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Discussion Paper WI-135

Measuring the Performance of Knowledge Management Initiatives

by

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October 2003

Presented at : OKLC 2004, Innsbruck, (Austria), April 2004

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Measuring the Performance of Knowledge Management Initiatives

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Abstract

The multifarious term 'Knowledge Management' is still widely used throughout theory and practice. Most of the worldwide top 500 companies use Knowledge Management systems to various extents and in various forms in their daily business. Many corporations have developed Knowledge Management initiatives; mostly without any economic evaluations. Due to more competitive market conditions, organizations are urged to evaluate the impacts of Knowledge Management initiatives more precisely. As existing measurement approaches solve the problem only partially, this article develops a performance measurement framework for a Knowledge Management initiative (according to North et al. 1998; Probst et al. 2000) including possible indicators within each category. The article is based on research within a recent Knowledge Management initiative at SGL CARBON, a global carbon manufacturing corporation.

Keywords: knowledge management initiative; performance measurement; intermediation.

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1 Introduction

Within the last years, nearly all major corporations started Knowledge Management (KM) initiatives, particularly to strengthen the knowledge base within the organization, especially to help employees share, activate and increase their knowledge to finally generate a more innovative, faster acting, competitive organization. Recognizing knowledge as the primary intangible resource to make companies more efficient and effective was the basis for the "knowledge-based economy" and for KM. Increasingly sophisticated customers, new technologies, eager new competitors, and the need for more innovative products forces companies to be able to manage their knowledge assets well. The introduction of a KM initiative is a large investment for many corporations. Therefore performance measurement systems are required to make the

benefits and the performance of KM initiatives transparent. Especially in times of scarce budgets the usefulness of KM is in doubt, as the business impact of such initiatives often can be hardly quantified or is only indirectly measurable.

Despite the overwhelming feedback KM has gained in the past years, implementations of KM initiatives often still lack an appropriate performance measurement systems (Amelingmeyer 2000; Davenport et al. 2000; Gentsch 2000; Nonaka et al. 1995). Current measurement approaches for Knowledge and KM, such as Tobin's Q (North et al. 1998) or Calculated Intangible Value (Stewart 1997), solve this problem only partially. Facing the problem of a continuous performance measurement of results and performance drivers of KM initiatives, this article develops a performance measurement framework mapping the different phases of KM initiatives (following North et al. 1998 and Probst et al. 2000). This approach has been developed in a project at SGL CARBON and is therefore applied to the specific requirements of a manufacturing corporation.

The article starts with a short literature review on Knowledge and KM in order to define the fundamentals (section 2). After that, current measurement approaches and their limitations are discussed (section 3). Then a framework for performance measurement of KM initiatives over different phases of development is presented portraying the case of SGL CARBON (section 4). Finally, conclusions are drawn and an outlook for further research is provided (section 5).

2 Knowledge and Knowledge Management

The last 5 years led to an immense amount of literature on Knowledge and KM (e.g. Amelingmeyer 2000; Brooking 1999; Gentsch 2000; Lehner 2000; North et al. 1998; Schindler 2001; Schreyögg 2001). In order to define and delimit the fundamentals and the view on the widely used terms Knowledge and KM, a review on selected fundamental literature is given in the following paragraphs.

2.1 Knowledge

Following Davenport and Prusak (2000): "Knowledge is a fluid mix of framed experiences, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information." Knowledge originates and is applied in the mind of individuals, whereas in organizations it can be embedded in routines, processes, practices, and norms

(Davenport and Prusak 2000). It actively enables performance, problem-solving, decision-making, learning and teaching by integrating ideas, experience, intuition, and skills, to create value for employees, the organization, its customers, and shareholders (Liebowitz 2000; Probst et al. 2000).

Commonly agreed, knowledge can be split into two types: explicit and tacit (Polanyi 1997 and Nonaka and Takeuchi 1995). Tacit knowledge is held by experts, having topic specific as well as cognitive skills that contain patterns of thought or notions, beliefs, institution and mental models. Explicit knowledge can be articulated in an artifact of some type outside a human being and be transferred e.g. to non-experts. Explicit knowledge is rational and includes theoretical approaches, problem solving, manuals, and databases. The transfer of knowledge from tacit to explicit or explicit to tacit can be viewed as a continuous learning process becoming the so-called knowledge spiral (Nonaka and Takeuchi 1995; Senge 1990). It enables building and conveying knowledge in need of good "Knowledge Management" to enhance the process, finally leveraging corporate performance.

2.2 Knowledge Management

KM is about interventions in the organizations' knowledge base, which by definition includes individual and collective intellectual assets that help an organization to perform its tasks (Amelingmeyer 2000; Probst et al. 2000; Romhardt 1998). It undergoes regular changes that constitute organizational learning (Senge 1990). A review of the early KM literature shows that raw technical approaches drew the initial interest, but are not sufficient to produce the desired outcome of KM (Davenport and Prusak 2000; Probst et al. 2000). While intranets and information repositories may provide means for people, they are not good in helping people apply the new knowledge in the context of process work (Massey et al. 2002). Therefore every KM initiative has not only technical aspects, but also involves people and processes.

Choi and Lee (2002) categorized KM from explicit- and tacit-oriented perspectives into four styles: dynamic, system-, human-oriented, and passive (See Figure 2).

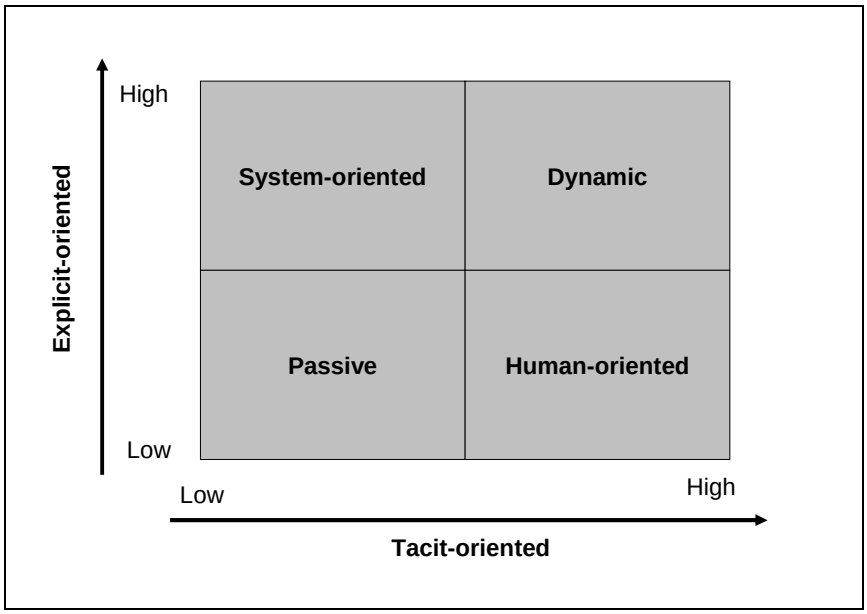

Fig. 1. Choi and Lee 2002 styles of KM

The explicit-oriented level considers the degree of codifying and storage of organizational knowledge needed for a person to use and access it. The tacit-oriented considers the acquisition and sharing of organizational knowledge. Passive style companies do not manage knowledge in a systematic manner and do not truly exploit knowledge. Companies of a system-oriented style put more emphasis on codifying and reusing knowledge, increased by the use of advanced IT systems to facilitate the complexity of accessing and using knowledge. The management capabilities are enhanced by group and standard training programs. The human-oriented style places the emphasis on acquiring and sharing tacit knowledge and interpersonal experience. Knowledge within the organization originates from informal networks with good relationships among organizational members. Those organizations tend to seek radical learning abilities and prefer procedures like storytelling as a way to share knowledge. The dynamic-style is the aggressive and integrative way to manage tacit and explicit knowledge dynamic. Chen and Lee (2002) found out that the dynamic-style results in the best performance according their measurement study. Ensuring successful KM requires close attention to the costs.

Figure 2 classifies different views on KM. These views are oftentimes mixed and bundled (Probst et al. 2000, Lehner 2000).

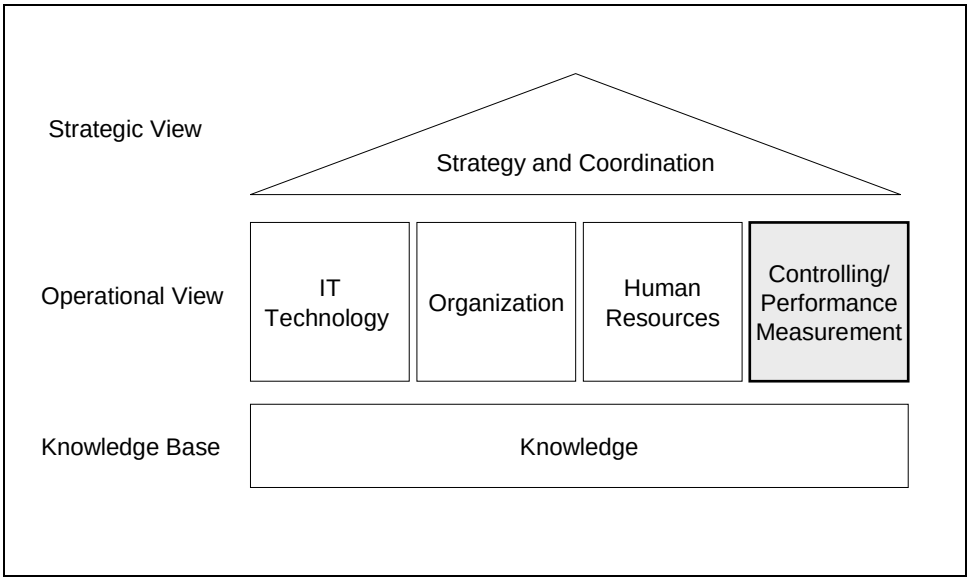

Fig. 2. Classification of different views on KM (following Schauer and Frank 2002)

Considering these views on KM, this article focuses on Controlling and Performance Measurement of Knowledge Management (Initiatives). The next section presents the current state of measurement approaches for Knowledge and Knowledge Management.

3 Measurement approaches for Knowledge and Knowledge Management

Current approaches can be split into a combination of objects for measuring knowledge and knowledge management in terms of value and status. The object "knowledge" relates to knowledge as a resource or output product, whereas the object "knowledge management" includes all actions, structures, and processes of managing knowledge. The column "value" describes monetary results and relations to business success, while "status" targets the quality and development status. Practical instruments and theoretical approaches can be determined for every quadrant; some instruments cover more than one quadrant. Figure 3 classifies measurement approaches in four quadrants (according to Deking 2002).

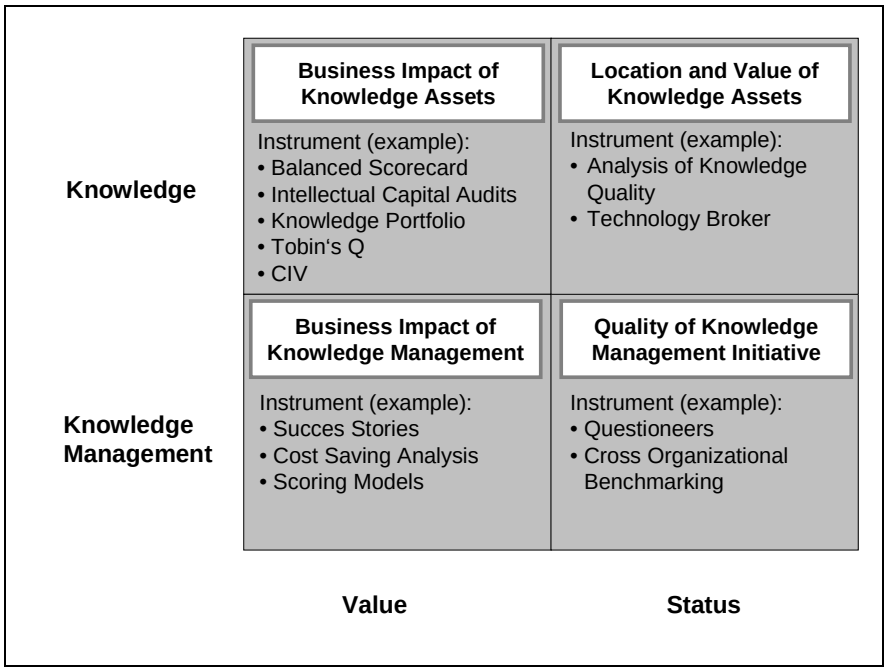

Fig. 3. The four quadrants of measurement enhancing the framework of Deking (2002)

According the several methods of measuring Knowledge and KM, the choice of practicable instruments depends on the context of development status, controlling objects, the management, the costs of implementing an instrument, and of the initiatives' goals. Most of the existing approaches concentrate on one quadrant. A common way to further structure KM measurement approaches is to distinguish between deductive-summarizing and inductive-analytical approaches. The deductive-summarizing approaches, such as Tobin's Q (North et al. 1998) or Calculated Intangible Value (CIV) (Stewart 1997), and inductive-analytical approaches, such as the Intellectual Capital Navigator (ICN) (Stewart 1997), Intangible Assets Monitor (IAM) (Sveiby 1997; URL 2), the Balanced Scorecard (BSC) (Kaplan and Norton 1996) or the Skandia Navigator (SN) (Skyrme and Amidon 1998; URL 3).

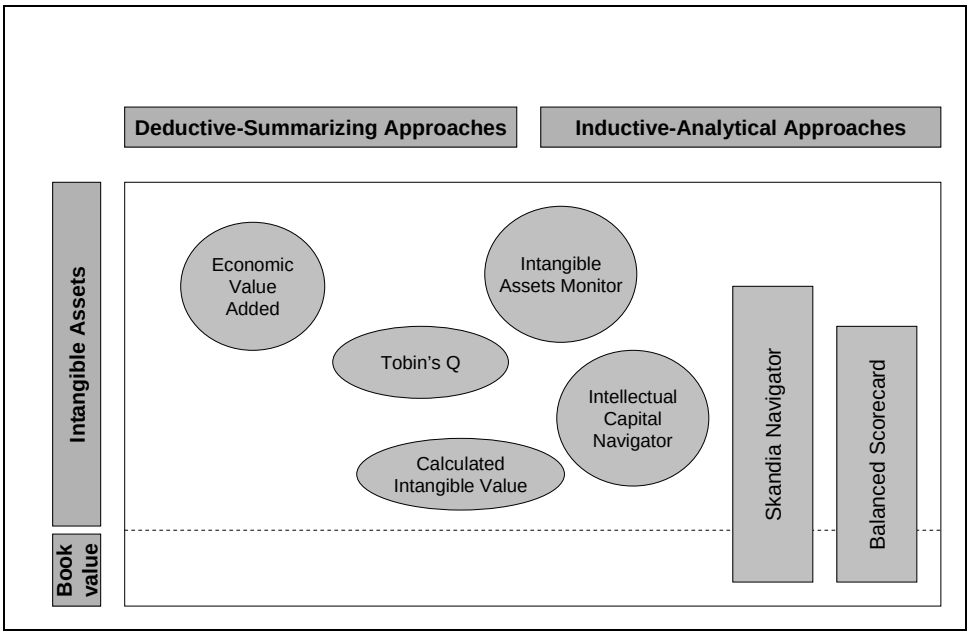

Fig. 4. Overview of Approaches to Evaluate Knowledge Management (North et al. 1998)

In case companies are in the same business area and market environment, deductive-summarizing approaches concentrate on the value of intangible assets, e.g. by the quotient of market value and book value. As aggregated values, these approaches are able to value the organizational knowledge base, but the cause-and-effect connection of intervention and changes in the knowledge base cannot be specified (North et al. 1998, p. 16). Inductive-analytical approaches are more suitable to connect company objectives with specific interventions. Two types can be identified: First, the analytical description and evaluation of different components within the organizational knowledge base, including further intangible assets. Sveiby's IAM and Stewart's ICN are part of this category. Second, approaches that integrate financial and non-financial indicators to align measures with strategies, such as the BSC and the SN. As previously mentioned, the Industrial Age business model is slowly replaced by the Information Age model. However, many measurement approaches are based on the underlying assumptions of the Industrial Age – the tangible-assets-based explanations (Housel and Bell 2001). In contrast the Information Age paradigm recognizes a set of knowledge assets distributed among machines, people, and processes to produce the desired outputs and operate processes. KM initiatives need feedback on how well the Knowledge is utilized within the company and provides valuable contribution to the company success. To enable the measurement intangible assets within the

organization have to be identified and their impact on business results has to be determined.

Most of the described existing approaches are the first step in an evaluation of interventions and outcomes of the organization's knowledge base (Maier and Haedrich 2001). Mostly questionnaires are used to determine a subjective success. A targeted development of the knowledge base and the reference to business results appears difficult to establish. Most approaches concentrate on metrics that are influenced by an abundance of single factors. Isolated successes are measured (Telephone availability), as well as static finance indicators (North et al. 1998). Some indicators appear confusing and may not provide a satisfactory description of the company's intangible assets, for example in the IAM outcomes are mixed with strictly descriptive elements (Tillquist and Rodgers 2002).

A specific case is the Balanced Scorecard (BSC) (Kaplan and Norton 1992/1996) as the concept measures how the strategy has been implemented into operations. The classic BSC measures performance in four perspectives: financials, customers, internal processes, and learning and growth. These perspectives provide a balanced view on financial and non-financial data of the present and future performance of the business. A further development of the classic BSC are Knowledge Scorecards with perspectives that are applied to the needs of knowledge organizations (See Deking 2002; Kaps 2001; Fairchild 2002). The previously named approaches face a drawback in terms of the maturity of KM initiatives. An APQC study (Lopez 2001) identifies several stages of a KM initiative within the implementation in a company and discusses different performance measurement system in single stages. According the APQC, measurement of KM follows a bell curve pattern through the life cycle of a business. In the early stages of KM implementations, formal measurement rarely takes place nor is even required. As it becomes more structured and widespread, the need for measurement steadily increases. The objectives of the start-up phase are to generate interest and support for KM, creating a higher value on measures, such as positive anecdotes or stories that indicate KM as a worthwhile instrument. The pilot project phase concentrates on more definitive measures, which develop an evidence of success or lessons learned that could be transferred to other initiatives. For the growth and expansion stage, KM is institutionalized across the organization and therefore measures are needed, that represent benefits of business units or even company-wide

benefits (Lopez 2001; Fairchild 2002). Figure 4 shows the KM measurement bell curve with a second curve that shows the growing importance of measuring the effectiveness of knowledge-intensive business processes (Massey et al. 2002).

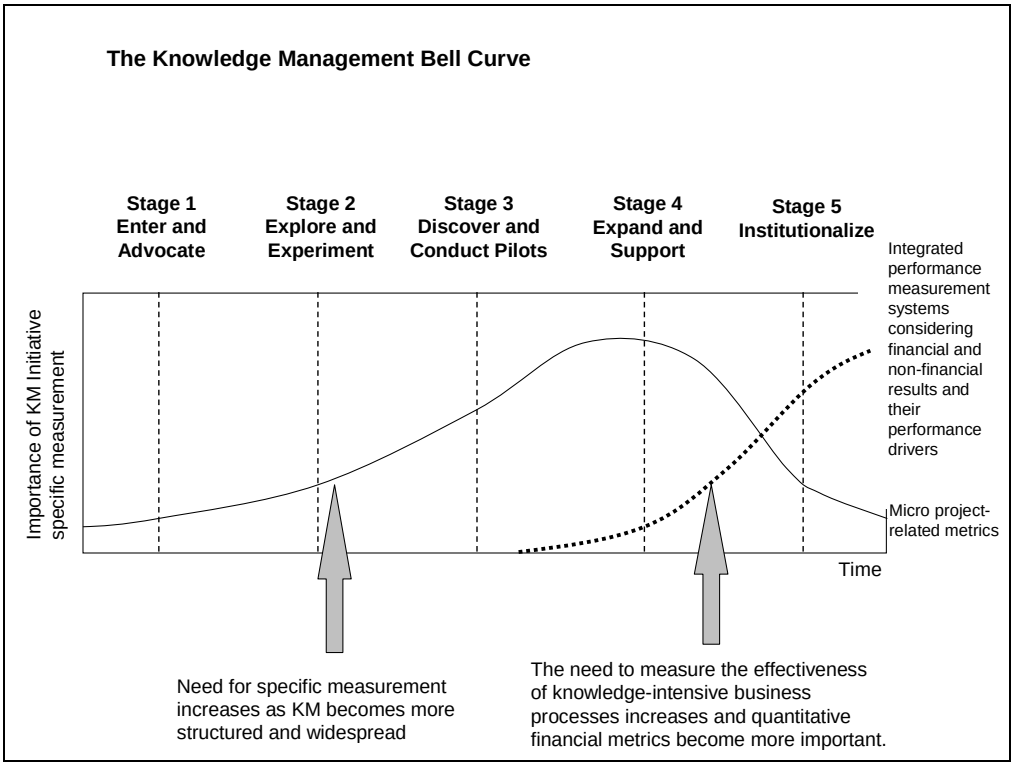

Fig. 5. The Knowledge Management Bell Curve

Since pure financial measures are not appropriate until stage four, previous stages can be measured with quantitative and anecdotal measurement approaches. Examples in the first two stages are the accredited budget and the number of sponsors, indicating an increasing support for a KM project. Stage three conducts software pilots; captures lessons learned and focuses on the business strategy, as well as cultural change is on the way. Although sometimes suggested in several measurement concepts (Maier and Haedrich 2001), metrics in this stage can only help determining the value and success of implemented KM software pilot systems. The overall success of a KM initiative, which may include programs for cultural change and process reengineering, can be measured from stage 4 on, when multiple KM projects in different business units are undertaken. Assuming that the previous stages proved enough commitment to officially expand KM, it becomes part of the organization's funded activities and gets implemented in an organizational view and in form of information technology. Each organization has to develop its own set of approaches, adapted to its own circumstances and problems (Probst et al. 2000). To fit the requirements a combination

of performance indicators is required (Deking 2002). A case study at SGL CARBON showed the usability of the multidimensional measurement approach of Probst et al. (2000) with exemplary indicators.

4 Performance Measurement of a Knowledge Management Initiative at a Manufacturing Corporation

This section develops a performance measurement framework on the case of SGL CARBON. With more than 8 000 employees and sales revenue of €1.233 million, SGL CARBON is the world's largest manufacturer of carbon, graphite and composite materials for industrial and aerospace applications. SGL CARBON has more than 30 production sites, as well as a sales and service network that covers 90 countries around the world (See SGL CARBON Annual Report 2001). The following approach to measure the performance of a KM initiative is based on a corporation that already finished the pilot testing and runs a working KM program matching at least stage 4 of the APQC bell curve (Lopez 2001). Having invested money and management time in building up KM, SGL CARBON was interested to make the impact of KM on business results and performance drivers more transparent[1]. At first section 4.1 shortly describes the requirements on performance measurement. Then section 4.2 defines the framework and its classes of indicators I-IV, which are then presented in sections 4.3-4.6.

4.1 Requirements on performance measurement

The industry or branch of the corporation and the corporation itself sets specific requirements for performance measurement of KM. Manufacturing companies rely on their knowledge workers in the same way other businesses, such as consulting or the IT industry do. For the measurement approach at SGL CARBON, a distinction between the overall KM initiative and the technological system of the initiative has been drawn. The KM initiative includes organizational instruments, such as incentive systems for cultural change, reward tenure, or process reengineering, as well as the information technology foundation for knowledge sharing and transfer. The technology system means the information technology level of the initiative, consisting of the company specific definition of KM.

[1] Although the framework was developed within SGL Carbon, the company did not prove the value and efficiency of the framework yet. An case study has to be concluded.

Indicators for KM initiatives can be quantitative and qualitative. Quantitative data provides hard data to evaluate performance. Qualitative indicators should be quantified, wherever possible or used to provide additional data for quantitative indicators. The selected performance indicators have to be related to the business objectives, esp. KM goals, of the corporation (Trittmann 2003). The implementation of the framework and its performance indicators has to be in an economic relation to the possible business improvement resulting from controlling efforts. Forcing the usage of KM systems and investing in a cultural change, which increases the usage again, leads to a stage, where performance indicators are required to show the impact on the business after time - tied to the maturity of corporations' KM initiatives (Lopez 2001). A concentration on only a part of the initiative, e.g. the system usage of knowledge tools, would neglect financial indicators. A KM initiative may take a few years to produce real business value (Davenport and Prusak 2000); therefore different performance indicators for different phases are necessary (Lopez 2001). Hence, the performance measurement framework should be flexible enough to be further developed over the course of time. Last, but not least, the performance measurement framework also has to be interoperable with other management instruments such as traditional accounting or Balanced Scorecard approaches.

4.2 Overview on the developed framework

Contrary to the other measurement approaches, this article tries to figure out a way to deal with every level of a KM initiative and different objects to enable an integrated measurement framework. The basic requirement for metrics in this area is the distinction of indicators to avoid mixing contents, inputs and outputs (Liebowitz 2000). North et al. (1998) and Probst et al. (2000) differentiate four classes of indicators (see table 1): Class I indicators describe the content of the organizational knowledge base in qualitative and quantitative terms; class II indicators determine processes as measurable dimensions of attempts to change the knowledge base; class III indicators measure intermediate outcomes and transfer effects; class IV indicators evaluate the effects of KM initiatives on business results.

Table 1. Classes of Indicators (North et. al.)

Class of indicators	**Definition of term**
Knowledge base indicators (Class I)	Constituents of the organizational knowledge base in qualitative and quantitative terms

Cost indicators (Class II)	Processes and inputs for changes in the organizational knowledge base (Costs)
Intermediation and transfer indicators (Class III)	Measure direct usage of the knowledge base and the results of knowledge transfer resulting in intermediate effects on the organization.
Effect indicators on business results (Class IV)	Evaluation of the effects on business results

Based on the classification figured in table 1 performance indicators are defined in the following. To meet the organization's knowledge goals, the knowledge base is changed by targeted interventions and includes the implementation of potential portal software, new incentive systems, and the acquisition of new knowledge from inside and outside the company. Intermediate organizational effects are the results, leading to shorter response times, better decision-making and thus to increasing customer satisfaction. The transfer effects also cover the technology system with increased use, more user satisfaction and the generation of knowledge context, in turn influencing the organization again. The performance measurement framework (Figure 6) separates indices into different classes to show the full context and effects of interventions in the knowledge base. Examples of Class I to III indicators are given; Class IV indicators are assumed to be already measured at most companies as they are basic financial measures. The different classes of indicators in the framework include quantitative and qualitative measures for organizational change and the underlying information technology.

The selection of performance indicators has to be harmonized within the requirements of the organization, esp. the general management and the management level of each business unit. The goal of the KM initiative in the company also plays a very important role. Therefore, the described measures present exemplary indicators that are not mandatory for every (manufacturing) corporation, nor mandatory for companies with the same size and revenue than SGL CARBON. To prove the resulting framework on being applicable for other corporations and industries as well, further research in this area should take place.

Figure 6 shows the performance measurement framework (based on North et al. 1998 and Probst et al. 2000), which locates the impact of interventions in the corporate knowledge base and the connection between the costs of interventions and the intermediate effects.

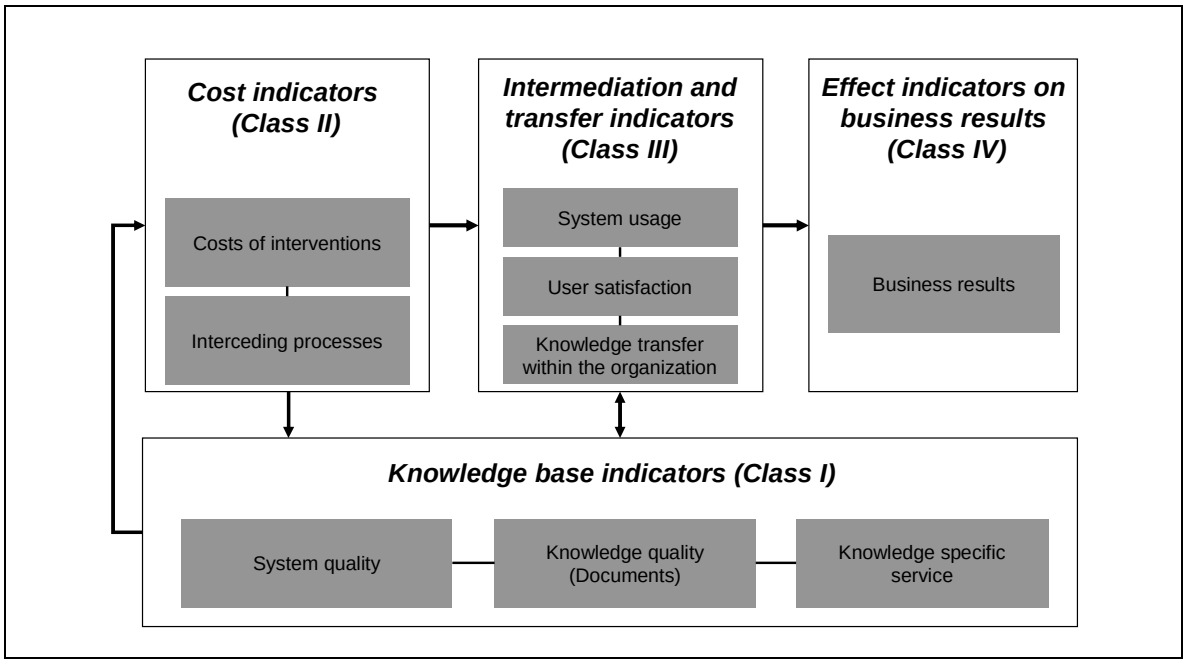

Fig. 6. Performance measurement framework for KM Initiatives

An improvement of values of performance indicators in Class I, II or III are assumed to positively drive business results (Class IV). For example, if the company decides to carry out targeted interventions in the knowledge base associated with higher costs, the knowledge quality and the system quality increase. A measured higher system quality and service lead to more interceding processes and again more budget to further increase the knowledge base quality. The interventions in the knowledge base produce the intermediate results including a higher user satisfaction and higher system usage. More knowledge is shared and transferred to enlarge the knowledge specific service for example as well as the knowledge in the heads of the employees, which is a part of the company's knowledge base increases. Following the theory of knowledge as a resource to business success (Wernerfelt 1984, 1995; Barney 1991), class IV indicators should be able to prove the value of a KM initiative. Even if the intermediate results and the causal link to a change in the company's financial results are not always clear, this approach helps to understand the connections between the intangible

resource knowledge, the management of it and the resulting financial outcomes (Probst et al. 2000).

4.3 Class I - Knowledge Base Indicators

By definition, Class I indicators describe the content of the organizational knowledge base in qualitative and quantitative terms. The knowledge base consists of individual and collective knowledge assets that the organization can use to perform its tasks (Knowledge Quality) and the information and data that is stored in the knowledge repositories (System and Service). Class I indicators are split into three sub factors: Quality of the system, quality of the provided knowledge in the knowledge base, and the knowledge specific service that is provided with the aid of an information technology system.

System quality

Despite the various attempts to measure the creative knowledge within the heads of the employees, we assume that it itself cannot be measured, only its outcome. Therefore the following metrics concentrate on the measurement of the knowledge repository's quality and the access to the knowledge base supported by the recommended knowledge portal. The system quality can be measured with qualitative rankings done by the users (see table 2).

Table 2. Examples of system quality measures

Performance topic	**Indicator**	**Implementation of performance measurement**
Quality of navigation structure	How fast can the user find the desired information?	Feedback buttons with ranking possibility on every portal page
Quality of search engine	Does the query result match what the user was searching for?	Average time of query to request, plus feedback buttons
Quality of expert search	Is the required expert found quickly?	Average time of query to request, plus feedback buttons

Knowledge Quality

This category comprises the quality of the information stored and the communicated knowledge of the KM information technology system (see table 3). The quality is

measured by the feedback of the employees using it, with feedback buttons and internal rankings.

Table 3. Examples of knowledge quality measures

Performance topic	**Indicator**	**Implementation of performance measurement**
Quality of the content	Quality of the provided documents within the repository	Feedback functionality attached to single documents. Higher rated documents are scaled up in the search lists. A repeated usage might also indicate a high-quality document.
Reliability, Up-to-dateness, Relevance, Accuracy of the content	Are the files and documents always up-to-date and do they fit the user's criteria?	Internal ranking, Feedback buttons, Trust buttons referring to author of document
Quality of experts	Could the expert help?	Feedback button referring to experts

Knowledge specific service

Knowledge specific service includes the distribution of information and relevant context in order to generate new knowledge.

Table 4. Examples of knowledge specific service measures

Performance topic	**Indicator**	**Implementation of performance measurement**
Quality of knowledge distribution	Is the right knowledge at the right time at the right person?	Average time employees spent searching the information
Support of communities and collaboration	Do communities of practice share knowledge more efficiently?	Feedback surveys of participants

Implementing a proper feedback function in the knowledge portal , which provides the user interface to access important documents, enables an immediate spontaneously vote on the quality of single functions. North et al. (1998) state several examples of

quantitative measures of the individual and collective knowledge, for example the "number and quality of external knowledge links". Depending on the effort to measure this, it is a practicable way to audit the company's external knowledge. A possible internal rating of the experts helps avoiding unnecessary contacts and the waste of time by contacting non-experts, although personal emotions might influence these ratings. A knowledge portal can provide a rating function if all contacts are maintained and updated regularly in the knowledge repositories.

4.4 Class II - Cost Indicators

The costs of interventions in the knowledge base influence the following intermediate outcomes and transfer effects. Class II indicators measure not only the real dollar value as costs, but also processes that intervene in the corporate knowledge base. Only those costs of interventions are taken into account that can influence the knowledge base or help accessing it. The provision of desktop computers may be a requirement to use all the provided KM information technology, but is not a direct intervention in the corporate knowledge base. Placing an infrastructure at the disposal to share and distribute knowledge is an intervention to easily access the knowledge base and considered to be of particular importance. The objective is to estimate the costs of buying, building, implementing, and supporting any application (Harvard Computing Group Report 1998):

Table 5. Cost types of KM initiatives

Cost types	**Items**
Hardware	Server, Network, Infrastructure
Software	Portal Software, Network: One-time purchases or development costs
Implementation	Consulting, customizing, training, and testing costs; communication costs
Support (Maintenance)	Annual system administration, support, and maintenance costs

Further expenses in the knowledge base, such as buying knowledge on CDs or hiring consulting companies are for interest as a Class II indicator, if proven as valuable to the company. Starting point of quantification are the costs, differentiated by one time investments and frequent costs. Costs can be measured easily, but have to be verified

if necessary, because the relation to really use the knowledge is hard to reconstruct. The standard Net Present Value or Total Cost of Ownership approach can be used to determine the costs (Weishaar and Hess 2003). Interceding processes are for example a "lessons learned" workshop or the implementation of action training. The following list specifies several possible indicators (Liebowitz 2000):

- Training expense / Employee
- Training expense / Administrative expense
- Time in training (days/year)
- Professional development / Number of employees
- Action training / Total training
- Number of conferences attended
- Number of best practices
- Number of lessons learned workshops

The KM core processes enable many supposable indicators in this class. The processes of knowledge acquisition and knowledge development directly influence the company's knowledge base and can be measured by measuring the impact of single instruments.

4.5 Class III – Intermediate and transfer indicators

The targeted interventions according to the previously defined knowledge goals should lead to improved knowledge utilization, because the underlying knowledge base becomes more valuable and transparent and the employees see a benefit using it. Class III indicators can be split into three sub categories (Probst et al. 2000): The system usage, user satisfaction, and effects on the organization and individuals, in this framework described with the knowledge transfer indicators.

System usage

The system usage is in the currently available literature the most frequently stated area, covering many easy quantifiable factors. Usually portal software or other KM tools provide several possibilities to monitor the system usage, oftentimes resulting in a statistical overflow of data. Depending on the desired information, only a few measures should be selected and put in a monthly report to monitor the system.

Table 6. Examples of system usage measures

Cost types	Items
Hardware	Server, Network, Infrastructure
Software	Portal Software, Network: One-time purchases or development costs
Implementation	Consulting, customizing, training, and testing costs; communication costs
Support (Maintenance)	Annual system administration, support, and maintenance costs

Ginzberg (1981) states that the measure "Frequency of use" suffers a typical problem: A high amount of usage may indicate an inefficient use or usability of the system, and also effective systems are possible that are used infrequently. The system success should rather be evaluated in terms of the way it is used, than the frequency of use.

User satisfaction

Besides the system monitoring, the end user satisfaction deeply influences the success of a KM information technology system. A satisfied user, additionally motivated because of incentives, will use the KM portal more frequently. In contrast to the Class I indicator "Knowledge quality", which measures the quality of single documents or files within the knowledge base, the Class III indicator "User satisfaction" measures the overall affective evaluation a user has regarding his experience related with the information system (Chin and Lee 1997). By improving the Class I "Knowledge quality" with Class II interventions, an intermediate result would be a higher user satisfaction in turn leading to more knowledge transfer and exchange. Doll and Torkzadeh (1998) propose an end-user computer satisfaction model (EUCS) with five items capturing the relevant factors that form satisfaction. A further development to this model is the approach of Chin and Lee (1997), who focus on the same five constructs, but specifically add new constructs to capture the satisfaction by separating expectations from desires and argues that both have an impact in the form of the difference between priors and post hoc usage perceptions. A frequent survey on the topic of user satisfaction should take place to avoid that employees do not use the provided knowledge.

Knowledge transfer

The interventions in the knowledge base cause intermediate effects on the organization, its individuals and communities by improving the measurable knowledge transfer. Effects on the creativity (Massetti 1996) are likewise possible as effects on communicating behavior (Blili et al. 1998). These measurements, as suggested by Maier and Haedrich (2001), are hard to capture and of limited expressiveness within the company. The employee, who is affected by the initiative in anyway, may be able to judge if his autonomy to make decisions or his creativity is enforced by the initiative, but measuring the enhancement is only measurable through the outcome in form of innovations or faster decisions. Through a far-reaching feedback system within the KM system, several indicators can be measured qualitatively, e.g. if willingness to share knowledge has risen since implementation of the portal software. The effects on organizational capabilities can be split into the internal capabilities as seen by the employees and management and the external capabilities as seen by the stakeholders, especially the customers (table 7).

Table 7. Examples for Knowledge Transfer as Intermediate and Transfer Indicator (See GKEC 2002)

Performance topic	**Indicator**
Knowledge transfer from organization to employees	Period of vocational adjustment: The time to adjust a (new) employee to the given processes within the company decreases, because most of the necessary knowledge is available easier.
Knowledge transfer from organization to projects	Reuse Rate: indicates the percentage of failed objects. This performance measure can be applied to a number of "re-inventing the wheel" cases: another measure is reuse opportunities ratio – the ratio between actual reuse content compared to opportunities. (Dvir and Evans 2000)
Knowledge transfer from R&D to production	Effectiveness of knowledge transfer from the Research & Development (R&D) department and the production area. A rating-based performance measure shows the closeness of working relationships between R&D and manufacturing using an internal self-assessment based on ratings.
Knowledge transfer from production to	Response time to customer queries: The response time can be tracked electronically and is closely correlated to the customer satisfaction. Response quality of customer queries: Average customer rating (internal and external) of overall technical capability of the firm in providing technical service and new product

customer service	innovations to bring value to the customers' future problems. Possible is an average rating by key external or internal customers using a 1 to 5 interval rating scale to evaluate various dimensions regarding product technology or process technology (URL 1).
External knowledge spillover	Response time to competitive moves: Time required for corporation to match the newest product of the competitor divided by the time required for competitor to match firm's newest product benefits. This indicates the ability of the corporation to maintain a leadership position or to match technology moves by the competition. The knowledge is generated by external experts, customers, supplier, competitors, and research institutions.

Indicators to measure the innovative capacity of a corporation, for example the "number of new patents within a year" or "quality of patents", that define the percentage of active and lucrative patents from the company's total patent estate, can be included in this model. As there is a debate about the validity of using the number of patents as an indicator of the innovativeness and technological strength of a company, these metrics are not part in this approach. Some companies do not patent extensively as a matter of strategy, and their patents might not be particularly valuable in other industries. If implemented, patent-based indicators should be benchmarked against competitors and compared to exploitation of the current technology position.

4.6 Class IV - Effect Indicators on Business Results

A start to measure a financial business effect is the measurement of savings related to the implementation of new applications. Documenting the expenses associated with tasks in the current environment for staffing, travel, and material can complete this. As a result of the interventions in the knowledge base employees may be able to complete their job requirements faster and more efficiently, customers may demand fewer employee resources, because other resources have been made available, or Paper, CDs, Copying costs etc., may be reduced. A table documenting the tasks, the number of people involved, the percentage of time, and the amount of savings can be applied und used as a Class VI indicator. This table samples current expenses to complete tasks and once the expenses are identified, the objective is to estimate the savings or any additional revenue of e.g. increased help desk productivity, savings in publishing and telephone costs etc., in the next period. It is possible to use the Class II indicators (Cost of interventions) in combination with the savings of Class VI indicators to calculate the effects on total cash-flow and based on this determine the Net Present

Value of the KM initiative. Cash-flow is affected by additional hardware, software, consulting, training and development costs of the KM system to the anticipated annual savings.

Table 8. Exemplary effect indicators on business results sorted by classical Balanced Scorecard perspectives

Performance topic	**Indicators**
Financials	Shareholder Value, NPV, Profit, ROI, ROA, ROE, ...
Customer Satisfaction	Number of refunds made, number of merchandising items returned, etc. (See Liebowitz 2000). Explanation: the customer satisfaction may increase because of faster response times and a better understanding of customer needs due to external knowledge links.
Internal Processes	- Efficiency of internal processes: e.g. percentage of tasks/milestones achieved within a certain timeframe measures the efficiency of a group/unit. - Quality of internal processes: the fraction of tasks finished correctly: perf(t):=(Number of tasks solved in time period/number of all tasks in that time period)*100
Potentials	Knowledge Value-Added Methodology (KVA): A possible measurement approach could include the KVA methodology by Housel and Bell (2002). The process-oriented view with learning time as basic metrics shows the performance of business units.

Another performance indicator to measure a financial effect of the KM initiative is the "gross profit margin" (GPM) (IRI 1995). The GPM is used in assessing the value of the technology assets of the firm and the contribution of the Research & Development (R&D) department to value creation. The GPM is calculated as a percentage of sales, where gross profit equals net sales minus cost of goods sold (product costs plus direct manufacturing costs). Value assessment can be based on change in GPM, regarding other influencing factors of manufacturing costs, where possible.

5 Conclusions and Outlook

The performance measurement framework for KM initiatives, developed in this article, supports managers at SGL CARBON to measure the quality of the knowledge base, to determine the total costs of such an initiative, to make the interventions on the

knowledge base and their effects on organizational capabilities transparent and finally to track the impact on business results. The framework provides an overview on what kind of knowledge, its quality and structure is available in the company and builds the opportunity to change this knowledge base by targeted interventions of a capable knowledge expert (e.g. a Chief Knowledge Officer). Monitoring costs and results of these interventions is a specific benefit of the approach, because even in early stages possible mistakes are made visible. Attached to knowledge goals the initiative should prove its value in finally producing more business outcome. In most cases, the quality and value of knowledge assets are only measurable indirectly. Multi-dimensional cause-and-effect chains of the implementation of KM are hard to describe and evaluate. Focusing on comprehensive indicators can help comprise cost and benefits and link knowledge issues to business results, but restricts the possibilities to practically change the underlying knowledge, which in theory determines the business results. The specific performance indicators have been selected based on the specific knowledge goals of SGL CARBON and therefore don’t provide a universally valid concept of measuring KM. For other branches performance indicators have to be applied, depending on the underlying information technology and the targeted goals of the organization. The implementation of the concepts needs a very exact definition of the KM strategy including the goals of the initiative to set the right performance indicators. The weighting of these performance indicators depends on the decision of the top management and may change over time. Results should be benchmarked in corporate and industry-wide studies, as the requirements and outcomes of KM are different for industries. The current values of performance indicators in the framework can be included in a report, which is handed out to the top management every month. A possible "cockpit", similar to the Balanced Scorecard cockpit could be added on to the monthly reports. If no results are measured, the underlying KM concept may lack the necessary support.

Further questions for research are e.g. an empirical analysis of the performance measurement approaches in use in different branches and different organizations (see e.g. Tillquist and Rodgers 2002) and how these approaches contribute to improved business results. Moreover, the empirical analysis of effects of Knowledge Networks enabled by strategic alliances between corporations would make the effects of Knowledge transfer between corporations more transparent. For practitioners the development of reference models for the implementation and performance

measurement of KM would support efficiency and effectiveness of the implementation of KM initiatives.

Still all KM initiatives have to be implemented in a large scale with all the detailed steps necessary for successful KM (Davenport and Prusak 2000). If a business owner and the management are committed to KM and have adequate performance measurement frameworks to prove its value, the value contribution of KM initiatives can be made more transparent.

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