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STATE-OF-THE-ART ON MATURITY MODELS FOR COLLABORATION

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Date of Publication: July 2009
Report Number: 01/2009

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Abstract

Measuring organizations' readiness for collaboration and accordingly knowledge management has been a topic for years. With the emergence of Web 2.0 and its new possibilities for more effective collaboration, it has become increasingly relevant to determine the maturity of an organization in regard to its ability to run a groupware successfully and enable its workforce to perform collaboration efficiently.

This paper provides a rigorous literature review on collaboration maturity models. Conducting literature review rigorously means to provide evidence and traceability in your literature search, selection, and evaluation. This paper comprehensively conducts and describes the literature review process of a state-of-the-art analysis for collaboration maturity models by means of the five phases for reviewing literature: definition of review scope, conceptualization of topic, literature search, literature analysis and synthesis, and research agenda.

Finally, this study has lead to 55 maturity models in the area of collaboration and knowledge management and e-learning. Three categories are identified: scientific, practitioner-oriented (scientific), and practitioner-based. Essentially, many maturity models are derived from the per se standard CMM, but, however, only a few are well enough documented to be further evaluated or applied in practice.

Keywords: Collaboration Maturity Model, Knowledge Management, Measurement, Rigorous Literature Review, Design Science Research

1. Introduction

Measuring organizations' readiness for collaboration and accordingly knowledge management has been a topic for years. With the emergence of Web 2.0 and its additional possibilities for easy collaboration, it has become increasingly relevant to determine the maturity of an organization in regard to its ability to run its groupware software successfully and get its workforce involved adequately. Essentially, this means the workforce needs to know and to perform collaboration effectively and efficiently.

Stoller-Schai defines Collaboration as a direct and reciprocally influencing discussion held by two or more persons to solve or cope with a task or problem. This takes place in a jointly created and negotiated, computer-moderated context (joint acceptation-space, cooperative setting) using shared resources (Stoller-Schai 2003, 47). Usually, groupware software supports this human interaction process.

Essentially, the term groupware seems to be outdated (see Google Trends "groupware"). Nowadays, the "groupware software" is affected by the emergence of Web 2.0 and the integration of functionalities of diverse well established software systems. Thus, a groupware can additionally consist of content management, document management, project management, search engine, portal, workflow mechanism, social network, wiki, and blog functionalities. Consequently, current groupware software like IBM Lotus Notes, Microsoft Office SharePoint Server, O3Spaces, Open Text Livelink ECM, or Oracle Collaboration Suite are suited to an enterprise application which makes it rather to an *enterprise collaboration suite*.

This paper conducts a state-of-the-art analysis of maturity models for collaboration. The superordinated research project's aim is to measure organizational maturity with respect to its collaboration effectiveness. The stage of collaboration effectiveness is reached if the knowledge workers are using the available resources (e.g., groupware, information, social network) collaboratively in an appropriate way in order to increase not only personal, but also organizational productivity (time and quality). Derived research questions can be stated as follows: Does the workforce of an organization collaborate effectively and efficiently? Is an organization prepared (i.e., mature) for the introduction of a groupware? How effectively is an organizations' collaboration compared to its competitors? What should an organization do to gain better collaborating staff and, thus, an effective and efficient collaboration? Following these research questions a maturity model seems to be an appropriate solution approach.

However, reviewing literature represents an "essential first step and foundation when undertaking a research project" (Baker 2000, 219). The goal of writing a literature review is to reconstruct the 'giant' of accumulated knowledge in a specific domain. In this process, literature search represents the fundamental first step that makes up the giant's skeleton and largely determines its reconstruction in the subsequent literature analysis (vom Brocke et al. 2009, 1). Thus, as previously outlined, this paper presents a state-of-the-art analysis of maturity models for the collaboration domain.

A literature review seeks to uncover the sources relevant to a topic under study (Levy and Ellis 2006, 181; Rowley and Slack 2004, 31). Thus, it makes a vital contribution to the relevance and rigor of research. On the one hand, relevance is improved by avoiding the reinvestigation of what is already known (Baker 2000, 220). On the other hand, rigor is derived from an effective use of the knowledge base (Hevner et al. 2004, 88) and refers in particular to the reliability and validity of the search process (Levy and Ellis 2006, 183).

According to *vom Brocke* et al. "the process of literature search should be comprehensibly described in order to enable readers to assess the quality of a review. Only then can other scholars in the field confidently use the results in their own research" (2009, 2). Moreover, having a look at the increasing number of top journals and, additionally, the increased number of articles per journal, the process of excluding sources has to be made as transparent as possible in order for the review to proof credibility (vom Brocke et al. 2009, 2).

The process of literature search comprises (1) the querying of scholarly databases using keywords and (2) backward or (3) forward searches on the basis of relevant articles (Webster and Watson 2002, xvi). Whereas backward search means reviewing the references of the articles yielded from the keyword search, forward search refers to both, reviewing additional sources that have cited the article and reviewing the authors' following publications (Levy and Ellis 2006, 191). Finally, *vom Brocke et al.* (2009, 7) formalized this process of literature reviewing presented in Figure 1.

This paper is structured as follows: According to the phases of the framework of literature reviewing (Figure 1) it firstly outlines the review scope and the conceptualization of the considered topic. Afterwards, the process and

results of the literature search will be presented. A closing literature analysis and synthesis will lead to a suggested research agenda.

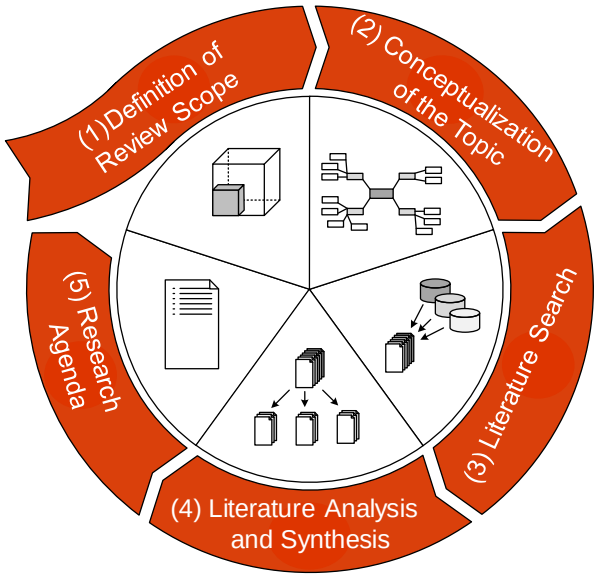


Figure 1. Framework for literature reviewing (vom Brocke et al. 2009, 7)

2. Definition of Review Scope

In order to clearly define the scope of a review, *Cooper* (1988, 109ff) presents an established taxonomy for literature reviews (cf. Table 1). Basically, this taxonomy comprises six constituent characteristics, each containing certain categories, some of which are mutually exclusive (perspective and coverage), while others can be combined (audience, organization, goal, and focus) (vom Brocke et al. 2009, 8). This taxonomy is supposed to be for "social scientists" in the field of "education and psychology" (Cooper 1988, 108). To apply this taxonomy in IS research, especially in design science research, I adopt it as follows: According to *Hevner et al.* (cf. 2004) who established the design science research which aims at creating and evaluating (IT) artifacts - *Cooper's* 'theory' building oughts to be equivalent to *artifacts* (cf. Table 1). Moreover, "Different semantics and individual views on theory and theorizing in design science research complicate the fixation of what is understood as *design theory*" (Mettler 2009, 6). Nevertheless, *Gregor & Jones* (2007, 322) define design theories as "principles inherent in the design of an IS artifact that accomplishes some end, based on knowledge of both IT and human behavior". Concluding, a*pplications* are equivalent to *instantiations* in design sciences research.

Generally, a literature analysis should be limited to certain period of time to gain relevant articles. Hence, I have additionally added this characteristic. *Periodic* means to search for articles which are published for example in January of each year. Contrary, *selective* does not follow any specified system. While *interval* focuses on a time frame, e.g., years 2000 to 2005, the *unrestricted* period does not exclude a time frame, not even historically.

Table 1. Taxonomy of design research literature review (following Cooper 1988, 109)

Characteristic	Categories			
Focus	Research Outcomes	Research Methods	Design theories / Artifacts	Applications / Instantiations
Goal	Integration	Criticism	Central Issues	
Organization	Historical	Conceptual	Methodological	
Perspective	Neutral Representation		Espousal of Position	
Audience	Specialized Scholars	General Scholars	Practitioners / Politicians	General Public
Coverage	Exaustive	Exhaustive and Selective	Representative	Central / Pivotal
Period	Periodic	Selective	Interval	Unrestricted

Focus. The focus of a review concerns the material that is of central interest to the reviewer (Cooper 1988, 108). This literature review focuses on the state of the art of maturity models for the collaboration domain. It attempts to collect maturity models which are rigorously constructed. *Mettler* (2009, 5) have stated that in "the constituent literature, the current understanding of maturity models in IS tends to be somehow in-between the […] artifact types (model and method)". Additionally, the resulting maturity model is rather an artifact than a theory when: firstly, a highly innovative phenomenon, unclear principles of form and function and no dominant design prevails; secondly, the required cases to derive maturity levels and recommendations may be missing as well and as a consequence; thirdly, testable propositions will probably remain untested since no person or firm has accomplished the final maturity requirements. Contrary, maturity models addressing a 'mature' domain fulfill all necessary and sufficient conditions for building a design theory (Mettler 2009, 6). Consequently, the focus of this literature review for the target collaboration maturity model is rather an *artifact*.

Goal. Goals concern what the author hopes the review will accomplish. The goal of a literature review can be an integration (integrate or synthesize past literature that is believed to relate to the same issue, e.g., formulate general statements from multiple specific instances, or e.g., resolving the conflict between contradictory ideas or statements of fact by proposing a new conception that accounts for the inconsistency), a criticism (critically analyzing the existing literature by e.g., demonstrating that past conclusions derived from the literature were unwarranted), or to identify issues central to a field (e.g., provide suggestions about how problems and controversies in an area might be overcome). Frequently, integration and criticism or integration and identification of central issues go hand in hand (Cooper 1988, 108ff). The goal of the following literature review is to find all or at least most of the maturity models of the domain collaboration which will be *criticized* and can be used in parts to construct a non-generic applicable and holistic collaboration maturity model. Providing a critique of summarized literature finally allows for conceptually reconstructing the central issues of a topic in an integrative framework for a clearer understanding (Torraco 2005, 361f).

Organization. How a paper is organized is a third characteristic that differentiates research reviews. Reviews can be arranged: (1) historically, introducing topics in the chronological order in which Knowledge in which they appeared in the literature; (2) conceptually, grouping works relating to the same abstract ideas; or (3) methodologically, bringing in works employing similar methods grouped as subtopics. Reviews can combine organizations, for example, by addressing works historically within a given conceptual or methodological framework (Cooper 1988, 111f). Focusing on different concepts (e.g., form and functioning, model and assessment), this literature review will analyze and organize the search results *conceptually*.

Perspective. The perspective considers how the reviewer's point of view influences the discussion of the literature which can be called a neutral representation (the reviewer attempts, at least initially, to present arguments or evidence for and against different interpretations of the literature) or espousal of position (the reviewer accumulates and synthesizes the literature in the service of demonstrating the value of a particular point of view by selectively ignoring or paying limit the attention to certain information) (Cooper 1988, 110). This literature review favors a *neutral representation*.

Audience. The audience distinction probably manifests itself most clearly through the writing style of the reviewer. Reviews can be written for groups of specialized researchers, general researchers, practitioners, policy makers, or the general public (Cooper 1988, 112). Addressing an audience of *specialized scholars* as well as *practitioners* in a neutral representation fulfills the design science research principles: rigor and relevance.

Coverage. The extent to which reviewers find and include relevant works in their paper is the single activity that sets this expository form apart from all others. The typology distinguishes between four types of coverage: exhaustive (includes the entire literature and provides a comprehensive presentation), exhaustive and selective (includes the entire literature, but presents only a selected sample), representative (presents works that are representative of many other works in a field), and pivotal (describes important initial efforts that have provided direction for a field) (Cooper 1988, 110f). The coverage of this literature review will be *exhaustive with selective citation*, which means to consider all the relevant sources, but describe only a sample.

Period. Having an established collaboration and knowledge management domain for several years and the recent described changes based on the emergence of the Web 2.0, the conducted literature review will focus on resources within the last decades, and especially the recent three years (*interval*).

3. Conceptualization of the Topic

A review must begin with "a broad conception of what is known about the topic and potential areas where knowledge may be needed" (Torraco 2005, 359). Developing maturity models by conducting design-oriented research means finding solution patterns for important unsolved problems or giving advice in solving problems in more effective or efficient ways (cf. Hevner et al. 2004).

Mettler (2009, 6f) present a meta model which simultaneously considers parameters for the development and application of a maturity model (see Figure 2). They argue, that "the development of the maturity model is intimately connected with the application phase and therefore should not be reflected separately" (Mettler 2009, 7). Furthermore, whilst design decisions within the generic phases may vary, the order of the phases is crucial (e.g., decisions made when preparing the deployment of the maturity model will impact the further application of the model). Hence, the left cycle (Table 2) is rather considered in a developer's perspective, while the right cycle (Table 3) is rather in a user's perspective.

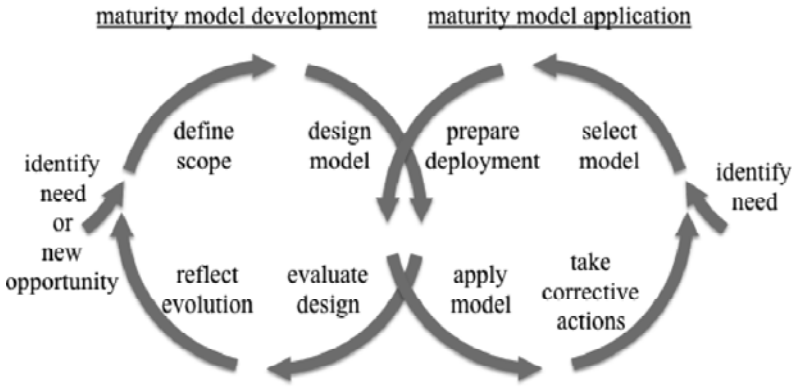


Figure 2. Phases of maturity model development and application (Mettler 2009, 7)

In order to describe the research scope and the specifications of the collaboration maturity model, design parameters for the development and the application are determined (cf. Table 2 and Table 3). This literature review aims at two possible findings: firstly, either there exists a similar model in the target domain which can be adopted in respect of form, or functioning, or both. However, reference modeling for maturity models is still an open research issue. Secondly, I need to develop a new maturity model based on existing concepts (form and functioning) of other maturity models either (1) of the target domain (e.g., because the existing maturity models of the target domain are too generic, but still include some useful ideas) or (2) of another domain (e.g., good practice in its domain), or (3) a combination of both. Table 2 and Table 3 help to understand the requirements of the collaboration maturity model which is an essential basis for the scope and conceptualization of the literature review's topic.

Table 2. Design parameters of maturity model development (following Mettler 2009, 7)

Phase	Desicion Parameter	Characteristic			
Define Scope	Focus / Breath	General Issue		Specific Issue	
	Level of Analysis / Depth	Group Decision-making	Organizational Considerations	Inter-org. Considerations	Global & Societal Considerations
	Novelty	Emerging	Pacing	Disruptive	Mature
	Audience	Managment-oriented	Technology-oriented	Both	
	Dissemination	Open		Exclusive	
Design Model	Maturity Definition	Process-focussed	Object-focussed	People-focussed	Combination
	Goal Definition	One-dimensional		Multi-dimensional	
	Design Process	Theory-driven	Practitioner-based	Combination	
	Design Product	Textual Description of Form	Textual Description of Form and Functioning	Instantiation (Assessment Tool)	
	Application Method	Self-assessment	Thirdparty Assisted	Certified Professionals	
	Responders	Management	Staff	Business Partners	Combination
Evaluate Design	Subject of Evaluation	Design Process	Design Product	Both	
	Time-frame	Ex-ante	Ex-post	Both	
	Evaluation Method	Naturalistic		Artificial	
Reflect Evolution	Subject of Change	None	Form	Functioning	Form and Funtioning
	Frequency	Non-recurring		Continuous	
	Structure of Change	External / Open		Internal / Exclusive	

Define scope. The definition of the scope comprises the most important design decisions. When considering the focus of the maturity model it is of concern whether the subject-matter is specific (e.g., risk management for a certain industry) or rather general (e.g., learning organization). For this purpose, I choose a more *general* approach, because this collaboration maturity model seeks to address several organizational units with a diversity of requirements and tasks (e.g., government, strategic alignment, training, change management, IT). Hence, its analysis will focus on internal *organization-wide considerations.*

"The cognition of the state in which an innovation is situated is thus extremely important" (novelty of the domain) (Mettler 2009, 4). Derived from the innovation process, four phases are differentiated whereas the disruptive phase usually has established a dominant design (i.e., a general agreed standard or best practice). However, dominant designs may not be better than other designs, but acceptance of an innovation will be on peak (Mettler 2009, 4). When focusing on the assessment of emerging innovations the levels of maturity may be extremely uncertain given that no dominant design is found already. Recommended improvement activities therefore probably will be estimated as speculation. On the other hand, when concentrating on mature innovations the levels of maturity are clear but the potential for improvement is only marginal. Thus, when defining the levels of maturity for a particular domain, a tradeoff between the state of innovation's uncertainty and its actual diffusion (which assists in predicting whether and how an innovation will be successful) has to be considered (Mettler 2009, 4). Being aware that the collaboration and knowledge management domain has not been emerging recently, but obtains continuous improvements through value-adding and changing circumstances (e.g., Web 2.0 paradigm, innovations in collaboration software, and enabling technologies), I consider this domain as a continuous-moving one with no dominant design yet and, hence, *pacing*.

In order to reach technical implementation as well as organizational adoption of a groupware, both *management and IT* need to be involved. Moreover, *open* access and dissemination is granted.

Design model. It is critical to have a clear understanding of what is meant by "maturity": process-focused (centre on activities and work practices in order to define more effective procedures, e.g., inputs and outputs of specified tasks), object-focused (features of work products are investigated in order to enhance their mode of operation) or people-focused understanding ("maturity" is inclined to people's skills and proficiency, e.g., people's feelings and behavior) (Mettler 2009, 8). Focusing on collaborative processes (process-focused), groupware functionalities (object-focused), and especially on knowledge workers capabilities (people-focused), the level of sophistication is increased for all three maturity factors (*combination*).

Seeking to achieve the single goal of collaboration effectiveness, the target maturity model will be *one-dimensional*. According to the design science research principles of rigor and relevance the maturity mode will be a *combination*

of both, theory-driven (using scientific knowledge base) and practitioner-based (theory building case studies) and ends in an *textual description of form and functioning*.

A promising approach for the maturity appraisal is the *third-party assisted* assessment which will be conducted in cooperation with an external coach, e.g., a scientific partner. In this assessment *management and staff* should be able to answer questions with respect to, e.g., government procedures or collaboration behavior.

Evaluate design. The subject of the evaluation could be the design process (i.e., the way the model was constructed) or the design product (i.e., the model itself) (Mettler 2009, 8). As recommended by *Mettler both* subjects of evaluation will be examined *ex-post* in a *naturalistic* (e.g., case studies) evaluation method.

Reflect Evolution. If for example the maturity of the phenomenon under study is growing (i.e., maturity stages needs to be adopted by the emergence of new best practices) or external standardization efforts require adaptations in form (e.g., the underlying meta model) or functioning (e.g., the way how maturity is assessed) than it might be essential to evolute the maturity model (Mettler 2009, 9). To a certain degree the collaboration maturity model should be adaptive in *form and functioning*. In order to guarantee a certain comparability the evolutionary changes needs to be restricted to once in a while (rather *non-recurring*). There are no limitations concerning the structure of change: modification can be *openly* induced.

Considering the design parameters of maturity model application Table 3, it attracts attention that some parameters are redundant, but from a user's perspective: In order to pinpoint only non-self-explaining parameters, the reliability parameter will be outlined. According to *Conwell et al.* (2000, 821) "*verification* is the process of determining that a [maturity] model […] represents the developer's conceptual description and specifications with sufficient accuracy" and *validation* is the "degree to which a [maturity] model […] is an accurate representation of the real world from the perspective of the intended uses of the model".

Table 3. Design parameters of maturity model application (following Mettler 2009, 9)

Phase	Desicion Parameter	Characteristic			
Select Model	Origin	Academic		Practitioner-based	
	Reliability	Untested	Verified		Validated
	Practicality	General Recommendations		Specific Improvement Activities	
	Accessibility	Free		Charged	
	Design Mutability	None	Form	Functioning	Form and Funtioning
	Application Method	Self-assessment	Thirdparty Assisted		Certified Professionals
Prepare Deploy-ment	Driver / Responsibility	Business		IT	
	Realization	Informal Appraisal		Formal Assessment Project	
	Application Area	Specific Entity		Multiple Entities	
	Respondents	Management	Staff	Business Partners	Combination
	Training	None	Basic		Extensive
Apply Model	Execution	Go		No Go	
	Frequency of Application	Non-recurring		Repeated	
Take Corrective Actions	Target Setting	Uncoupled		Coupled	
	Implementation	On the Fly		Project	
	Implementer	Line Organization	Staff Organization		Externals

In order to determine the search terms (i.e., search string), the target domain of the maturity model needs be more clarified. Hence, I have used the following classification schema for maturity models: Given are the possible domain "clouds" of (1) information and communication technology, (2) information systems development, (3) information for knowledge work, customer satisfaction and business performance, (4) people and organization, (5) commerce and business administration (Mettler and Rohner 2009, 4). By means of this classification schema, it is not easy to assign the collaboration maturity model to (3) or (4) since both are not disjunctive sets. However, looking at the intersection area of (3) and (4), this schema gives some hints for the search string: knowledge management, collaboration, organizational learning, change management, training and HR, behavioral aspects, etc. Use kartoo.com or a similar graphical meta search engine in order to identify synonyms and other topic-related terms: groupware, CSCW, People, change, competency, learning organization, enterprise information. Using the terms *maturity model* and *maturity* in combination with the previously listed terms should lead to a rich amount of resources.

4. Literature Search

The literature search as an essential part of the literature review can be conducted in many different manners. Hence, v*om Brocke et al.* (2009, 9) propose a literature search process in four phases each with a search task and a evaluation task: journal search, keywords search, backward search and forward search. As "scanning a journal's table of content is a useful way to pinpoint other articles not detected by keyword search" (Webster and Watson 2002, xvi), I expand the literature search process with an additional phase "journal's table search" (Figure 3).

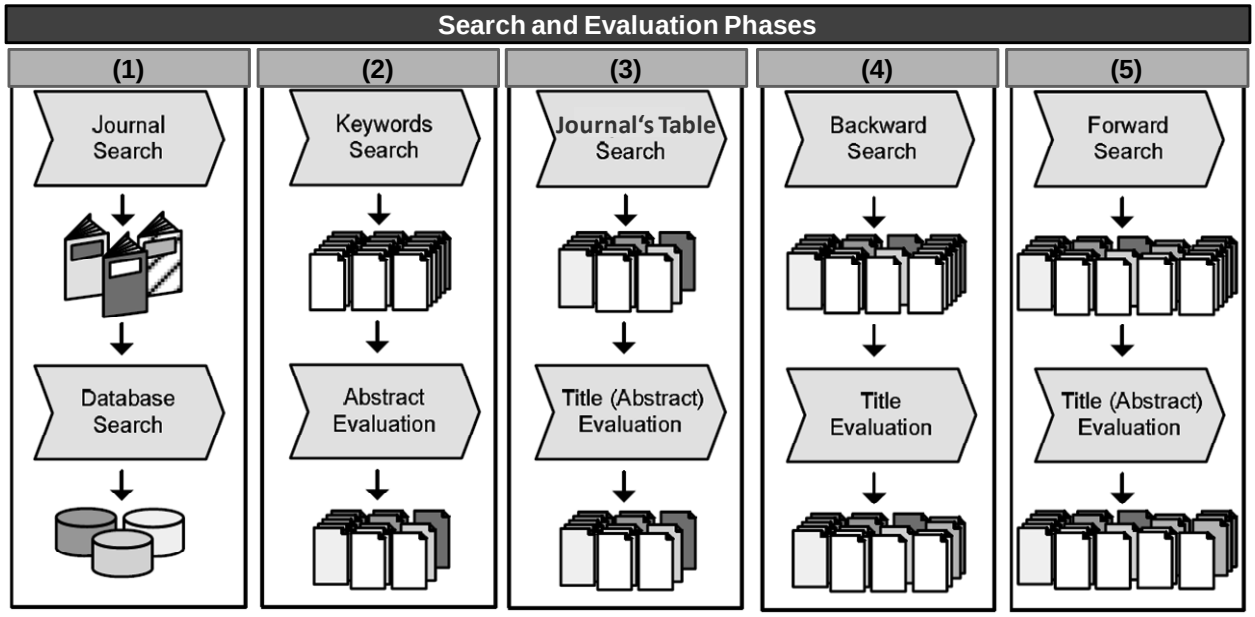


Figure 3. Literature search process (following vom Brocke et al. 2009, 9)

Journal search. It is recommended not to search by journal, but rather by querying scholarly databases allowing for a topic-based search (Webster and Watson 2002, xvi). Since "one challenge [of literature search] lies in identifying proper databases" (vom Brocke et al. 2009, 9) I focus on databases which search journals listed in the AIS World MIS Journal Ranking. Additionally, *Scirus* serves as a meta journal database which aggregates the content of several databases and publishers, e.g., Elsevier, and ScienceDirect. Moreover, the AIS World database *AISeL* helps finding articles from renowned conferences (proceedings) which are also a well promising source.

Since "published research literature [concerning maturity models] presents a filtered record of activity and thinking" (Mettler and Rohner 2009, 4) in the fast-moving field of IS, non-research sources are likely to yield rich information about further topics and future trends. For this reason, I have conducted two parallel literature searches, one focusing on the scientific literature and the other drawing on alternative sources available via the World Wide Web. For the latter purpose I used *Scirus (Web Sources)*, *Google (file:pdf)*, and *Google Scholar* to find further practitioner-based maturity models.

Keyword search. Keywords search is crucial, because the selection and combination of these search phrases sets "the parameters of the research itself" (Baker 2000, 222). A pre-study reveals that the search terms suggested in chapter 3 are not as useful for database search, since the resulting hits tend to null. Nevertheless, these search terms help filtering the rich World Wide Web resources. Hence, I iteratively modified and tested the suggested search terms and finally adopted them as presented in Table 4 which has produced most promising results. In order to ensure that relevant maturity models are not excluded with the rather specific search strings of (1) and (2), however, I added (3) to additionally receive topic-related maturity model which do not match the common terminology.

Table 4. Results of the literature search

		1	2	3	Total Hits	Net Hits
		"collaboration" AND "maturity model" <title, abstact, keywords>	*"knowledge management" AND "maturity model" <title, abstact, keywords>*	*"maturity model" <title> AND NOT "capability" <title> (deducted with results from 1 and 2)*	(after reading title and keywords) seems to fit for domain (search terms hits title or keywords)	after removing double counts and papers with less than 5 pages **
	Journal Data Base					
Scientific-based Paper	ACM Digital Library	2 (96)	1 (33)	0 (9)	3	3
	AISeL	0	1 (2)	3 (8)	4	3
	EBSCOhost (Business Primier Source)	1 (2)	1 (2)	2 (35)	4	1
	EMERALD	1 (6)	2 (5)	3 (11)	6	1
	JSTOR	0	0	0 (4)	0	0
	ProQuest	2 (11)	9 (15)	2 (63)	13	13
	ScienceDirect	0 (1)	2 (2)	0 (9)	2	2
	Scirus (Journal Sources)	2 (79)	2 (58)	1 (7)	5	0
	Wiley InterScience	0 (15)	0 (12)	0 (5)	0	0
					37	23
	WWW Source					
Practitioner-oriented (Scientific) Paper	Scirus (Preferred Web)	2 (512)	2 (289)	2 (15)	6	1
	Google Scholar	10 (3130)*	25 (1500)*	22 (422)	57	22
Practitioner-based Paper	Google (filetype:pdf)	10 (17400)*	19 (6420)*	13 (470)	42	9
					105	32

*** only the first 500 hits have been analyzed (the amount of addional relevant papers has tend to null by search hits over 300)**
**** including non-available papers**

Conducting the search string (1) and (2), the total sum of hits (in brackets) is deduced by evaluating title, keywords, and partly abstract. This leads to several selected papers which seem to fit for the target domain (without brackets). While papers found with (1) and (2) need to undergo a *homonym sense check* (Is the paper's content what it looks like? For example, a "collaboration maturity model for organizations" can either focus on internal collaboration processes between the knowledge workers or it can mean that an organization is working together with others in a supply chain.), papers found with (3) need to undergo a s*ynonym sense check* (Does this paper fit to the target domain even if keywords do not match any ex-ante determined search term?). Hence, conducting the search string (3), the total sum of hits is deduced by evaluating title, keywords, and partly abstract with respect to the search terms suggested in chapter 3. This altogether provides a total sum of hits of 37 papers. For quality issues, papers with less than five pages have been excluded as well as double counts. This leads to a total net sum of 23 scientific papers (cf. Appendix Table 5). Whereas 3 (*italic* font) of the 23 paper are not publicly available (for free) a search for similar publications of these authors has been conducted (see forward and backward search).

The parallel literature search via the World Wide Web has yielded further documents ranked by relevance and link popularity. This amount of papers was narrowed down (by using previously described practices) to 23 practitioner-oriented (scientific) papers (cf. appendix Table 6) and 9 practitioner-based papers (cf. Appendix Table 7) within the time period of 1999-2009. Whereas 4 (*italic* font) of the 32 paper are not publicly available (for free) a search for similar publications of these authors has been conducted (see forward and backward search). This paper base builds the starting volume for conducting the following search phases.

Journal's table search. Scanning a journal's table of content is a useful way to pinpoint other articles not detected by keyword search (Webster and Watson 2002, xvi) – especially to detect relevant papers in special issues of the regarded topic. In this case, the journal's table search does not lead to any additional papers.

Backward search. The backward search refers to reviewing older literature cited in the articles yielded from the keyword search (Torraco 2005, 360). Since author, title, and publication date of cited papers are the few available information, these need to serve as selection criteria and have provided 17 additional papers (cf. Appendix Table 8).

Forward search. The forward search means reviewing additional sources that either have cited the article or have been published by the author afterwards (Webster and Watson 2002, p. xvi). In order to gain the former the *ISI Web of Knowledge* or *Google Scholar* can be used which offer a "cited by" functionality per article. Selecting papers by reading title and abstract has lead to additional 3 papers (cf. Appendix Table 9).

Finally, a total sum of 67 available (**bold**) papers could be extracted as extremely relevant to the considered topic.

5. Literature Analysis and Synthesis

After collecting sufficient literature on a topic it has to be analyzed and synthesized (phase 4). For the analysis, a concept matrix for IS literature reviews by *Webster & Watson* (2002, xvii) can be used, which subdivides topic-related concepts into different units of analysis. This allows for arranging, discussing, and synthesizing prior research. A successful literature review constructively informs the reader about what has been learned. In contrast to specific and critical reviews of individual papers, the reader should be told what patterns are in the literature (Webster and Watson 2002, xviii). Moreover, heavy criticism on individual papers should be avoided, since "previous work is always vulnerable. Criticizing is easy, and of little value; it is more important to explain how research builds upon previous findings rather than to claim previous research is inadequate and incompetent" (Daft 1985, 198).

First of all, related work on collaboration maturity models is rare, whereas a huge amount of so called knowledge management maturity models exists and still expands. Compared to the claims of the *Conceptualization of the Topic* section, the extracted maturity models fail or leak in a couple of factors, as far as observable: entire *maturity definition*, *design product* in an applicable manner, design a useful *application method*, *evaluate design* appropriately, spend thoughts on future *evolution* (cf. Table 2), and achieve *reliability* (cf. Table 3).

Basically, the maturity models can be divided into CMM-based and in non-CMM-based concepts (cf. Teah et al. 2006, 403 ff). The capability maturity model (CMM) of the Software Engineering Institute (SEI) of the Carnegie Mellon University is a quasi-standard for evaluating software engineering processes (cf. Paulk et al. 1993). Following the CMM approach, a maturity model is assembled according to the meta-model in Figure 4. Each knowledge management (KM) activity belongs to a corresponding target management object (i.e., component), a maturity level, and a key area. A key area is a cluster of related KM activities in an area that, when implemented collectively, satisfy a set of goals considered important for improvements in that area (cf. Hsieh et al. 2009, 4093f). In order to emphasize, an activity is always connected to a maturity level, which means that along the maturity range different topics (activities) are of relevance. In conclusion, the required activities changes with increased maturity which implies that a maturity model is rather a maturity process. Non-CMM-based maturity models are rather chaotic and leak in an appropriate *form* or *functioning*.

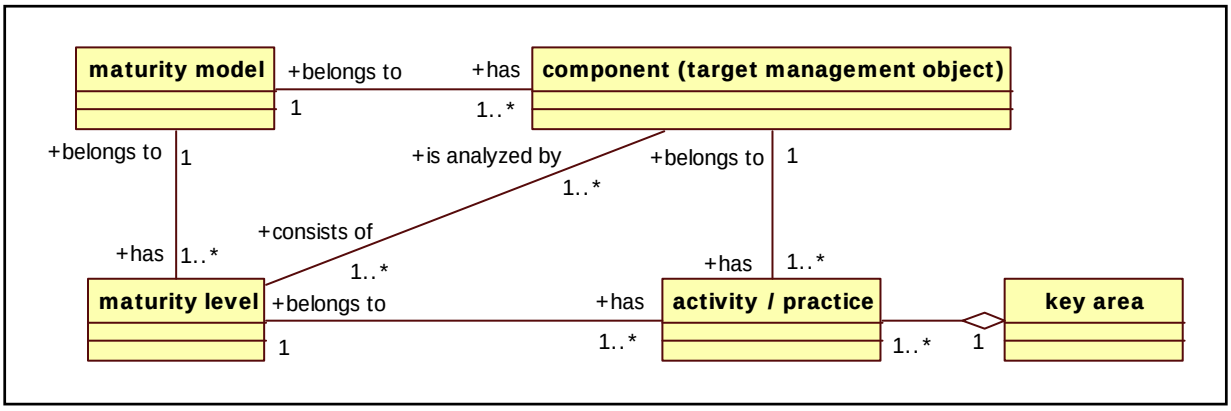


Figure 4. Knowledge management maturity meta-model

Moreover, the extracted maturity models can be classified as: practitioner-based, i.e., consulting firms (e.g., KPMG, Infosys, WisdomSource, Tata Consultancy Services), or organizations which strived for a self-assessment (e.g., Siemens); practitioner-oriented "scientific", i.e., research institutes (e.g., APQC); and scientific, i.e., academic researchers. Indeed, this classification does not imply an evaluation of the models' quality, but suggests a different focus on target group. Generally, the majority of papers are "lousy" in presenting the research framework, design, and methods, hence, a reconstruction and validation is difficult. Additionally, the models are outlined generically and do not recommend specific improvement activities, so that an application (i.e., assessment) needs further investigation.

6. Research Agenda

The synthesis of literature is further expected to result into a research agenda (phase 5), comprised of sharper and more insightful questions for future research (Webster and Watson 2002, xix). The research agenda finally provides the basis for extending the review.

Considering the shortcomings of recent work, I propose a set of questions to be answered:

Comparing the two domains of knowledge management and collaboration, both have significant overlaps. It reveals that aspects of collaboration – of course by definition of knowledge management – are included in KM activities (e.g., community building, establish an open and trusted culture), or technology (e.g., conferencing system, project space, DMS).

1. Which of the knowledge management maturity models' content (i.e., activity, component, key area) can be transferred to a collaboration maturity model and how?

Applying the CMM, most maturity model constructors fall into the trap to force themselves to transfer the CMM maturity level description to their model. This results in an artificial fitting maturity level description, which is neither applicable for assessment nor usable for subsequent communication.

2. How can maturity levels of this "fluffy" domain be outlined explicitly and clearly in order to provide a benefit for readers without the need to comprehend the whole maturity model?

As a collaboration maturity model needs to combine process maturity, object maturity, and people capability in order to address all organizational aspects adequately (whereas CMM only focuses process maturity), this leads to the last question:

3. Is using the CMM standard a promising way to construct a multi-dimensional (i.e., process, technology, people) collaboration maturity model and how can this one-dimensional CMM approach be reasonably extended?

7. Discussion and Conclusion

The literature review reveals that many maturity model papers have been written in recent years. Nevertheless, providing a domain, components and subcomponents rounded down by a generic description of maturity stages is not very rigorous. Most papers however fail to take the application of the model into consideration in the maturity model development process.

Essentially, this state-of-the-art analysis provides an almost complete summary of maturity models relevant for collaboration or knowledge management. Indeed, choosing other search terms in the database search would have led to another universe, however, the conducted table, backward, and forward search ensures the coverage of different-named still relevant papers.

Concluding, in order to apply a rigorous and relevant collaboration maturity model, I need to develop a new maturity model based on existing concepts (form and functioning) of other maturity models by a combination of maturity models (1) of the target or a related domain, because existing maturity models of the target domain are too generic, but still include some useful ideas and forces the constructor to the focus, and (2) of another domain, i.e., good practice in its domain (e.g., CMM).

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Appendix

Table 5. Scientific papers from journal data bases (19th March 2009)

Author	Year	Title	Publication
Dayan, R.; Evans, S.	2006	KM your way to CMMI	Journal of Knowledge Management, 10(1), 69-80
Desouza, K. C.	2006	Knowledge Management Maturity Model: Theoretical Development and preliminary empirical Testing	Dissertation Thesis, University of Illlinois at Chicago, USA
Gillies, A; Howard, J.	2003	Managing change in process and people: combining a maturity model with a competency-based approach	TQM & Business Excellence, 14(7), 779-787
Gottschalk, P.	2008	Maturity model for email communication in knowledge	International Journal of Law, Crime and Justice, 36(1), 54-66
Hogan, T. J.	2008	The Adaptive Leadership Maturity Model	Organization Development Journal, 26(1), 55-62
Hsieh, P. J.; Lin, B.; Lin, C.	2009	The construction and application of knowledge navigator model (KNMTM): An evaluation of knowledge management maturity	Expert Systems with Applications: An International Journal, 36 (2), 4087-4100
Jones, C. R.	2007	Exploring the practices of knowledge sharing between projects: An investigation of the dimensions of what, when, and how	Disseration Thesis, Capella University, Minnesota, USA
Kenny, J.	2006	Strategy and the learning organization: a maturity model for the formation of strategy	The Learning Organization, 13(4), 353-368
Lutteroth, C.; Luxton-Reilly, A.; Dobbie, G.; Hamer, J.	2007	A Maturity Model for Computing Education	9th Australasian Computing Education Conference (ACE2007), Ballarta, Australia
Magdaleno, A. M.; Cappelli, C.; Baião, F. A.; Santoro, F. M.;	2008	Towards Collaboration Maturity in Business Processes: An Exploratory Study in Oil Production Processes	Information Systems Management, 25(4), 302–318
Marshall, S.; Mitchell, G.	2004	Applying SPICE to e-Learning: An e-Learning Maturity Model?	6th Australasian Computing Education Conference (ACE2004), Dunedin, New Zealand
Martin, V. A.; Hatzakis, T.; Lycett, M.; Macredie, R.	2004	Bridging the Business/IT Gap through the Relationship Management Maturity Model	Australasian Conference on Information Systems (ACIS), Tasmania, Australia
Martin, V. A.; Hatzakis, T.; Lycett, M.; Macredie, R.	2004	Building the Business/IT Relationship through Knowledge Management	Journal of Information Technology Cases and Applications, 6(2), 27-47
Martin, V. A.; Hatzakis, T.; Lycett, M.; Macredie, R.	2005	Cultivation Knowledge Sharing through the Relationship Managment Maturity Model	The Learning Organization, 12(4), 340-355
Mehta, N.; Oswald, S.; Mehta,	2007	Infosys Technologies: improving organizational knowledge flows	Journal of Information Technology , 22(4), 456-464
Muller, M. J.; Raven, M. E.; Kogan, S.; Millen, D. R.;	2003	Introducing Chat into Business Organizations: Toward an Instant Messaging Maturity Model	GROUP'03, Sanibel Island, Florida, USA
Natarajan, G.	2005	A KM Maturity Model for the Software Industry	Knowledge Management Review, 8(1), 20-24
Natarajan, G.	2004	Knowledge Management Maturity Model for Software Export	Dissertation Thesis, Indian Institute of Technology, Bombay,
Paulzen, O.; Perc, P.; Doumi, M.; Cereijo-Roibas, A.	2002	A Maturity Model for Quality Improvement in Knowledge Management	Australasian Conference on Information Systems (ACIS), Melbourne, Australia
Robinson, H. S.; Anumba, C. J.; Carrillo, P. M.; Al-	2006	STEPS: a knowledge management maturity roadmap for corporate sustainability	Business Process Management Journal, 12(6), 793-808
Steinhauser, L.	2008	Improving the success of sustaining collaborative work practices enabled through information technology	Dissertation Thesis, University of Nebraska at Omaha, USA
Teah, H. Y.; Pee, L. G.; Kankanhalli, A.	2006	Development and Application of a General Knowledge Management Maturity Model	10th Pacific Asia Conference on Information Systems (PACIS), Kuala Lumpur
Wademan, M. R.; Spuches, C. M.; Doughty, P. L.	2007	The People Capability Maturity Model: Its Approach and Potential to Improve Workforce Performance	Performance Improvement Quarterly, 20(1), 97-124

Table 6. Practitioner-oriented (scientific) papers from WWW sources: *Scirus (Preferred Web)* and *Google Scholar* (24th March 2009)

Author	Year	Title	Publication
Aggestam, L.	2006	Towards a Maturity Model for Learning Organizations - the Role of Knowledge Management	17th International Conference on Database and Expert Systems Applications (DEXA 2006), Krakow, Poland
Berztiss, A. T.	2002	Capability Maturity for Knowledge Management	13th International Workshop on Database and Expert Systems Applications (DEXA 2002), Aix-en-Provence, 162-166
Ehms, K.; Langen, M.	2000	Ganzheitliche Entwicklung von Wissensmanagement mit KMMM	Wissensmanagement 4, 20-25
Feng, J.	2006	A Knowledge Management Maturity Model and Application	PICMET 2006, Istanbul, Turkey
Feng, J.	2005	Constructing a knowledge management maturity model from perspective of knowledge management	IEEE International Engineering Management Conference
Freeze, R.; Kulkarni, U.	2005	Knowledge Management Capability Assessment: Validating a Knowledge Assets Measurement Instrument	38th Annual Hawaii International Conference on System Science (HICSS)
Gallagher, S.; Hazlett, S.-A.	1999	Using th Knowledge Management Maturity Model (KM3) as an Evalutation Tool	Draft Paper for the Conference on Knowledge Management: Concepts and Controversies, Warwick, UK
Harris, K.	2006	A Knowledge Management Maturity Model Explains Where You're Going and How to Get There	Gartner Research
Hefke, M.; Kleiner, F.	2005	An ontology-based software infrastructure for retaining theoretical Knowledge Management Maturity Models	1st Workshop FOMI
Hu, C.-C.	2007	A Study on Knowledge Management Maturity Model: A case Study of the Physical Training Organization of the Air Force	Master Thesis, Department of Sport Promotion, Taiwan
Klimko, G.	2001	Knowledge Management and Maturity Models: Building Common Understanding	2nd European Conference on Knowledge Management (ECKM), Bled, Slovenia
Kruger, C. J.; Snyman, M. M. M.	2007	Guidelines for assessing the knowledge management maturity of organizations	South African Journal of Information Management, 9(3), 1-11
Kruger, C. J.; Snyman, M. M. M.	2007	Formulation of a strategic knowledge management maturity model	South African Journal of Information Management, 7(2)
Kulkarni, U.; Louis, R. S.	2003	Organizational Self Assessment of Knowledge Management Maturity	9th Americas Conference on Information Systems (AMCIS)
Kulkarni, U.; Freeze, R.	2005	Measuring Knowledge Management Capabilities	Encyclopedia of Knowledge Management
Magdaleno, A. M.; Araujo, R. M.; Borges, M. R. S.	2007	Designing Collaborative Processes	International Workshop on Business Process Modeling, Development and Support (BPMDS),Trondheim, Norway, 283–290
Mann, J.	2007	Use Gartner's Maturity Model to Improve Enterprise Collaboration	Gartner Research
Markow, T. T.	2004	A Knowledge Maturity Model: An Integration of Problem Framing, Software Design, and Cognitive Engineering	Master Thesis, Department of Computer Science, North Carolina State University, USA
McKey, P.; Ellis, A.	2007	A Maturity Model for Corporate Learning Environments	World Conference on Educational Multimedia, Hypermedia and Telecommunications, Chesapeake, Virginia, USA, 1186-1194
Mohanty, S. K.; Chand, M.	2004	5iKM3 Knowledge Management Maturity Model	Tata Consultancy Services
Ramaprasad, A.; Desouza, K. C.	2002	Knowledge management maturity model: Operability, flexibility, adaptability, exaptability, agility	Working Paper, University of Illlinois at Chicago, USA
Santanen, E.; Kolfschoten, G.;	2006	The Collaboration Engineering Maturity Model	39th Hawaii International Conference on System Sciences (HICSS)
Weerdmeester, R.; Pocaterra, C.;	2003	Knowledge Management Maturity Model	Information Societies Technology (IST) Programme

Table 7. Practitioner-based papers from WWW sources: *Google (filetyp:pdf)* (30th March 2009)

Author	Year	Title	Publication
Gallagher, P. S. ; Altalib, H.	2008	Assessing Knowledge Management Maturity within NASA's Johnson Space Center	The Interservice/Industry Training, Simulation & Education Conference (I/ITSEC), Orlando, Florida, USA
Grundstein, M.	2008	Assessing Enterprise's Knowledge Management Maturity Level	1st World Summit on the Knowledge Society (WSKS), 380-387
Hefke, M.; Trunko, R.	2002	A Methodological Basis for Bringin Knowledge Management to Real-World Environments	Practical Aspects of Knowledge Management (PAKM) Vienna, Austria, 565-570
Liebowitz, J.; Beckman, T.	2009	Moving Toward a Knowledge Management Maturity Model (K3M) for Developing Knowledge Management Strategy and Implementation Plans	Advances in Management Information Systems, 12, 163-179
Kruger, C. J.	2008	Knowledge Management Maturity from a strategic / managerial Perspective	Dissertation Thesis, University of Pretoria, South Africa
Kulkarni, U.; Freeze, R.	2004	Development and Validation of a Knowledge Management Capability Assessment Model	25th International Conference on Information Systems (ICIS)
Lin, H.-F.	2007	A stage model of knowledge management: an empirical investigation of process and effectiveness	Journal of Information Science, 33(6), 643-659
Magdaleno, A. M.; Capelli, C.; Baiao, F.; Santoro; Aroujo, R. M.	2008	A Practical Experience in Designing Business Processes to Improve Collaboration	Lecture Notes in Computer Science, 4928, 156-168
Patrizi, J.; Levin, G.	2007	A Knowledge Management Maturity Model for a Global Field Services Organization	APQC knowledge management conference, Houston, Texas, USA

Table 8. Papers from backward search (2nd April 2009)

Author	Year	Title	Publication
Bohn, R. E.	1994	Measuring and Managing Technological Knowledge	Sloan Management Review, 36(1), 61-73
Curtis, B.; Hefley, W. E.; Miller, S.	2001	People Capability Maturity Model (P-CMM)	Carnegie Mellon Software Engineering Institute (SEI)
de Gooijer, J.	2000	Designing a knowledge management performance framework	Journal of Knowledge Management, 4(4), 303-310
EFQM	2003	The EFQM Excellence Model	European Foundation for Quality Management, Brussels
Fairchild, A. M.	2002	Knowledge Management Metrics via a Balanced Scorecard Methodology	35th Hawaii International Conference on System Sciences (HICSS)
Harigopal, U.; Satyadas, A.	2001	Cognizant enterprise maturity model (CEMM)	IEEE Transactions on Systems, Man, and Cybernetics Part C-Applications and Reviews, 31, 449-459
Hiebeler, R. J.	1996	Benchmarking Knowledge Management	Strategy & Leadership, 24(2), 22-29
Kochikar, V. P.	2000	The Knowledge Management Maturity Model - A Staged Framework for Leveraging Knowledge	KM World, Santa Clara, California, USA
KPMG Consulting	2000	Knowledge Management Research Report	KPMG Management Consulting
Krankanhalli, A.; Tanudidjaja, F.; Sutanto, J.; Tan, B. C. Y.	2003	The Role of IT in Successful Knowledge Management Initiatives	Communcations of the ACM, 46(9), 69-73
Lee, J.; Kim, Y.	2001	A stage model of organizational knowledge management: A latent content analysis	Expert Systems with Application, 20(4), 299–311
O'Dell, C.	2000	APQC's Road map to knowledge management results: Stages of implementation	American Productivity & Quality Center - APQC, Houston, Texas (USA)
Rosemann, M.; de Bruin, T.	2005	Towards a Business Process Management Maturity Model	European Conference on Information System (ECIS), Gothenburg, Sweden
Roy, R.; del Rey Chamorro, F.M.; van Wegen, B.; Steele, A.	2000	A Framework To Create Performance Indicators In Knowledge Management	3rd International Conference on Practical Aspects of Knowledge Management (PAKM2000), Basel
Strassmann, P.A.	1998	The Value of Knowledge Capital	American Programmer, 11, 1-10
Suresh, J. K.; Mahesh, K.	2006	Ten Steps to Maturity in Knowledge Management	Chandos Publishing, Oxford, UK
WisdomSource Technologies	2008	K3M - The Knowledge Management Maturity Model	WisdomSource Technologies

Table 9. Papers from forward search (3rd April 2009)

Author	Year	Title	Publication
de Bruin, T.; Rosemann, M.; Freeze, R.; Kulkarni, U.	2005	Understanding the Main Phases of Developing a Maturity Assessment Model	16th Australasian Conference on Information Systems (ACIS), Sydney, Australia
Kruger, N. C. J.; Johnson, R. D.	2008	Assessment of Knowledge Managements Growth in South Africa	http://www.globdev.org/dev/files/18-Paper-Kruger-Assessment-of-KM-
Kulkarni, U; Ravindran, S.; Freeze, R.	2006	A Knowledge Managment Success Modell: Theoretical Development and Empirical Validation	Journal of Management Information Systems, 23(3), 309-347