An Empirical Investigation of Maturity Levels in Knowledge Management

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Abstract: The purpose of this paper is to analyse if knowledge management maturity models can be applied in corporate practice. So far, empirical studies have mainly examined the influence of knowledge management (KM) on innovation and have identified KM success factors. The underlying assumption is that more KM leads to more innovation and an improved corporate success. Therefore, a thorough KM application is recommended. Little attention has been paid to the question which level of KM application is effective and efficient for a company. This paper tries to close this gap using the concept of KM maturity. It investigates if different KM maturity levels can be identified in corporate practice and in how far they are influenced by specific factors, e.g. company size. To answer the research questions, exploratory case studies were conducted through semi-structured qualitative interviews with representatives from ten northern German companies.The results show that the practical applicability of KM maturity models (KMMM) is still limited. None of the companies can be categorized to have a high KM maturity level despite their multiple use of KM tools. As influence factors the size of a company and an externally certified quality management were identified. To validate these findings an additional online survey was conducted with 79 participants. The results of this survey support the general statements above, but also show a significant relation with the KMM level and employees' participation in knowledge management and the innovation success of a company compared to its main competitor. The paper contributes to the understanding of KM maturity and its influence factors and thus provides the foundation for further empirical research. Moreover, the findings help organisations to position their KM efforts.

Keywords*:* knowledge management, maturity levels, influence factors, success factors, case study research, online survey

1. Introduction

The resource-based view (RBV) of the firm is characterised by the idea that rare firm-specific resources which can't be easily adapted or imitated by competitors, e.g. machine capacity, production experience or customer loyalty, are the main success factors for competitiveness, growth and profit of a company. During the last decades, the awareness of knowledge as probably the most important firm-specific resource has led to the development of the knowledge-based view (KBV) of the firm. Knowledge is a specific resource in comparison to financial or physical resources. It does not depreciate and "can generate increasing returns even when it is shared" (Curado and Bontis, 2006, p. 375). Knowledge is subject to economies of scale and scope and thus implies increasing returns, especially in knowledge-intensive industries. Therefore, a company has to create, apply, integrate and document its organisational knowledge carefully in order to gain competitive advantages (Wernerfelt, 1984, Wernerfelt 1995, Grant, 1996, Grant, 1997, Grant, 2002).

As companies have realized that the effective use of their knowledge can grant them an advantage over their competitors, knowledge management (KM) has become increasingly important (Nonaka/Takeuchi, 1995). KM comprises the systematic creation, application, integration, and documentation of organisational knowledge. During the recent years, it has run through a life cycle. At the beginning of the nineteen nineties the primarily technology-driven euphoria has led to a KM hype. KM was implemented in various organisations using a selection of different frameworks and approaches. Heisig (2009) reviews and compares about 160 different KM frameworks from science, practice, associations, and standardisation bodies. Considering the sharply increasing numbers of publications KM was established as an own academic research discipline. However, the euphoria was soon followed by harsh criticism and disillusion. As KM was mainly considered as an IT problem, its implementation often only increased IT spending and led to a mass of unused data and an information overload. Some even consider KM as an organisational fashion. It is assumed that only one sixth of all KM initiatives have significantly contributed to corporate success within the first two years after their implementation and that the majority of KM initiatives are abandoned (Kay, 2003; Meier/Weller, 2012).

The primary motivation for KM implementation must be to improve business performance. Nevertheless, only a few empirical studies have examined the effect of KM on corporate success so far: Choi and Lee (2003) analyse the effects of different KM styles on corporate performance on the basis of a questionnaire. Their analysis of 54 large South-Korean firms reveals that KM methods can be categorised into four styles: dynamic, system-, human-oriented and passive. The dynamic style results in higher corporate performance, the human- and system-oriented styles do not show any difference in terms of corporate performance, whereas the passive style is less effective. Corporate performance was measured from a non-financial perspective and consists of items such as overall success, market

share, growth rate, profitability, innovativeness and business size compared to key competitors which are valued on a six point Likert scale. Darroch (2005) examines the relationships between knowledge management, innovation and firm performance in 443 companies with more than 50 employees in New Zealand. Her results support the view that firms with KM capabilities use resources more efficiently, are more innovative and perform better than companies without a developed KM. Kruger and Johnson (2011) examine the correlation between KM maturity and organisational performance (OP) for nine South-African organisations in three industries. The study is based on 434 interviews of managers located at three different group levels (operational, middle and senior management) over a five-year period. They come to the conclusion that companies reporting a higher OP recorded higher KM maturity as well. But findings also indicate that there are conditions under which companies with higher OP scores recorded lower KM maturity. Pawlowsky et al. (2011) examine the state-of-the art and possible KM success factors and the relevance of KM activities for corporate success in German companies. They conduct a survey of 3,401 German companies in 2010/2011. As a result they find a medium level of KM activities. Whereas company size and industry have no statistically significant influence on the level of KM activities, market challenges as a lack of qualified employees or a highly dynamic market and corporate strategy have a statistically positive correlation with the level of KM activities. In addition the level of KM activities has a strong positive impact on the level of employee motivation, innovative capabilities, competiveness and financial success. López-Nicolàsa and Merono-Cerdán (2011) also find a strong positive impact of KM strategy on innovation and organisational performance for 310 Spanish companies. Moreover, KM strategies indirectly (through an increase on innovation capability) impact on performance, thus reinforcing the total effect of KM strategies on performance.

Overall, some studies support the view that companies with an elaborated KM are more innovative and competitive and have a better financial performance. Most studies assume that more KM activities lead to an improved corporate performance. On the other hand, the nature of this relationship and possible influence factors are not really addressed. Especially, it is unclear if the scope of applied KM activities is influenced by specific factors, such as company size.

During recent years various KM maturity models have been developed in order to structure the KM implementation process. The idea originated from maturity models mainly created for the software development processes (Carnegie Mellon University 1994; Dayan/Evans 2006). KM maturity can be defined “as the extent to which KM is explicitly defined, managed, controlled, and effected. It describes stages of growth of KM initiatives in an organization” (Pee/Kankanhalli, 2009, p. 81). Most KM maturity models (KMMM) have been criticised as ad-hoc in their development and not empirically validated. In addition, some researchers have severe concerns about the practical applicability of these models and the extent to which they reflect actual corporate KM practice (Kulkarni/St. Louis, 2003). In addition it is proposed that the influence of situational factors on KM maturity has to be addressed by future research and integrated into the models (Pee/Kankanhalli, 2009).

Thus, the main aims of this study are to examine in how far different KM maturity levels can be identified in corporate practice, which factors influence the KM maturity level of a company and if there is a relationship between KM maturity levels and corporate success. This paper contributes to KM research by extending our understanding of the practical applicability of KMMMs and of influence factors concerning the KM maturity level. In addition KMMMs provide a template against which organisations can map their KM progress. The original value results from the application of the KM maturity concept in various companies of different sizes and in different industries. For this first explorative research the KM maturity model of Pee and Kankanhalli (2009) is used. The model is explained in the second section of this paper.

The rest of the paper is structured as follows: In the second section basic notions are defined and a framework for KM maturity is introduced. Then the data and the methods of the conducted case studies and the online survey are described, before the empirical results are reviewed. Finally, implications for further research and corporate practice are drawn and limitations of the paper discussed.

2. A framework of KM maturity and its influence factors

There is no generally accepted definition of knowledge in theory and practice, leading to considerable confusion about what can be summarised as knowledge and how knowledge can be separated from the related concepts of competencies and capabilities. In corporate practice, often all data, information, know-how, routines, and processes of a company are summarised as organisational knowledge. With such a broad definition, KM can hardly be distinguished from information and data management (Heisig, 2007; Meier/Weller, 2012). Some researchers define

knowledge as a justified belief that increases an entity's capacity for effective action (Alavi/Leidner, 2001; Nonaka, 1994). It is justified because it is grounded in information as well as in the values and prior understandings of the holder, which means that knowledge is relational and context-specific. To separate knowledge from data and information it is required that knowledge can be converted into an improved corporate competitiveness or corporate value.

Knowledge is often described in terms of dichotomies e.g. implicit/tacit versus explicit knowledge or individual versus organisational/collective knowledge. The distinction between explicit and implicit/tacit knowledge is widely accepted. Explicit knowledge can be articulated and easily communicated between individuals and organisations. Tacit knowledge (skills, know-how, and contextual knowledge) is manifested only in its application – transferring it from one individual to another is costly and slow (Nonaka, 1994, Alavi/Leidner, 2001). Explicit knowledge is subject to economies of scale as it is costly to create but cheap to replicate, whereas tacit knowledge is more subject to economies of scope (Grant, 2002). Another commonly used classification is the differentiation in individual and organisational knowledge. Individual knowledge consists of the know-how, skills, and competencies of the employees and can be transferred into organisational knowledge. Organisational knowledge is manifested in internal processes, external co-operations with customers, suppliers and other partners or the technologies of a company. Organisational knowledge is at least partly documented in IT-systems or paper-based documents (Nonaka, 1994, Davenport/Prusack, 2000). Another classification differentiates knowledge in human knowledge (skills, competencies, and abilities of individuals and groups), relational knowledge (about relationships with suppliers, allies, and customers), and structural knowledge (knowledge that is company property, e.g. patents, copyrights, and trademarks; processes, methodologies, models; documents and other knowledge artefacts as computer networks and software) (Stewart, 1997).

As there is no commonly accepted definition of knowledge, there also isn't one for KM. It is unclear if KM only deals with the creation and dissemination of new knowledge or with the systematic administration of existing knowledge as well. Often, it is defined as a process consisting of not necessarily sequential KM activities. We understand KM as a systematic process for identifying, creating, acquiring, sharing, and documenting individual and organisational knowledge in order to improve a company's competitiveness and performance (Davenport/Prusack, 2000, Alavi/Leidner, 2001). It is "the systematic effort to capture, store, retrieve, reuse, create, transfer and share knowledge assets within an organization, in a measurable way completely integrated in its operational and business goals, in order to maximize innovation and competitive advantage" (Dayan/Evans, 2006, p. 70). Because of the multi-facet concept of knowledge, KM is a multi-discipline approach as well. It covers aspects of human resource management, process management, innovation and technology management, and information and IT management (North, 2013). Therefore, existing KM models are founded on different theories and methods and vary greatly in terms of focus and scope. In general, they can be categorised as process-oriented, human-oriented and technology-oriented (Alavi/Leidner, 2001).

In order to structure the KM implementation process, KMMMs have been developed during the last years. They are based upon the idea of capability maturity models (CMMs). The most famous model was developed by the Software Engineering Institute of the Carnegie Mellon University in collaboration with the software community. Since its publication in 1991 the model has become a de facto standard for assessing and improving software engineering processes (Carnegie Mellon University, 1994; Dayan/Evans, 2006). As software engineering and KM are both assumed to be based on a standard set of prescribed activities, researchers and practitioners have tried to transfer the basic concept in order to develop a KM maturity model (Dayan/Evans, 2006). KM maturity models state that the implementation of KM approaches follows an ideal evolutionary path (Kulkarni/St. Louis, 2003). In addition, it is assumed that

- the entity's development can be simplified and described with a limited number of maturity levels (usually four to six),
- the levels can be ordered sequentially and characterised by certain requirements which have to be completely fulfilled in order to reach a certain level and
- the entity progresses from one level to the next without skipping any level (Pee/Kankanhalli, 2009.)

Pee and Kankanhalli (2009) provide a thorough review and comparison of KMMMs and integrate the different concepts. Overall, the majority of the reviewed KMMMs differentiate between five maturity levels starting from an initial level 1 where the organisation suffers from a lack of awareness of the need for a systematic KM and ending at an optimised level 5 where KM activities are deeply integrated into the organisation and continually improved upon.

Based on their review, the authors integrate the different KM maturity concepts and develop an own model named General KM Maturity Model (G-KMMM). Supported by the idea of KM being a multi-discipline approach, in their model KM maturity is assessed from different perspectives. These perspectives, namely HR management, process management and technology management, lead to the three key process areas people, process and technology. In addition five different maturity levels are specified. For each maturity level, requirements for the three key process areas are derived (see table 1). An organisation reaches a maturity level if it fulfils all requirements for this level and the levels below.

Table 1: Maturity levels and key process areas of the G-KMMM

Maturity level	General description	Key process areas		
		People	Process	Technology
1 Initial	Little or no intention to formally manage organisational knowledge	Organisation and its people are not aware of the need to formally manage its knowledge resources	No formal processes to capture, share and reuse organisational knowledge	No specific KM technology or infrastructure in place
2 Aware	Organisation is aware of and has intention to manage its organisational knowledge but it might not know how to do so	Management is aware of the need for formal KM	Knowledge indispensable for performing routine task is documented	Pilot KM projects are initiated (not necessarily by management)
3 Defined	Organisation has put in place a basic infrastructure to support KM	Management is aware of its role in encouraging KM Basic training on KM is provided Basic KM strategy is put in place Individual KM roles are defined Incentive systems are in place	Processes for content and information management is formalized Metrics are used to measure the increase in productivity due to KM	Basic KM infrastructure in place (e.g. single point of access) Some enterprise-level KM projects are put in place
4 Managed	KM initiatives are well established in the organization	Common strategy and standardized approaches towards KM KM is incorporated into the overall organisational strategy More advanced KM training Organisation KM standards	Quantitative measurement of KM processes (i.e. use of metrics)	Enterprise-wide KM systems are fully in place Usage of KM systems is at a reasonable level Seamless integration of technology with content architecture
5 Optimising	KM is deeply integrated into the organization and is continually improved upon KM is an automatic component in any organization processes	Culture of sharing is institutionalised	KM processes are constantly reviewed and improved upon Existing KM processses can be easily adapted to meet new business requirements KM procedures are an integral part of the organisation	Existing KM infrastructure is continually improved upon

Source: Pee/Kankanhalli, 2009, p. 90.

Although there are almost no studies identifying possible influence factors on KM maturity, it is obvious that not all companies can and should achieve the fifth level. Possible influence factors on KM maturity are:

- Company size: The larger a company is, the more difficult it is to identify knowledge in the organisation. On the other larger companies have more financial resources for a thorough KM implementation. Therefore, we expect larger companies to have a higher KM maturity than smaller companies.
- Industry: Companies in knowledge-intensive industries are expected to have a higher KM maturity than companies from less knowledge-intensive industries.
- Innovation activities: Here we expect that incremental innovations require a higher KM maturity concerning processes and technologies whereas radical innovations require a higher KM maturity with regard to the key process area people.
- Existence of a certified quality management (QM) system: As the certification of a QM system requires a thorough process management and documentation, we expect companies with a certified QM to have a higher KM maturity, especially with respect to the key process area "processes", than companies without a certified QM system (for the relationship between QM and KM see Ribière/Khorramshahgol, 2004 and Jochem et al., 2011).
  Relevance of different types of knowledge: Explicit knowledge requires a documentation and thus a higher KM maturity concerning the key process area "technology" can be expected. Tacit knowledge can only be transferred via direct collaboration and thus a higher KM maturity concerning people and processes is probable.

Based on this KM maturity concept a semi-structured interview guideline was developed to see if maturity levels can be observed in practice. Besides looking at the use of KM tools the case studies also offer a first opportunity to check whether maturity stages are influenced by factors as corporate size, industry, innovation activities, the existence of an externally certified quality management (QM) system, or the relevance of different knowledge components. Based on the results of the interviews a questionnaire for the online survey was developed. For each KMM level one or two relevant items were selected.

3. Data and methods

To empirically check for possible KM maturity levels, a case study approach and an online survey were chosen. Case studies allow rich empirical descriptions of the subject of interest and help to understand complex social phenomena to a deeper extent than survey-based empirical studies (Yin, 2009, Eisenhardt/Graebner, 2007). The case study approach focuses on contemporary events and enables a researcher to ask "how" and "why" questions which are explanatory in the context of KM (Yin, 2009). The following survey allows us to validate the results.

The case studies were mainly based on semi-structured qualitative interviews. In total case studies from ten different companies were documented. The participating companies were chosen with regards to their size and industry to enable a broader exploration of the research questions and theoretical elaboration. It also allows to search for patterns in KM regarding the above mentioned influence factors and enables an easier replication of the case studies (Eisenhardt/Graebner, 2007). IT, Mechanical Engineering, and Energy were selected as industries because we assume that all three are knowledge-intensive and thus KM is an important management issue. From each of the three industries one small (< 250 employees), one medium (250 – 500 employees) and one large (> 500 employees) company were analysed. All companies are from the federal state of Schleswig-Holstein in Germany, as this research is part of an EU funded project concerning regional aspects of KM (for more information see www.win-vin.eu).

When comparing the innovation activities of the ten analysed companies, we find that all but one company conduct own R&D, but their R&D spending differ considerably from 0-5% to over 10% of sales. There is no obvious relationship between the R&D spending and the industry or the size of the company. The companies work on product and process innovations that are mainly incremental and market driven. Only three companies from the mechanical engineering sector state that their innovation activities are market as well as technology driven. Seven out of ten companies have a certified QM system. The existence of a certified QM system is clearly influenced by company size.Over a two months period one interview per company was carried out. Interview partners were top representatives, either on managing director level (5), from R&D or technical department (3), from Quality Management (1) or others (1). Once the interviews were documented, the documentation was sent back to the interview partners for validation. This process helped to eliminate possible misunderstandings or poor recalls of the answers given. The final versions of the documented interviews were then used to analyse the data. Where possible data was transferred into quantitative numbers (yes/no, ranking numbers, etc.) to facilitate an easier comparison between the different case studies. Also, additional information about the companies was collected from publicly available sources like the Internet, the company webpage or Youtube videos and analysed.

The results of the case study research were validated by an online survey. Based on the interview experience the questionnaire was further developed and modified. Finally, it consisted of eight parts covering the three KM key process areas. For each maturity level one or two questions were asked. The answers were nominally or ordinally scaled using a six point Likert scale (ranging from 1= to a very low degree to 6 = to a very high degree). In addition, the companies were asked to evaluate their success. The success consists of three different items: employees' participation in KM activities, innovation success compared to the main competitor and financial success compared to the main competitor.

The survey was conducted from March to May, 2014. 612 companies in the federal state of Schleswig-Holstein were addressed. 79 questionnaires were usable for the analysis, that means a response rate of about 13%. Over 70% of the companies have less than 100 employees; 11.5% have between 101 and 500 employees, the rest has more than 500 employees. Thus, small companies are a little bit overrepresented. 50% of the companies are in the manufacturing sector, 38% in the service sector, the rest is equally distributed over the other sectors. On average, the companies are 41.4 years old. The responding persons were mainly in the top management (72%), only three respondents consider themselves as knowledge managers. The other respondents are quality managers, IT managers, HR managers, or R&D managers. 71.9% of the companies have an externally certified quality management.

The G-KMMM is used as a framework for assessing the KM maturity of the analysed companies. Literature suggests to evaluate KM maturity with a questionnaire answered by the person responsible for KM in an organisation (self-assessment). The questionnaire is structured with respect to the different key process areas (people, processes and technology/systems). For each area and each maturity level different activities are described and it is suggested that the knowledge manager of an organisation has to assess in how far these activities are fulfilled (Kulkarni/St. Louis, 2003). In our study we choose a different approach. The KM maturity level was assessed by a researcher. Reliability was improved as the KM maturity assessment was replicated by a second researcher based on the documentation.

4. Empirical results concerning KMM levels

4.1 Relevance of knowledge components

The interviews reveal that most companies are aware of the importance of their knowledge base for their corporate success. Asked about the relevance of different knowledge components, the interviewees consider human knowledge as the most relevant component followed by relational knowledge. Structural knowledge and the technology base, although also important, rank lowest. Most interview partners state that all knowledge components are closely interlinked and show a lot of synergies. Although there is a general agreement on the ranking of the components some differences can be observed. Two IT companies do not consider their technology base as being very relevant, whereas two mechanical engineering companies rank this knowledge component first together with their human knowledge. Interviewees explained this with different durations of technology life cycles in their industry. The longer the life cycle and therefore the influential time span of a used technology, the more relevant the technology base seems to be.

Considering the human knowledge the motivation of the employees is regarded to be as important as their qualification. Two IT companies and one energy company even rank motivation higher than qualification. This is explained with short knowledge life cycles in their business. A basic qualification is always considered as prerequisite, but the faster the knowledge in the industry changes the more important it is for an employee to be motivated and flexible to embrace new knowledge. Three out of ten companies suffer already from a lack of qualified employees, all but one company expect such a lack in the future.

In general the relationship to customers is seen as the most important relational knowledge, followed by the relationship to suppliers, universities and research institutions. The structural knowledge was rated as less relevant than the other knowledge components. Structural knowledge involves the corporate culture, the organisational structures, and processes as well as the IT systems. The interviews do not deliver enough findings to differentiate between the elements of structural knowledge. Further research should focus on this in more detail, as for a long time the use of IT systems was regarded as especially important for KM (Kruger/Johnson, 2011) before companies and researchers adopted a more multidimensional approach (Pee/Kankanhalli, 2009). In addition, Stewart (1997) describes the structural knowledge as even more important than the human capital – at least from a management perspective. It requires organisational structures to convert human capital into economic success.

Interestingly there seems to be a relationship between the size of a company and its assessment of the relevance of explicit versus implicit knowledge. All large companies, and one medium sized, state that most of their knowledge is explicit. All small companies, and one medium sized, state that most of their knowledge is implicit. Reasons for this finding could be either that larger companies have a greater need to document their knowledge than smaller companies. Alternatively, it could be that larger companies have more financial and personal resources, which they invest in knowledge documentation.

4.2 KM activities

During the interviews some participants reported that they have already installed a variety of KM tools, others talked about their urgent need to install specific KM tools. All companies use a variety of methods to develop their knowledge, like internal R&D, personnel development, patent research, participating in networks, etc. It became clear that most of the methods and tools named were not immediately linked to KM. It is therefore assumed that the companies actually use an even wider variety of instruments without considering them as being part of KM.

Knowledge is mainly internally shared via meetings, specific information events for employees, and the intranet. Instruments used for external knowledge sharing are more heterogeneous and range from fairs and exhibits, internet activities, personal interactions with sales staff, to networking activities. All companies with a higher perceived relevance of explicit knowledge use an intranet to share knowledge internally. On the other hand, the use of knowledge sharing methods is not linked to the industry or R&D spending. All companies participate in networks as a way of knowledge sharing, although to a different degree and on different levels. Usually top management plays the leading part in networking or initiating networking. Although networks are considered as being important, none of the companies offer incentives for employees to participate in networks. Nevertheless most companies participate actively in networks (offering training, organizing events, etc.). As reasons for a non-active participation either a lack of KM or the very young age of the company are named. Not all the companies participating actively in networks judge their network activities as unexceptionally positive. Depending on their specific company history or the stage of their organisational development they profit differently from networks. While some use the active networking to transfer, and therefore manage knowledge, others only participate in active networking because 'it belongs to doing business' but has no direct influence on their KM.

All companies use at least one method to document their knowledge. As documentation tools QM manuals, Wikis, Intranet, CRM tools as well as document sharing and document management tools are listed. The level of documentation activities is clearly influenced by the perceived ratio of relevance of explicit versus implicit knowledge. Companies reporting to use more explicit knowledge report noticeably more documentation tools and IT systems used for KM than the ones that report more implicit knowledge in their organization. The often assumed positive relationship between the use of KM tools in terms of IT systems and the quality of KM is not necessarily supported. The heavy use of software systems sometimes even leads to an 'information/knowledge overload'. This is often the case when companies have introduced a number of different tools assuming these would support their KM process, but have not matched and synchronized the systems. It seems to be a maturing process, as several companies have reported to use a number of uncoordinated systems, which need to be consolidated. Additionally the interviews show that the installed systems are sometimes not actively used by the employees. It seems that the KM implementation is often focused on IT systems without installing the necessary processes to effectively use these systems beforehand.

The results are supported by the online survey. In the majority of the companies, there are several loosely coupled KM activities, but not an integrated and formalised KM system. Concerning the key process area "people", 28.6% of the responding companies have defined KM positions with respective decision authorities. Three companies label this position as knowledge manager, in the other companies the position is located at the board of directors, the innovation or R&D department or within quality management. 27.1% of the companies offer mostly non-financial incentives for knowledge documentation and knowledge sharing to their employees, and four companies reward their employees financially for KM activities. 26.8% have integrated KM aspects in their business strategy to a high or very high degree. On the other hand, only 7.6% of the companies have implemented a budget for KM activities and 10,9% agree that KM has a led to a knowledge-sharing culture in their companies.

The key KM process area "processes" is not quite as well developed in the responding companies. Only 29.7% of the companies agree that the knowledge indispensable for routine tasks is documented to a high or a very high degree, and only six companies document lessons learned from projects to a high or very high degree. The mean rate of approval for the effective usage of KM systems is 3.52, respective 3.82 for the continuous improvement and adaption

of KM processes to changes in the business environment. In addition, only 7.6% of the companies measure or benchmark their KM activities on the basic of specific metrics.

As in the interviews, the key process area "technology" is the most developed element of a KM system. All companies use IT to support their KM activities, among which internal search engines (81,3%), Wikis (67,2%), document management systems (65,6%), group ware systems (62,5%), project data bases (53,1%) and the intranet (50%) are the most used systems or tools. On the other hand, the companies consider the degree of integration of their tools as barely medium, with a mean of 2.98.

4.3 KM maturity levels

To test the practical application of the KMM all companies were classified into the five maturity levels.

Concerning the three different key process areas, the results of the interviews indicate that the companies achieve the highest maturity level looking at the use of KM technologies (see table 2). Five out of ten companies reach the third maturity level "Defined" with either basic KM systems (e.g. Wikis, intranet, document management systems) or even an integrated system of several tools in place. The lowest KM maturity level is achieved concerning the key process area "people". The majority of the interviewed managers are aware that KM is an important success factor for their company and that a formal KM would be necessary but consider KM mainly as an IT management problem. The results concerning KM processes are mixed. Some of the interviewed companies have no formal processes for knowledge documentation and sharing implemented in their organisations whereas others have clearly defined procedures for content and information management. Overall, larger companies achieve a higher KM maturity level than smaller companies, but neither of them can be categorised on a level higher than "Defined". Even large companies, although showing a general awareness of the necessity of KM and already using a variety of KM tools, seem to consider KM as being one of many prerequisites for the main business areas; its installation and development being a trade-off between costs and benefits. Therefore, quantitative measurements of KM processes, which are expected for higher maturity levels, are usually not in place.

Table 2: Classification of KM maturity levels for the participating companies

Case studies / Key Process Areas	People	Process	Technology
A (small)	Aware	Initial	Aware
B (small)	Aware (on the transition to Defined)	Initial	Initial
C (small)	Aware	Initial (parts of Aware)	Initial
D (medium)	Aware (very first parts of Defined)	Aware (parts of Defined)	Aware
E (medium)	Initial	Aware (parts of Defined)	Aware
F (medium)	Defined	Defined	Defined (in parts Managed)
G (large)	Aware (on the transition to Defined)	Defined (with parts of Optimizing)	Defined (on the transition to Managed)
H (large)	Aware (on the transition to Defined)	Defined	Defined (on the transition to Managed)
I (large)	Aware (on the transition to Defined and with parts of Optimizing)	Defined	Defined (on the transition to Managed)
J (large)	Initial (on the transition to Aware)	Defined	Defined

The results also show that it is often impossible to classify the companies on the same level in each key process area. For example, large companies often have a basic KM infrastructure in place or even enterprise-wide KM systems. Therefore their maturity level in the area of technology is fairly high. On the other hand, most companies do not have an explicit KM strategy as an integral part of the overall organisational strategy, which prevents them from reaching one of the higher levels in the people area.

Looking at the maturity level in the area of processes all companies having a certified QM system reach higher levels than the ones without a certification. An external certification forces the organisations to set up and describe formal

processes including KM processes. The necessity of describing the corporate processes leads to a higher awareness and documentation of the knowledge available in the company, therefore the majority of certified companies also report to have more explicit, than implicit, knowledge.

Findings also indicate that there is reason to believe that KMMM should be worked with differently depending on the size of an organisation or its stage of organisational growth. Large companies often have a greater need for KM documentation and thus provide additional financial and personal resources for the implementation of KM. For small companies it might not be reasonable to strive for the highest level in these models, as the costs for further developing their KM might exceed the benefits. This seems especially true for the technology area where companies seem to go through a learning process.

The results of the interviews are validated on the basis of the online-survey. The following table shows the number and the percentage of companies reaching a specific KMM level.

Table 3: Number and percentage of companies reaching a specific KMM level KMM level

	People	Technology	Process
Initial	29 (45,3%)	4 (6,3%)	28 (43,8%)
Aware	21 (32,8%)	22 (34,4%)	18 (28,1%)
Defined	7 (10,9%)	8 (12,5%)	5 (7,8%)
Managed	2 (3,1%)	9 (14,1%)	3 (4,7%)
Optimising	5 (7,8%)	21 (32,8%)	10 (15,6%)

As a higher level is only attributed to a company if all the requirements of that level are fulfilled, we have to add that 33 companies have achieved parts of higher levels for the key process area “people”, 9 for the key process area “technology” and 31 for the key process area “processes”.

Overall, the participating companies of the online survey reach higher KMMM levels than interview companies. Like in the case studies the highest KMM levels are reached for the key process area “technology”, whereas the key process area “people” is ranked lowest. The average KMM level for the key process area ‘people’is 1,95 (aware), with only seven companies reaching the levels ‘Managed’ or ‘Optimising’. For the key process area “processes” the average level is 2,2 (aware), with 13 companies reaching levels ‘Managed or ‘Optimising’. On the other hand, concerning the key process area “technology” the average KMM level is 3,33 (defined) and 30 companies are reaching the levels ‘Managed’ and ‘Optimising’. These results indicate a clear technology focus concerning knowledge management in the majority of the companies.

Contrary to the interviews, there is no statistically significant correlation between the KMM level and the size of a company.

Finally, a correlation analysis between the achieved KMM levels and the three success items was executed in order to identify relevant aspects in terms of success of KM (see table 4).

Table 4: Results of the correlation analysis of the KMM levels and corporate success

	Degree of employees’ participation in KM	Innovation success relative to main competitor	Financial success relative to main competitor
KMM level “People”	corr = 0,368 p = 0,003	corr = 0,241 p = 0,095	corr = 0,059 p = n.s.
KMM level “Technology”	corr = 0,350 p = 0,008	corr = 0,291 p = 0,042	corr = 0,220 p = n.s.
KMM level “Process”	corr = 0,501 p = 0,000	corr = 0,289 p = 0,044	corr = 0,143 p = n.s.

With: corr = correlation coefficient, p = probability, n.s. = non significant

First, Pearson’s correlation coefficients were calculated and then checked by calculating Kendall’s Tau. There are highly significant positive correlations between all achieved maturity levels and the degree of employees’ participation in KM, and significant respective weakly significant positive correlations with innovation success relative to main competitor. These results support the findings of former studies concerning the relationship between KM and

innovation success (e.g. Darroch, 2005, Pawlowsky et al., 2011). Unfortunately, there is only little and statistically non-significant correlation with the financial success.

5. Discussion and implications

Both the interviews and the online survey reveal a limited practical applicability of KMMMs. Firstly, there often is no common understanding of knowledge and KM activities in companies. Most interviewees had some understanding, but it did not necessarily match the scientific concepts or those of other practitioners. This means that KM maturity based on self-assessment as proposed by many KMMMs can lead to severe problems of misunderstanding and misinterpretation in practice.
Secondly, KM activities cover a wide range of concepts, instruments, and tools that are widely spread throughout an organisation. Some companies have installed a specific knowledge manager, whereas in others the quality manager or a senior manager is in charge of KM. The different understandings of knowledge and KM and the various KM responsibilities can cause severe problems during the self-assessment, as it is unclear who should be addressed in the company.

Thirdly, maturity models assume that all companies should follow an ideal path when implementing KM and develop successively from one maturity level to the next. The results show that not all companies follow this ideal implementation path. The findings rather indicate that the scope of KM activities seem to be influenced by specific factors such as the existence of a certified QM system, which is positively linked to a KM maturity especially with respect of the key process area “processes”. Moreover, company size indicates the necessity of a systematic KM and is – at least in the case studies - also positively related to KM maturity. In addition, larger companies have more financial resources for KM activities.

The findings also suggest that there are only a few general recommendations regarding KM. Foremost it is the basic understanding that there is no “one system fits all”-approach. For companies just starting with KM it is advisable to begin with an external QM certification, because it can help organisations to structure their processes, which is an integral part of KM. Overall, companies should not use KMMMs as a template, but customise them with respect to their specific requirements.

Overall, KMM seems to be positively linked to the degree of employees’ participation in KM and to innovation success. As the key process area “technology” appears to be quite well developed in a range of companies, these firms should concentrate on the further development of the areas “people” and “processes”. It also seems quite important to define KM responsibilities and budgets for KM activities, with the KM being integrated in the corporate strategy and KM processesdefined, implemented and measured. For companies starting with KM the focus should be put on basic KM training for the employees, the implementation of a basic IT infrastructure for KM, and a basic process for the documentation and storage of knowledge.

6. Limitations and future research

Some limitations of our approach have to be addressed: Because of the restricted number of analysed companies, our results can only be moderately generalised. Thus, large-scale research has to be executed. Furthermore, only one person per company has answered the questions during the semi-structured interview in the case studies or during the online survey. The results clearly indicate that different KM areas have to be assessed by different people in an organisation (Kulkarni/St. Louis, 2003). Often, the position of a knowledge manager is not established, so it is recommended that the key process area “people” should be assessed by the top management or the head of human resources, the area “process” by the quality manager and the area “technology” by the IT manager or the head of the R&D department. Although survey-based self-assessment of KM maturity is suggested, the evaluation was executed by the researchers. As there is no common understanding of knowledge and KM, we doubt that a valid and reliable self-assessment is currently possible. Therefore, we suggest a further development of maturity metrics and scales to enable a thorough self-assessment. We have only examined a few selected influence factors on KM maturity. A significant influence of the industry and the innovation activities have not been found, the influence of company size is not clear but this may be due to the selected companies. Certainly, more influence factors should be taken into consideration and possibly be integrated into KMMM.

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