified indicators by the use of an open survey [see Section 3].
(3) Development of a reference model for the description and portability of KM BPCs [see Section 4].

This paper is structured as follows: Sections 2, 3, and 4 describe the major steps of our approach as outlined above. In Section 5 and 6, we discuss some related work and potential critical success factors of our approach, we summarize our main results, and discuss some plans for the further application of our reference model and the overall BPC based approach.

2 Identification of Indicators for Best-Practice Characterization

In order to identify useful and significant indicators for BPC characterization, we first assessed potential indicators with respect to several dimensions:

- *Their relevance with respect to KM interventions:* Is the indicator oriented towards KM goals? Is it influenceable in a KM project?
- *Their survey economics:* Is the indicator available? Is it cheap to record?
- *Their survey credibility:* Is the indicator easy to understand for end users? Is it based on a solid data basis?

Based on these considerations, we analyzed KM methodologies and KM case studies (a) in the standard literature ([Davenport, 00], [Eppler, 01], [Probst, 06], etc.), (b) in results of open available KM surveys and (c) found in highly frequented KM community web pages (e.g., the KnowledgeBoard[1]) in order to identify potential indicators. Based on this state-of-the-art survey and our own considerations, we created a preliminary list of 28 indicators for the description and portability of BPCs (cp. Table 4).

3 Verification of Selected Indicators

3.1 Open Web Survey

For verifying the significance of the potential indicators and for assigning appropriate weights to the most significant ones in the similarity-based retrieval procedure (cp. [Hefke, 06b]), we performed an open web survey[2] in English and German language: We interviewed people who (i) were just in the process of implementing KM, (ii) had already implemented KM, or (iii) were just sensitized with the KM topic. The survey was partitioned into three parts:

[1] cf. http://www.knowledgeboard.com
[2] cf. http://www.knowledge-management.de.tc

- In the **first part of the survey**, we asked *14 general questions*, about the organisational sector, number of employees, country of origin, organisational structure, infrastructure, as well as organisational culture and financial ratios. Furthermore, the respondents could describe their experiences with KM and asses their own maturity level regarding KM.
- In **part two of the survey**, we only interviewed respondents that had *already implemented KM* or planned to do this in the near future. That part summarizes questions related to concrete KM measures (e.g., organisational, cultural or technical measures), the number of (planned) KM workers or departments, considered quality standards, implementation time, dynamic changes during the KM introduction, etc.
- The **third part of the survey** could again be answered by all respondents. Here, we asked the following four questions with regard to all of our proposed 28 Knowledge Management BPC indicators:
  - How important would you consider the declaration of indicator XY for the selection of a KM Best Practice Case?
  - Does the indicator XY tell you something about the success or failure of a Knowledge Management Project?
  - On which part of Knowledge Management has, in your opinion, the indicator XY the most influence?
  - Do you think that the indicator XY is suited to classify companies?

3.2 Evaluation Results

3.2.1 Important Results of The First Questionnaire Part

All in all, 147 respondents participated in the survey. After verifying the data sets, 103 applicable ones were remaining. The web page has been visited by more than 700 people. Hence the return rate was about 15 percent. Although we could, of course, not ensure to retrieve *representative* results, the relatively high number of respondents seemed to be promising – keeping in mind that KM had been declared a "dead topic" already several times. The geographical distribution, company size and industry sector of the respondents were as follows:

Country	**Number of respondents**	**%**
Germany	64	62
Great Britain	9	9
Austria	6	6
Australia	5	5
USA	5	5
Other countries	14	14

Table 1: Geographical Distribution of Respondents

Company Size	Number of respondents	%
0 – 9	16	16
10 – 49	15	15
50 – 249	27	26
>= 250	45	44

Table 2: Company Size of Respondents

Industry Sector	Number of respondents	%
Real estate, renting & business activities	33	32
Manufacturing	14	14
Public Administration	10	10
Education	6	6
Wholesale and Retail Trade	6	6
Others	34	34

Table 3: Industry Sector of Respondents

Moreover, 51% of the respondents had already introduced KM, and 22% planned to do it in the near future. Regarding the KM maturity level, 38% characterized themselves more or less as an "Expert", whereas 32% of the respondents were at least "more than sensitized" with the KM topic. About 33% of the respondents were just "sensitized". 86% of the respondents have approved that they would resort to BPCs when implementing KM. That points out the importance of (structured and portable) BPCs for Knowledge Management.

3.2.2 Important Results of The Second Questionnaire Part

As mentioned above, the second part of the questionnaire has only been made available to respondents who have already implemented KM. Concerning **taken KM measures** with regard to KM, the respondents' mostly mentioned activities were of communicational nature, directly followed by technical and organisational measures.
Moreover, we have asked for dynamic changes during the KM introduction with regard to the number of (KM) employees, turnover and profit. Basically, we could find out that expectations regarding KM were at least fulfilled by most of the respondents, or even exceeded. An exception is only given by the number of employees. Here, 17% of the respondents stated that the number of employees has indeed been grown up, but not as much as planned before. The number of KM workers has been grown up to a higher degree (stated by 40% of the respondents). Though only 42% of the respondents stated that KM activities have a direct impact on the turnover, 62% have made the experience that there has been a profit increase due to KM. This result is remarkable, because a constant turnover combined with a higher profit must come from costs savings, although in most cases, KM activities are combined with additional ex-

penses. Thus, cost savings due to KM were stated by more than 64% of the respondents who had already implemented KM.

3.2.3 Important Results of The Third Questionnaire Part

Due to space limitations, we can not discuss here in detail the respondents' appraised relevance with regard to all proposed 28 KM BPC indicators.[3] But, at least, we present the most interesting results: While evaluating the survey results, we differentiated between different clusters (e.g., company size, sector and knowledge culture, KM maturity level, etc.); not surprisingly, we found that there are differences in the relevance of specific indicators between the clusters. However, some indicators are independent of our predefined clusters. Except for finding an appropriate solution or a typical procedure for organisational, technical and cultural knowledge problems, the most important independent indicator that has been stated by the respondents regarding a successful KM project is the ***sustainability*** of accomplished KM activities, followed by the indicators ***qualitative benefit***, ***(strategic) knowledge goals***, the organisational ***department*** that is performing KM activities, the ***maturity level*** of an organisation that would like to implement KM, the ***organisational culture***, as well as ***implementation time*** and ***amortisation time***.

4 Development of the Reference Model

As a result of the indicator identification and verification, we extracted a list of indicators as shown in Table 4 + 5 (sorted by relevance). Based on these classified indicators, we developed an ontology-based reference model for the description and transferability of KM BPCs as sketched in Figure 1.

An ontology (cp. [Staab, 04]) comprises the definitions of concepts, concept hierarchies and properties that can either be attributes of concepts (for their more detailed description) or relations between concepts. An ontology can be instantiated by an instance pool. A concrete Knowledge Management BPC is therefore in our case represented as a set of jointly related ontology instances, which is structured and stored by an ontology management tool (cp. [Hefke, 04]).

The ontology-based reference model distinguishes between (1) indicators describing an organization profile in general (e.g., company size and sector, legal form, turnover, profit, software infrastructure, technologies, etc.) and (2) KM-specific indicators (e.g., knowledge problems and goals, solutions and methods, employees or departments involved in KM activities, considered business processes, planned / taken implementation time and costs, status, regarded quality standards, and the current KM maturity level of an organization).

[3] All detailed results of the web survey are publicly available on our website: http://www.knowledge-management.de.tc

Indicator	Classification	Range of values	Relevance
Knowledge problems and addressed core processes	organizational, technical, cultural	e.g., knowledge identification, acquisition	high
(Technical) solutions, methods and knowledge instruments	-	e.g., yellow pages, think tanks, learning sabbaticals, lessons learned database, knowledge marketplace, scenario technique, storytelling, knowledge mapping, and much more …	high
Knowledge goals	normative, strategic, operative	e.g., systematization of service knowledge, identification of decentral knowledge, knowledge transfer among employee generations, creation of a knowledge balance, and much more …	high
Sustainability	-	free text	high
Qualitative benefit	-	e.g., increased turnover / profit	high
Increased competitiveness	-	e.g., faster knowledge distribution	high
Implementation time	-	nonnegative integer	high
Involved department	-	e.g., marketing, HRM, PR, IT, controlling, R&D, production, …	high
Maturity level	-	depends on the underlying maturity model	high
Organization sector	primary, secondary and tertiary sector	e.g., IT, finance & insurance, government, ...	high

Table 4: Indicators for the Description of BPCs which were Considered Highly Relevant for Portability

Indicator	**Classification**	**Range of values**	**Relevance**
Amortization time	-	nonnegative integer	medium-high
Quantitative Benefit	-	free text	medium-high
Implementation costs	technical, organizational, person-related	nonnegative integer	medium
Affected organizational level	-	e.g., team, department	medium
Used software/ technologies and KM instruments	-	e.g. , Lotus Notes, Semantic Web Technologies	medium
Number of involved KM workers	-	nonnegative integer	low
Considered quality standards	-	e.g., EFQM	low
Turnover and profit		integer	low
External support	-	e.g., public funding	low
Implementation status	-	completed, in progress	low
Legal form	-	e.g., ltd.	low

Table 5: Indicators for the Description of BPCs which were Considered Less Relevant for Portability

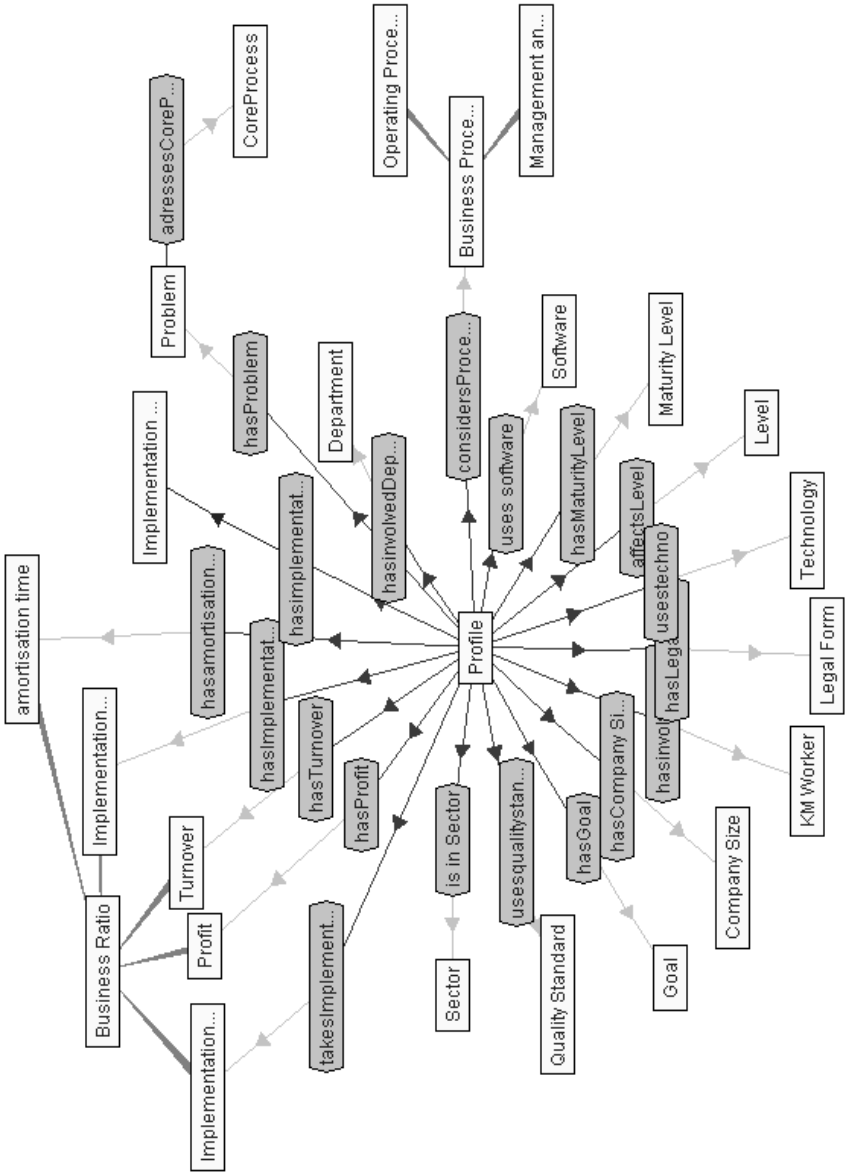

Figure 1: Classes and Relationships of the KM BPC Reference Model – Excerpt of Those Entities That Are Considered for Similarity Matching (Rectangles are Classes, Rounded Hexagons Are Directed Relationships or Attributes)

All indicators are represented by either concepts or attributes of the ontology. Moreover, indicators are:

- **hierarchically structured** by the use of concept hierarchies (e.g., knowledge problems are subdivided into organisational, technological and cultural ones; knowledge goals are partitioned into strategic, normative and operative knowledge goals; an organisational sector can be a "primary", "secondary" and "tertiary"; and processes are classified into business processes using the APQC Process Classification Framework[4] and knowledge processes), or
- **interlinked using relations** (e.g., the indicator "problem" is linked to the indicator "solution" by the relation "has solution").

In a next step, we defined a measurable and above all comparable range for all entities (a necessary precondition for the intended automated retrieval process for BPCs). In addition, all attributes were classified regarding their ability to describe the situation before, during, and after the KM introduction. Several attributes may even change their value *during* the KM introduction process (e.g., turnover, number of employees, etc.).

5 Discussion and Related Work

Let us briefly recapitulate the overall approach underlying our work:

1. to base KM introduction on the reuse of **best practice cases (BPCs);**
2. to describe each KM BPC through a number of attributes and relationships which instantiate the structures of a KM BPC **reference model** that is represented as a formal ontology;
3. to retrieve in a concrete situation where a KM initiative is to be planned and outlined, already existing similar BPCs, where:
   (a) similarity-based retrieval is implemented through a **combination of case-based reasoning** (CBR) methods **with ontological background knowledge,** and
   (b) the similarity measure – as a central means for retrieval in CBR – which assigns **weights to particular facets of case descriptions** which shall represent these facets' respective importance for the assessment of the relevance of a stored case in a given, new situation (i.e. the estimated portability)

The technical aspects of this approach have already been published earlier such that related work for all issues subsumed under (3a) – similarity-based retrieval, similarity frameworks, and combinations of Semantic Web technology (ontologies) and CBR – can be found, for instance, in [Hefke, 06; Hefke, 06c].
In this paper, our focus was on a more methodological issue, so to speak, the *content* rather than the *technology*. In particular, this comprises:

- the idea of BPC-based KM planning and introduction,
- the reference model for KM BPCs, and
- the weights for the particular BPC facets as relevance indicators.

[4] cf. http://www.apqc.org

Let us discuss our contributions and the relevant related work for these issues.

5.1 Best Practice Cases for KM Planning and Introduction

Reuse of Best Practice Cases is one of the earliest and most prominent Knowledge Management goals at all. Thus, the KM literature provides manifold examples for best practice sharing and gives advice how to do this best; see, for example, [Kwiecian, 95; Skyrme, 02]. A conceptually similar and technically almost identical KM goal is **lessons-learned sharing and reuse;** see, e.g., [Aha, 00; Sharif, 05]. For lessons-learned systems, CBR-like approaches and faceted description schemas are not seldom; cp. [Weber, 00; Weber, 01].

However, in spite of being a favourite subject *to be supported by* KM, a case-based best-practice sharing approach is astonishingly seldom considered as a method *for supporting KM* introduction or for planning and running KM initiatives. Although many of the best and most successful KM books are strongly example-based (like [Davenport, 00; Mertins, 03; Probst, 06]), although the best KM education is certainly case-study oriented, and although business consultants as the most influential KM practitioners are usually acting in a case-based manner to a big extent, to all our knowledge, reuse of best-practice cases has not yet largely found its way into academic KM methods and tool-supported KM introduction approaches.

Typical methods for KM introduction are **top-down** and assume a **framework-driven** analysis, modeling, and planning phase which might be supported by questionnaires or similar, simple, analysis instruments; see, for example the Know-Net method [Mentzas, 02]. Sometimes, the as-is diagnosis and the subsequent suggestion of appropriate KM instruments and strategies are facilitated by some notion of **KM maturity;** see, e.g., [Kochikar, 00; Langen, 02]. Recent publications lay some special emphasis on **social network analysis,** collaboration and community management (cp. [Apostolou, 07; Müller-Prothmann, 06, Mahadevan, 04]), but this is still the idea of a top-down, analysis-based procedure for planning and running KM initiatives.

On the contrary, the case-based approach to problem-solving (cp., for instance, [Aamodt, 94; Althoff, 01]) is not necessarily so much based on an explicit understanding and an explicit diagnosis of the problem at hand; it rather employs stored experience which proved to work well and which combines manifold aspects of problem understanding and problem solving in the integrated, holistic form of a Best-Practice Case. Thinking positive, this means (i) that you can apply the CBR paradigm even in cases that you haven't fully understood (which is often the case in complex applications) and (ii) that you not even have to understand each and every detail. Thinking negative, this means that you actually don't have a clear explanation *why* the system makes specific suggestions – this may be particularly bad if you don't understand why some suggestions did *not* work well in a given application context. Nevertheless, we believe that the BPC-based approach can add value to the existing KM ideas, for several reasons:

- In contrast to some expert-system application areas of CBR, our approach does *not* lead to a fully-automatic problem solution. Instead, it offers to the user a list of potentially relevant example cases, and leaves it to the human consultant to reject or apply, to reuse or adapt the stored experience. So, the ultimate power of interpreting, evaluating, and contextualizing the stored knowledge, relies with the end user.

- Even in the case that detailed suggestions for very specific problem instances seem by far too difficult to be suggested by a software system – even more, by a software system with only a shallow understanding of the problem domain – the case-based approach can at least be used more or less at a "meta level"; i.e., for helping to find the broad direction for finding a solution by the selection of similar cases with their respective solution approaches (used methods, used tools, documented experience with these approaches) and thus constraining the space of solution approaches to be considered further for human analysis and creativity.
- In the case that *there is* symbolic, clear and definitive knowledge about the KM application domain (e.g., because certain methods have been proven not to work under certain conditions, or certain process steps are necessary to be done in certain contexts), this knowledge is not necessarily lost in the "implicitness of the case base"; such knowledge can be expressed in the form of decision rules which can be combined in manifold ways with the case-based mechanisms.[5]

The case-based approach is certainly an intuitive and easy to start with idea that reduces the initial workload and the required "analytical depth" when designing a KM initiative, and that makes full use of the wealth of anecdotical and episodical knowledge available in KM. On the other hand, it moves the critical success factors to some extent from having a comprehensive and thoughtful KM introduction method (and being able to apply it) to having (1) a meaningful case base (that covers well all relevant operating points in the space of potential applications) and having (2) a smart similarity measure which assigns weights in such a way to BPC facets that computed similarity is a good predictor for future usefulness of a stored case. Obviously, both issues (1) and (2) are difficult and really crucial for the success of our approach; nevertheless, we believe that it is promising, because several characteristics of the BPC approach can be identified and some actions can be taken that reduce the danger of failure:

(1) Regarding the problem of populating a representative and comprehensive case base:
    - **Constructing prototypical cases:** besides *episodic* BPCs which describe concrete, real-world experiences made in former KM projects, we decided to include also *prototypical* cases: Those are constructed artificially, by hand, for representing some abstract, well-known knowledge which may not (not yet, or not in the optimal form) be contained in one of the existing, concrete cases.[6]

[5] [Prentzas, 02] gives an overview about combinations of rule-based and case-based reasoning. Already [Wess, 95] introduces explicit rules – if available – as part of the similarity computation – for instance, for cutting away uninteresting areas in the case base, or for rule-based, context-specific, computation of partial similarities. The realization of such mechanisms is not yet foreseen in our current implementation [Hefke, 06], but because of our Semantic Web oriented base technology, this would be easy to realize.

[6] To rephrase a little bit: *Episodic* BPCs describe concrete, former KM projects run by some organization and fed into the system in a relatively unchanged, "raw" form.

- **Population of case base over time:** it is a salient feature of CBR that the case base may grow with every usage of the system, incorporating step by step the experience and insights of each and every case dealt with using the system. If the initial case base is big enough to motivate a somewhat critical amount of system usage, this implicit learning mechanism will lead to an increasingly more representative case base – if the community or one key user (like a KM consulting company) starts to use the system systematically in real-world and large scale.

(2) Regarding the similarity measure:

- **Community involvement:** as already mentioned, a case-based system implements in its attribute weights an intuitive notion of relevance of a certain case feature for predicting the case's expected usefulness (adaptability, portability) in a new situation. The whole idea is essentially heuristical and can be applied when not too much deep analytical and causal knowledge in a domain is available. In such a situation, it is nearby to exploit the "intelligence of the crowd" and try to collect and integrate the intuition and experience of many people. This is exactly what we did and discussed extensively in this paper: collect and integrate the opinions of many KM practitioners about the relevance of BPC attributes and characteristics as indicators for assessing case similarity.
- **Learning over time:** another salient feature of CBR systems is that they can continuously be extended, adapted, and improved. One of the most powerful techniques is the collection of user feedback for automatically adapting the weights of individual runtime to better match the users' expectations. In this way, even an imperfect similarity measure – if good enough to create *some* system usage – can be used to start and can be improved over time with more and more system usage (cp. [Stahl, 05]).

Coming back to widespread methods for KM introduction, another significant thread of research must be mentioned. Still pretty much top-down and based on a relatively heavyweight analysis and modeling, but better oriented towards well-known techniques in the enterprise and better to combine synergetically with other – non-KM – initiatives: **Business-Process Oriented KM methods** (BPOKM, cp. [Abecker, 04; Gronau, 05; Strohmaier, 04] and many others). Some authors, in particular [Heisig, 05], propose a link between business-process analysis and a solution database of KM best-practices; however, in that context, best practices means rather KM methods that have proven to be useful in a certain usage context than whole example cases of KM application – as we use the term best-practice case in *this* paper. The whole BPOKM approach is much more analytical and based on a diagnosis of the KM problems at

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Prototypical cases are created by hand to feed into the system any kind of knowledge not directly found in a concrete project, yet. This may be general text-book knowledge, but the mechanism can also be used for creating a better understandable/ transferable format which combines the knowledge coming from *several* concrete projects.

hand than ours which maps actual problem and context specifications to stored experiences – which may happen (and work well) without actually having understood these problems in depth. As already said above in general, such top-down methods like BPOKM and our approach can be seen competitive, but the can also be seen complementary or orthogonal: A BPC might suggest to employ a BPOKM method in a certain situation, or a BPOKM approach may consult a best-practice case base to select the most promising instrument for improving a certain business process that has been identified as a support candidate for KM tools and methods.

In addition to all the published top-down, holistic, and comprehensive KM methods, there is one approach which has some similarities with ours because it also aims at a (semi-)formalization of documented best practice: The **pattern-based KM approach** presented in [Persson, 03; Persson, 06]. The authors derived several KM introduction case studies from a number of organizational patterns and anti-patterns describing best and worst practices for specific KM introduction activities. Similar to the idea of design patterns in Software Engineering, the organizational patterns are defined mainly text-based, but filling a given structure providing slots for the *problem* addressed, the *context*, the *goal* to be achieved and the *solution* proposed. The patterns are jointly inter-related and can be used for major steps in the KM introduction. They are relatively abstract and general compared with our BPCs, especially when compared with our *episodic* BPCs which describe concrete example implementations. On the other hand, the patterns seem mainly to support KM introduction at a similar level of granularity as we do; examples given in [Persson, 06] comprise such specific KM introduction activities as "how to select a knowledge champion in the top management" or "how to select a knowledge champion in the lower levels", but also very broad activities such as "how to tailor a general KM strategy to your organizational needs".

Overall, the pattern-based approach fits well with our ideas. Unfortunately, from the available publications about Persson's approach, it became not completely clear to us how detailed and formal the pattern description is, which functionalities the mentioned pattern repository offers, or which overall procedure is followed for making optimum use of the KM patterns. Nevertheless, it seems to be an interesting idea to further explore the commonalities and differences between the pattern approach and ours, and maybe work towards a unified theory, method, and system in the future.

Similarly, [Strohmaier, 05] presents a pattern-based approach for the identification of knowledge problems and the provision of suggested solutions. The authors define a pattern as a "relation between a certain *context*, a *problem*, and a *solution*". Altogether, we can see the close relationship to the top-level conceptualizations used in KMIR as shown in Figure 2. Essentially, these authors' patterns can be seen one KM BPC each, in our terminology and system. Because the patterns represent general knowledge abstracted from concrete cases, they could be incorporated as prototypical BPCs into KMIR. Examples for the authors' 10 identified core **knowledge problem patterns** (from [Strohmaier, 05]):

- *Mythos:* points to KM instruments including storage- or transfer mechanisms that were established within organizations, but are not actively used or do not contribute to key value-generating activities.

- *Knowledge Detour:* identifies situations where knowledge is transferred between two actors through a series of mediators, potentially causing misunderstandings or loss of information.

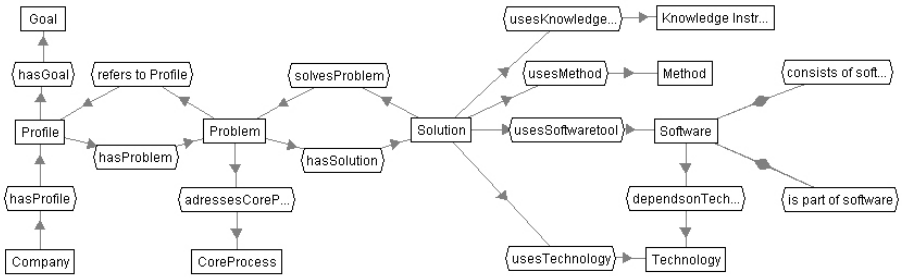

Figure 2: Relationships between Organization Profile, Problem, and Solutions in the KMIR Reference Model

Again, we would see Strohmaier's knowledge problem pattern not a competitor, but rather a content supplier for our system. However, they provide some clear, analysis and modeling based, method and procedure how to apply their patterns, whereas KMIR provides basically a technical infrastructure for automated assessing of context similarity, assuming that a context description is given. Maybe, Strohmaier's method could inspire a method to better apply a KMIR-like approach. However, on the other side, KMIR was designed to some extent to be less analysis and modeling driven, and more to accept end users' context and problem descriptions as they come naturally when filling out the KMIR profiling questionnaires. Probably, practical experience must show which approach with what level of upfront analysis, technical support, and analysis automation, works best in real-world scenarios.

A further candidate for the examination of the mutual differences and similarity, is the theory of **lessons-learned systems** as proposed by [Weber, 00]. Although lessons-learned systems typically support *KM processes* (i.e. improving experience sharing and reuse within a specific operational business process) and not the KM *meta* process (introduce and run a KM initiative) as we do, the literature provides some promising contributions, in particular long-standing experience with CBR approaches for storage and retrieval, a reference model for BPC description which is pretty much similar to our BPC reference model, and methodological guidance how to select and describe good lessons-learned episodes.

5.2 A Reference Model for KM BPCs & The Relevance of Individual Attributes

A **reference model (RM)** is a *general* or *generic* model (well-documented in the form of a definitive document or a conceptual representation) for a *class* of "entities" (processes, systems, states of affairs, …) such that (i) on the basis of this generic model, it is possible to plan/ instantiate/ refine/ configure *specific models* which are

the in turn the basis for the construction of *concrete entity realizations/* instantiations (e.g., a software system), and (ii) the general model can be used as the common denominator for comparing different specific models describing the same entities.
A reference model hence represents sort of a model template or a model-design pattern and can be seen as an idealized, typical model for the class of entities under consideration. Reference models are used for purposes such as:

1. to support reuse of existing models in order to reduce modeling costs and/ or increase modeling quality;
2. to facilitate model change/ modification/ adaptation to new or changing requirements, as well as model refinement/ adaptation for specific user groups;
3. to describe systems in a general, authoritative manner, for instance, for standardization.

Reference models (typically, of system architectures, information models, or business processes) play a significant role in business informatics and have been proposed by [Fettke, 05] as a complementary instrument to support *Business Engineering* – which is concerned with an engineering-based (re-)design of an organization by defining strategy, business processes, and software systems. We strongly support the authors' suggestion, but extend/ refine them in two directions:

a. Defining a KM strategy, processes, and software systems (as well as cultural interventions and affected organizational structures) must, of course, be part of Business Engineering.
b. The approach, methods and techniques of Business Engineering can not only be employed for designing or radically redesigning an organization or a service, they should also be considered a natural way for realizing continuous process improvement and for supporting service innovation.

Having said this, we can already note that reference modeling in general did not yet play an extraordinary role in Knowledge Management, up to now. In particular, to the best of our knowledge, there is no other work comparable to our suggested BPC reference model. The only contributions which might be interesting to be examined in some more detail, are the two already mentioned above: (i) the organizational patterns introduced by Persson and colleagues – although they seem to be only semi-formal and much natural-language based – or also design patterns and their creation and quality assurance processes in Software Engineering; and (ii) the lessons-learned structure and associated processes introduced by Weber and colleagues.

And because there is no related work about reference modeling for best-practice cases, there is of course neither related work about reference models for KM best-practice cases or for similarity measures for BPC selection.

Although we don't see, up to now, relevant existing related work, we consider our approach nevertheless well suitable to contribute to the RM topic, for several reasons:

- The idea of using a (standardized) ontology language as a powerful conceptual modeling approach for expressing reference models, is not yet widespread in the literature, but fits well in the overall "philosophy" of reference modeling. It opens up also additional opportunities for automated processing, using formal inferences and reasoning tools (e.g., for checking consistency of models, automated generation of derived artefacts, or automated propagation of changes to derived artefacts).

- The initial list of indicators as well as their structuring has to a large extent been based on an analysis of the most important existing works, and can thus be seen as their generalized, integrated, and harmonized abstraction from these specific models.
- The weighting of relevance indicators has been based on the consensus – or, at least, the condensed opinions – of a significant number of stakeholders, and can thus be seen authorative, to some extent.

6 Summary, Conclusions and Some Future Work

In this paper we described our work on identifying relevant indicators for the description and assessment of the portability of Best-Practice Cases for a KM introduction. The approach is motivated by the fact that many practically successful KM projects are obviously based on the simple concept of learning from good examples and transferring good practices – if applicable – to the own organization. Computer support for such an approach requires first the identification and recording of a huge and representative amount of cases – which can be done by manually analysing and processing the KM literature. However, finding the most suited BPC in a concrete, new situation is difficult, because assessing an organization's actual situation is a complex, experience-based task. One has to identify the relevant case attributes (or, similarity indicators) and their respective relevance (i.e. weights) for case-similarity assessment.
To this end, we selected a basic set of indicators and verified them by the use of an open web survey. In a next step, the survey results were adjusted, evaluated and interpreted. Based on that, we developed an ontology-based reference model for KM BPCs.

It turned out that at least the voluntary participants in the survey consider the idea of automated case retrieval feasible. One may argue that the number of 103 participants is not yet sufficient for a convincing assessment of case attributes and relevances. However, it is a starting point which can be further refined in subsequent assessment workshops or survey rounds.

The reference model, as well as the identified relevance weights of the indicators, provides a good basis for structuring episodic as well as prototypical, BPCs of a (successful) Knowledge Management introduction. Therefore, we integrated the reference model ontology in our KMIR[7] (Knowledge Management Implementation and Recommendation) software framework which accompanies organisations in the implementation of KM. KMIR retains BPCs of a successful KM introduction in an ontology-structured case base, and matches a new organisation profile against existing BPCs. The most similar retrieved BPC is then returned as a recommendation, adapted, and finally offered for reuse by the requesting organisation [Hefke, 06].

The retrieved relevancies of single indicators from the survey delivered the basic settings for similarity weights used in the matching component of the KMIR framework. At present, the KMIR framework comprises 36 structured episodic Best Practice Cases (BPCs) of real KM introductions. 39% of the BPCs are provided by SMEs and 61% by LSEs. In addition, the BPCs dispose of 180 defined knowledge goals, 159 problem Descriptions and 132 solutions (Table 6 and Table 7 summarize

[7] cp. http://www.kmir.de

the current content of our case base – thus also somehow summarizing the structure of today's widely available KM BPC literature). It will be a future challenge to find suitable ways for integrating more and more real-world experience into the system (either by acquiring new cases, or by getting more questionnaire respondents for assessing the relative weights of BPC indicators, or by using the system and creating feedback for improving case base and similarity measure).

Total number of problems	159
Ratio of organisational problems	69%
Ratio of technical problems	12%
Ratio of cultural problems	19%
Ratio of problems addressing core process "Defining Knowledge Goals"	2%
Ratio of problems addressing core process "Identifying Knowledge"	4%
Ratio of problems addressing core process "Acquiring Knowledge"	9%
Ratio of problems addressing core process "Developing Knowledge"	1%
Ratio of problems addressing core process "Distributing Knowledge"	33%
Ratio of problems addressing core process "Using Knowledge"	13%
Ratio of problems addressing core process "Preserving Knowledge"	14%
Ratio of problems addressing core process "Measuring Knowledge"	4%

Table 6: Number/ Ratio of Knowledge Problems

Total number of goals	180
Ratio of normative goals	17%
Ratio of strategic goals	32%
Ratio of operative goals	52%

Table 7: Number/ Ratio of Knowledge Goals

From the academic point of view, some further analyses and methodological extensions can be thought of as already shortly discussed above: clarification of the relationship of our approach to organizational patterns, software design patterns, and intelligent lessons-learned approachs, maybe merging of the research threads; in particular, finding a common reference model for the description of lessons learned, organizational patterns and KM BPCs, and definition of quality assurance processes for identifying, describing and maintaining a respective case base; integration of the KMIR approach with a KM maturity model; further investigation of the role of KMIR

for KM reference modeling, the role of reference modeling in general for KM, and the role of ontologies and Semantic Web technologies for reference modeling.

From a software-technical point of view, possible extensions for our KMIR implementation have been identified, like the usage of rules for integrating symbolic, explicit knowledge into similarity computation, or the incorporation of feedback mechanisms for weight adaptation at runtime. A system extension currently under work produces suggestions for user actions by collecting and integrating several suggested measures coming from different stored cases considered relevant for the new case at hand.

A last challenging field of possible future work is the evaluation of our KMIR system, both with respect to efficiency and to effectiveness. Regarding efficiency, recent experiments show that also a "heavyweight", knowledge-based similarity computation can be run sufficiently fast for our current case base consisting of some dozens of stored BPC descriptions. Improvements by standard techniques such as caching were easily achievable. However, scalability for a rapidly growing case base is still to be proven. Regarding effectiveness, the problem is much more difficult, because the only really convincing way of showing the coverage of our case base, the quality of retrieval, and the portability of BPCs, seems to use the system long-term and large-scale in the field.

Acknowledgements

The work described has been supported by several public and industrial funding sources and has been developed within a series of joint research projects run at FZI – the technology transfer center for ICT at the University of Karlsruhe (Germany). These projects comprise in particular "Im Wissensnetz" (a joint research project about Knowledge Management in eScience, partially funded by the German National Ministry for Education and Research bmf) and "Nepomuk" (a Euopean Integrated Project about networked semantic desktops, partially funded by the European Commission under the IST programme FP6).

References

[Aamodt, 94] A. Aamodt, E. Plaza (1994), Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches, AICom - Artificial Intelligence Communications, vol. 7, no. 1, pp. 39-59, IOS Press, 1994

[Abecker, 04] A. Abecker, Business-Process Oriented Knowledge Management: Concepts, Methods and Tools, Dissertation, Institute AIFB, University of Karlsruhe, 2004

[Althoff, 01] K.-D. Althoff, Case-Based Reasoning, in: S.K. Chang (ed.), Handbook on Software Engineering and Knowledge Engineering, vol. 1 "Fundamentals", pp. 549-588, World Scientific, 2001

[Apostolou, 07] D. Apostolou, N. Papailiou, G. Mentzas, Developing Knowledge Networks: A Practical Methodology and Experiences from Cases, Int. Journal of Knowledge Management Studies (IJKMS), Special issue on: "Knowledge Management in Practice", forthcoming, 2007

[Aha, 00] D.W. Aha, R. Weber (eds.), Intelligent Lessons Learned Systems: Papers from the AAAI Workshop, Technical Report WS-00-08, Menlo Park: AAAI Press, 2000

[Davenport, 00] T. Davenport, L. Prusak, Working Knowledge. How Organizations Manage What They Know, Boston: Harvard Business School Press, 2000

[Ehms, 02] K. Ehms, M. Langen, Holistic Development of Knowledge Management with KMMM®, online publication: http://www.knowledgeboard.com, last access: 12-31-2006

[Eppler, 01] M. Eppler, O. Sukowski, Fallstudien zum Wissensmanagement: Lösungen aus der Praxis, St. Gallen: NetAcademy Press, 2001

[Fettke, 05] P. Fettke, P. Loos, Der Beitrag der Referenzmodellierung zum Business Engineering (in German), HMD no. 241, pp. 18-26, 2005

[Gronau, 05] N. Gronau, C. Müller, R. Korf, KMDL - Capturing, Analysing and Improving Knowledge-Intensive Business Processes, Journal of Universal Computer Science, JUCS vol. 11, no. 4, pp. 452-472, 2005

[Hefke, 04] M. Hefke, A Framework for the Successful Introduction of KM Using CBR and Semantic Web Technologies, Journal of Universal Computer Science, JUCS vol. 10, no. 6, pp. 731-739, 2004

[Hefke, 06] M. Hefke, A. Abecker, KMIR - a Knowledge Management Implementation and Recommendation Framework using CBR and Semantic Web Technologies, Proc. MKWI-2006, Passau, Germany, February 2006

[Hefke, 06b] M. Hefke, V. Zacharias, E. Biesalski, A. Abecker, Q. Wang, M. Breiter, An Extendable Java Framework for Instance Similarities in Ontologies, Proc. 8th Int. Conf. on Enterprise Information Systems ICEIS-06, Paphos, Cyprus, May 2006

[Hefke, 06c] M. Hefke, A. Abecker, A CBR-Based Approach for Supporting Consulting Agencies in Successfully Accompanying a Customer's Introduction of Knowledge Management, Proc. 8th European Conference on Case-Based Reasoning ECCBR-06, Ölüdeniz/Fethiye, Turkey, LNCS 4106, Berlin, Heidelberg: Springer-Verlag, 2006

[Heisig, 05] P. Heisig, Integration von Wissensmanagement in Geschäftsprozesse, Dissertation TU Berlin, Berlin: eureki, 2005

[Kochikar, 00] V.P. Kochikar, The Knowledge Management Maturity Model - A Staged Framework for Leveraging Knowledge, KMWorld Conference, 2000

[Kwiecian, 01] S. Kwiecian, Best Practice Replication: The Evolution of KM at Ford Motor Company, Journal of Knowledge Management, vol. 5, no. 3, October 2001

[Lindstaedt, 02] S.N. Lindstaedt, M. Strohmaier, H. Rollett, J. Hrastnik, K. Bruhnsen, G. Droschl, M. Gerold, KMap: Providing Orientation for Practitioners When Introducing Knowledge Management, Proc. PAKM-2002, LNCS 2569, pp. 2-13, Berlin, Heidelberg: Springer-Verlag, 2002

[Mahadevan, 04] V. Mahadevan, Z. Chaczko, R. Braun, A Holistic Approach of Knowledge Management Initiative for a Telecollaboration Business System, International Business Research Conference, Melbourne, Australia, November 2004

[Mentzas, 2002] G. Mentzas, D. Apostolou, R. Young, A. Abecker, Knowledge Asset Management, London: Springer-Verlag, 2002

[Mertins, 03] K. Mertins, P. Heisig, J. Vorbeck (eds.), Knowledge Management. Concepts and Best Practices, 2nd edition, Berlin, Heidelberg: Springer-Verlag, 2003

[Müller-Prothmann, 06] T. Müller-Prothmann, Leveraging Knowledge Communication for Innovation. Framework, Methods and Applications of Social Network Analysis in Research

and Development, Series: European University Studies, Series V: Economics and Management, Vol. 3189, 2006

[Persson, 03] A. Persson, J. Stirna, H. Dulle, G. Hatzenbichler, G. Strutz, Introducing a Pattern Based Knowledge Management Approach - the Verbundplan Case, 4th Int. Workshop on Theory and Applications of Knowledge Management (TAKMA), in DEXA'03 Workshops, pp. 777-781, IEEE Computer Society, 2003

[Persson, 06] A. Persson, J. Stirna, How to Transfer a KM Approach to an Organization – A Set of Patterns and Anti-Patterns, Proc. PAKM-2006, LNCS 4333, pp. 243-252, Berlin, Heidelberg: Springer-Verlag, 2006

[Prentzas, 02] J. Prentzas, I. Hatzilygeroudis, Integrating Hybrid Rule-Based with Case-Based Reasoning, Proc. ECCBR-2002, pp. 336-349, LNCS 2416, Berlin, Heidelberg: Springer-Verlag, 2002

[Probst, 06] G. Probst, S. Raub, K. Romhardt, Wissen managen. Wie Unternehmen ihre wertvollste Ressource optimal nutzen, 5th edition, Wiesbaden: Gabler Verlag, 2006

[Sharif, 05] M.N.A. Sharif, N.H. Zakaria, L.S. Ching, L.S. Fung, Facilitating Knowledge Sharing Through Lessons Learned System, Journal of Knowledge Management Practice, vol. 6, March 2005

[Skyrme, 02] D.J. Skyrme, Best practices in Best Practices, David J Skyrme Associates, 2002

[Staab, 04] S. Staab, R. Studer, Handbook on Ontologies, Berlin, Heidelberg: Springer-Verlag, 2004

[Stahl, 05] A. Stahl, Learning Similarity Measures: A Formal View Based on a Generalized CBR Model, Proc. ICCBR-2005, pp. 507-521, LNCS 3620, Berlin, Heidelberg: Springer-Verlag, 2005

[Strohmaier, 04] M. Strohmaier, B-KIDE: A Framework and a Tool for Business Process Oriented Knowledge Infrastructure Development, Dissertation, University of Graz, Aachen: Shaker Verlag, 2004

[Strohmaier, 05] M. Strohmaier, S.N. Lindstaedt, Application of Knowledge Problem Patterns in Process Oriented Organizations, in: K.-D. Althoff et al. (eds.), Professional Knowledge Management (WM2005), LNCS 3782, pp. 259-268, Berlin: Springer-Verlag, 2005

[Weber, 00] R. Weber, D.W. Aha, H. Muñoz-Avila, L. Breslow, An Intelligent Lessons Learned Process, Proc. ISMIS-2000, LNCS 1932, pp. 358-367, Berlin, Heidelberg: Springer-Verlag, 2000

[Weber, 01] R. Weber, D.W. Aha, I. Becerra-Fernandez, Intelligent Lessons Learned Systems, Expert Systems with Applications, vol. 20, no. 1, pp. 17-34, Elsevier, 2001

[Wess, 95] S. Wess, Fallbasiertes Problemlösen in wissensbasierten Systemen zur Entscheidungsunterstützung und Diagnostik (in German), infix-Verlag, 1995