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Maturity Models in Information Systems Research: Literature Search and Analysis

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Abstract:

This article collects and analyzes seventy-six maturity model articles that have been published in leading Information Systems (IS) journals and conference proceedings during the past fifteen years. We study the IS literature on maturity models from three different perspectives: a research perspective, which is particularly relevant for scholars who are interested in the design and adoption of maturity models; a publication perspective, which reflects the interests of authors and reviewers of maturity model articles; and a practitioner's perspective, which is especially relevant for maturity model users and consultants. The results are interesting in several respects. From the research perspective, the Capability Maturity Model (CMM) is the most dominant foundation of past IS research on maturity models. In contrast, theories on the design and adoption of maturity models are distinctly rare in our sample. The publication outlets that are considered feature quantitative and qualitative empirical research alike, but—with a decreasing number—purely conceptual research as well. Of late, past maturity model research can mainly be located in the area of IT and organizations, while the formerly very popular domain of IS development is of less interest today. As for the publication perspective, we find that the level of publication activity in the field has generally been increasing over the last fifteen years, with North American and European researchers dominating the academic discussion. Finally, with regard to the practitioner's perspective, we compile advice on the practical application of maturity models from a critical analysis of the literature. It is hoped that the results can stimulate and guide future research in the field and inform the development and usage of theoretically sound maturity models in practice.

Keywords: maturity model, stage model, stages-of-growth model, literature analysis, meta-analysis, IS research

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I. INTRODUCTION

Maturity models are conceptual multistage models that describe typical patterns in the development of organizational capabilities [de Bruin et al., 2005; Kazanjian and Drazin, 1989; Solli-Sæther and Gottschalk, 2010]. As such, they usually depict a sequence of stages that together form an anticipated, desired, or logical path from an initial to a target maturity state, either for individual entities or regarding a complete set of organizational capabilities [Becker et al., 2009; Gottschalk, 2009; Kazanjian and Drazin, 1989]. Maturity models are commonly applied in organizations to assess the as-is situation, to derive and prioritize improvement measures, and to control progress [de Bruin et al., 2005; Iversen et al., 1999].

Maturity models have become an important topic in both Information Systems (IS) research and practice [Mettler et al., 2010]. In practice, international consortia, software companies, and consultancies have developed a huge number of maturity models during the past few years [e.g., Hewlett-Packard, 2007; IBM, 2007; OGC, 2008]. One of the most prominent examples is the Capability Maturity Model Integration (CMMI) [CMMI Product Team, 2010], which has already been used in about 3,000 companies [SEI, 2009]. Scott [2007] believes that organizations will increasingly adopt maturity models to stimulate and guide the development of their IS capabilities. Thinking along these lines, Mettler [2011] writes that the need for new maturity models will not diminish, as they are valuable tools to assist decision makers in practice. IS researchers have also considered the topic [e.g., de Bruin et al., 2005; Solli-Sæther and Gottschalk, 2010]. For example, they designed models that depict the stages that organizations typically move through in adopting and managing IT [e.g., Galliers and Sutherland, 1991]. The maturity models they developed cover a wide range of application areas, including e-government [Layne and Lee, 2001], e-business [Prananto et al., 2004], business process management [Rosemann and de Bruin, 2005], software engineering [Paulk et al., 1993], and knowledge management [Kulkarni and Freeze, 2004]. In addition, the impact of the Capability Maturity Model's key processes [Paulk et al., 1993] on software development productivity and quality has been examined by IS researchers [e.g., Jiang et al., 2004; Phan, 2001; Ramasubbu et al., 2008].

Despite their high relevance for both IS research and practice, the development and adoption of maturity models is still beset with several problems. Accordingly, they have been subject to fundamental criticism; in particular, maturity models have been regarded as oversimplifying reality and lacking an empirical foundation [Benbasat et al., 1984; de Bruin et al., 2005; King and Kraemer, 1984; McCormack et al., 2009]. In response, IS researchers have become increasingly interested in the development of guidelines that are intended to support more rigorous design processes of maturity models [e.g., Becker et al., 2009; de Bruin et al., 2005; Maier et al., 2009; Solli-Sæther and Gottschalk, 2010]. Notwithstanding these endeavors, further research is still needed to establish maturity models as a field of IS research that is not only of high practical relevance but also of theoretical value.

What can a literature analysis contribute to the prospering field of maturity model research and practice? The growing body of research publications on maturity models in the IS domain necessitates an analysis and synthesis. It has been argued that research in a field progresses through assessment of the methods employed [Scandura and Williams, 2000], analysis of the knowledge and theories built upon, and identification of knowledge gaps that can be filled by fellow researchers [Webster and Watson, 2002]. We believe that a systematic study of past maturity model research can make a difference by informing three particular perspectives: (A) a research perspective that relates to the theoretical and methodological aspects of maturity models, (B) a publication perspective that reflects the interests of potential authors or reviewers of maturity model articles, and (C) a practitioner's perspective that covers issues relevant to the end users of maturity models in particular. Consequently, this article intends to make the following primary contributions. (A) First, it informs IS researchers about the theoretical foundations, methodological approaches, and research areas covered in past studies on maturity models. (B) Second, authors, reviewers, and editors of maturity model articles are provided with insights that they can use to steer their publication-related activities. (C) Third, adopters of maturity models from practice can benefit from a summary and discussion of the key results and implications of past maturity model research.

The remainder of this article is organized as follows. In the next section, we provide the background for our review and discuss the notions of maturity and maturity models respectively. We then set out the design of this study by describing our research questions and the organization of our literature search. For each of the above three perspectives A–C, we take a step-by-step approach in the following sections to tackling the research questions, presenting our findings, and laying out their implications. The final section concludes the article and explains its limitations.

II. RESEARCH BACKGROUND

Maturity can be considered as a measure that allows organizations to evaluate their capabilities with regard to a certain problem area [Rosemann and de Bruin, 2005]. The concept can refer to different types of organizational resources. Mettler [2011], for instance, distinguishes between the maturity of processes, the maturity of objects or technologies, and the maturity of the people's capabilities. Maturity models describe typical patterns in the development of these and similar resources [Kazanjian and Drazin, 1989; Solli-Sæther and Gottschalk, 2010]. Different degrees of maturity are described as stages, with each stage being superior to the previous one [Rao et al., 2003]. Maturity models provide the constructs—in the form of descriptors or variables that characterize each stage—that organizations require to determine their level of progress [Dekleva and Drehmer, 1997; Fraser et al., 2002; Gottschalk, 2009; Holland and Light, 2001; Rao et al., 2003]. The general idea of maturity models is that such hierarchical progression is beneficial to organizations, and that it cannot be easily reversed [Solli-Sæther and Gottschalk, 2010].

Maturity models have their early roots in multistage models, among them being the hierarchy of human needs [Maslow, 1954], the theory of economic growth [Kuznets, 1965], and Nolan's [1973, 1979] stage model on the progression of IT in organizations. In particular, Nolan's stage hypothesis triggered much related research in the IS domain. Although the empirical validity of this model has been subject to criticism [King and Kraemer, 1984; Prananto et al., 2003], it has been widely adopted and has informed the design of several other maturity models [Solli-Sæther and Gottschalk, 2010]. However, maturity models became especially popular with the emergence of the Capability Maturity Model (CMM) in the late 1980s [Paulk, 1995; Paulk et al., 1993; de Bruin et al., 2005]. Since then, a plethora of new maturity models have been developed that frequently used the structure of the CMM as a blueprint [Becker et al., 2009]. The CMM was constantly updated and integrated with related models, resulting in the CMM Integration (CMMI), which is currently available in version 1.3 [CMMI Product Team, 2010].

As to the purposes of maturity models, it has consistently been argued that they can support self- or third-party assessment, as well as benchmarking, and provide a roadmap for continuous organizational improvement [Iversen et al., 1999]. De Bruin et al. [2005] accordingly identify a descriptive, comparative, and prescriptive purpose of maturity models. The descriptive purpose of use is maturity assessment, which can be thought of as a snapshot of an organization regarding its performance at a certain point [Chiesa et al., 1996]. On the basis of this snapshot, a comparison can then be made in the form of benchmarking against best-in-class organizations [de Bruin et al., 2005]. Finally, because many maturity models also have prescriptive components, they further allow for organizational improvement, that is, step-by-step progression on the predetermined sequence of maturity stages [de Bruin et al., 2005; IT Governance Institute, 2007].

There are many related notions in IS research that surround the maturity model concept. For instance, maturity models are frequently referred to as stages-of-growth or stage models also [e.g., Prananto et al., 2003; Solli-Sæther and Gottschalk, 2010]. In the IS domain, they are understood as both theories and IT artifacts. Nolan's [1973, 1979] stage model, for example, is often regarded as a theory because it explains and predicts the evolution of IT in business. In this line of thought, Solli-Sæther and Gottschalk [2010] consider the development of stage models as a theory building endeavor, and Hackney et al. [1999] use the notion of "stages of growth theories." In contrast, some IS researchers consider maturity models to be an IT artifact, as conceptualized by March and Smith [1995] [e.g., Becker et al., 2009; Donnellan and Helfert, 2010; Mettler and Rohner, 2009; van Steenbergen et al., 2010]. In such cases, the development and evaluation of maturity models can be perceived to typically follow the design science paradigm [Hevner et al., 2004].

III. STUDY OVERVIEW

Research Questions

As indicated in the Introduction, in this article we aim to describe and analyze the current state of maturity model research in the IS domain for the following three perspectives: (A) a research perspective that relates to the theoretical and methodological aspects of maturity models, (B) a publication perspective that reflects the interests of potential authors, editors, and reviewers of maturity model articles, and (C) a practitioner's perspective that covers issues relevant to the end users of maturity models in practice. Within these perspectives, we further distinguish six distinct roles that can benefit from a discussion of the maturity model literature. For each of these roles, we explore a set of relevant research questions, which we explain in the following.

(A) Research perspective. The study of the maturity model literature may be of interest to designers of maturity models (role 1). As Gregor [2006] points out, theories in IS research may not only cover explanation or prediction, but design as well. As for design, IS researchers are potentially interested in developing, evaluating, and/or refining existing models [e.g., Kulkarni and Freeze, 2004; Rosemann and de Bruin, 2005; Teah et al., 2006]. In such cases it will be important to build the design of a maturity model on a sound theoretical basis, to apply suitable research

strategies and methods, to evaluate existing models within the same research area, and to relate to prior efforts in the field [Becker et al., 2009; de Bruin et al., 2005; Solli-Sæther and Gottschalk, 2010]. It is very likely that maturity model designers are interested not only in the development of new models for as yet uncovered research areas, but also in the comparison and integration of existing maturity models. Another addressee of our literature analysis on maturity models is that of an organizational theorist (role 2) interested in understanding and theorizing organizational development. Here it may be beneficial to assess the theoretical basis of existing maturity models or explore their functioning as a well-established means in guided organizational change [van de Ven and Poole, 1995]. With regard to the research perspective and these two roles, our literature analysis seeks to address the following research questions covering theoretical, methodological, and content-related aspects:

A.1 What are the theoretical foundations of maturity model studies? (Theory)

A.2 What is the methodological orientation of maturity model research? (Methodology)

A.3 Which IS research areas have already been covered by maturity model studies and which areas are still under-researched? (Content)

(B) Publication perspective. Our literature analysis may help fellow researchers to publish academic papers on maturity models (role 3: author). For example, authors are likely to have an interest in past publication activities, including the recent developments in the field, geographical aspects, or the publication outlets that are most receptive to maturity model research. In addition, the study can serve the interests of editors and reviewers (role 4) who need to assess a maturity model article against the background of the state-of-the-art in the field. With regard to the publication perspective and these two roles, our literature analysis addresses the following research questions covering developmental, geographical, and outlet-related aspects:

B.1 How did the academic discussion in the IS literature on maturity models develop over time? (Development)

B.2 In which geographical communities is the maturity model concept discussed most? (Geography)

B.3 Which IS publication outlets are most receptive to maturity model research? (Outlets)

(C) Practice perspective. Finally, our literature analysis seeks to serve the interests of potential users of maturity models (role 5) by summarizing the practical implications of past maturity model research. In addition, we aim to give an impulse for consultants and assessors (role 6) by discussing methodological and structural-conceptual issues of maturity model development and application. With regard to the practitioner's perspective, and to support the adopters and designers of maturity models from practice, our literature analysis addresses the following research questions that cover both the implications of prior research and the subset of discussions on the critical aspects of maturity models:

C.1 What are the practical implications of past maturity model research? (Implications)

C.2 What are the critical aspects of the maturity model concept that may diminish its applicability in practice? (Critique)

In conclusion, in our analysis we discuss the current state of maturity model research with the help of three perspectives (i.e., research, publication, and practice). With these perspectives we hope to cover the issues that are most relevant for both researchers and practitioners in the field, while acknowledging that the topic has a broad relevance for academia and industry alike. The further distinction between typical roles within these perspectives (i.e., designers, theorists, authors, reviewers, editors, users, and consultants) is intended to enable an organization of the study results that suits the interests of the different stakeholders of this research. While other researchers would probably have taken different perspectives on the analysis of the literature, we believe that they are general enough to accommodate a broad range of questions relevant to the study of maturity model research. Also, we acknowledge that the three perspectives are partly related (e.g., the publication perspective can be relevant for both researchers and practitioners). While some researchers would speak in favor of a sharper distinction between the three perspectives, and roles respectively, it is our belief that, with this approach to analyzing the literature, we can better explain and discuss the study's implications for the various parties that might have an interest in our results.

Literature Search

It has been argued that the literature search strategy plays a salient role in a literature review [Levy and Ellis, 2006; Webster and Watson, 2002]. Many IS researchers suggest a systematic and structured approach to searching and reviewing the literature [Bandara et al., 2011]. "... the process of searching the literature must be comprehensibly described. Only then can readers assess the exhaustiveness of the review and other scholars in the field can more confidently (re)use the results in their own research" [vom Brocke et al., 2009, p. 2206]. In particular, it has been suggested that information be provided about the (number of) articles considered, the period covered, the journals and conferences included, the databases queried, and the keywords applied [vom Brocke et al., 2009]. In addition,

backward searches (i.e., searching within the bibliographies of the articles produced by the keyword search) and forward searches (i.e., searching for other papers that have cited these articles) can improve the number of potentially relevant articles to be included in the review [Levy and Ellis, 2006; Webster and Watson, 2002].

Our literature search can be summarized as follows. We searched through a fifteen-year period (1996 to 2010) in twenty-two leading IS journals, comprising the nineteen “pure IS journals” identified by Walstrom and Hardgrave [2001] plus three journals within the Senior Scholars’ Basket of Journals [AIS, 2007], which are not considered in that list (*Information Systems Journal*, *Journal of the Association for Information Systems*, *Journal of Information Technology*). We complemented our journal search with five major international conferences sponsored by or affiliated to the AIS (Americas, European, International, Mediterranean, and Pacific Asia Conference on Information Systems). We used the electronic libraries provided by the ACM (Association for Computing Machinery) and AIS (Association for Information Systems), as well as the databases EBSCOhost (Business Source Premier), informaworld, INFORMS, ProQuest, ScienceDirect, and WILEY to search for maturity model articles published in these outlets. In line with Solli-Sæther and Gottschalk [2010], who use the three notions of *maturity models*, *stage models*, and *stages-of-growth models* synonymously, we applied the phrases “maturity model,” “stage model,” and “stages-of-growth model” in all our searches. The literature search in the journals and conference proceedings that were considered resulted in eighty-six articles that we checked manually with regard to their relevance. We sorted those papers out whose length was too short to allow for detailed content analysis (e.g., studies that were presented during poster sessions at conferences) and further excluded articles that do not match our understanding of the above search terms (e.g., the term “stage model” also refers to an operations research methodology). This procedure led us to base our analysis on a set of seventy-six articles (see Table 1), including thirty-eight journal and thirty-eight conference papers (see Appendix A). We did not conduct a backward or forward search. The keyword search was conducted in January 2011.

Table 1: Results of the Literature Search

Journal/Conference	Database	Search fields	Relevant articles
<i>ACM Transactions on Information Systems</i>	ACM Digital Library	Abstract	0
Americas Conference on Information Systems	AIS Electronic Library	Abstract	27
<i>Database for Advances in Information Systems</i>	ProQuest	Citation and abstract	2
<i>Decision Support Systems</i>	EBSCOhost	Abstract	0
European Conference on Information Systems	AIS Electronic Library	Abstract	5
<i>European Journal of Information Systems</i>	ProQuest	Citation and abstract	2
<i>Information & Management</i>	ProQuest	Citation and abstract	5
<i>Information Resources Management Journal</i>	EBSCOhost	Abstract	1
<i>Information Systems</i>	ScienceDirect	Abstract, title and keywords	0
<i>Information Systems Journal</i>	WILEY Online Library	Abstract	3
<i>Information Systems Management</i>	EBSCOhost	Abstract	10
<i>Information Systems Research</i>	INFORMS	Abstract and title	1
International Conference on Information Systems	AIS Electronic Library	Abstract	3
<i>Journal of the Association for Information Systems</i>	AIS Electronic Library	Abstract	1
<i>Journal of Computer Information Systems</i>	EBSCOhost	Abstract	1
<i>Journal of Database Management</i>	EBSCOhost	Abstract	0
<i>Journal of (Organizational and) End-User Computing</i>	ProQuest	Citation and abstract	3
<i>Journal of Global Information Management</i>	EBSCOhost	Abstract	1
<i>Journal of Information Systems Education</i>	ProQuest	Citation and abstract	3
<i>Journal of Information Technology</i>	EBSCOhost	Abstract	2
<i>Journal of Information Technology Management</i>	Journal homepage	Title	0
<i>Journal of Management Information Systems</i>	EBSCOhost	Abstract	1
<i>Journal of Organizational Computing and Electronic Commerce</i>	informaworld	Abstract	1
<i>Journal of Strategic Information Systems</i>	ScienceDirect	Abstract, title and keywords	0
Mediterranean Conference on Information Systems	AIS Electronic Library	Abstract	1
<i>MIS Quarterly</i>	EBSCOhost	Abstract	1
Pacific Asia Conference on Information Systems	AIS Electronic Library	Abstract	2
Total			76



As Gregor [2006, p. 622] writes, the “analysis of existing work is not straightforward.” We analyzed the sample of maturity model studies in a collaborative manner. The first author was responsible for the categorization of the papers, and he discussed issues that emerged during the analysis with the other authors until an agreement was reached.

IV. RESEARCH PERSPECTIVE

What Are the Theoretical Foundations of Maturity Model Studies? (A.1)

Approach

A defining criterion of research is that it not only exceeds the existing body of scientific knowledge, but also draws from it [Hevner et al., 2004]. At the outset of our analysis, we accordingly analyzed the foundations of IS research on maturity models. On the one hand, these foundations can include theories that inform and guide the design of maturity models or that are used to reflect on their development, adoption, and use. On the other hand, maturity models themselves can create the foundation of research, for example, in design-oriented studies that empirically evaluate the models’ utility in practice and refine them on the basis of the experiences gained, in rather conceptual works that compare or integrate maturity models of a particular domain, in reflective research that explains or predicts their performance in practice, or in survey studies that adopt maturity model elements as questionnaire items. Furthermore, related artifacts like standards (e.g., ISO 9000), IT management frameworks (e.g., ITIL and COBIT), and management methods (e.g., Total Quality Management) are possible foundations of maturity model research.

Findings

The literature analysis suggests that the CMM and its successor the CMMI are the most dominant foundations of past IS research on maturity models. While the CMM is used as a reference in twenty-nine papers, the CMMI provides the foundation of research in seven papers. Another eight papers refer to Nolan’s [1973, 1979] stage theory. Other maturity models provide the ground for thirteen papers, including the e-government stage model by Layne and Lee [2001], the Sourcing of IT Work Offshore stage model [Carmel and Agarwal, 2002], Tuckman’s [1965] stage model of team psychosocial development maturity, the stage models on IS implementation by Kwon and Zmud [1987] and on innovation diffusion by Rogers [1983], and different BPM maturity models [Rohloff, 2009; Rosemann and de Bruin, 2005]. Apart from maturity models, there are several guidelines, standards, and methods that are used as a reference, for example, ISO 9000 [Ashrafi, 2003; Hassan and Sherdil, 1997], Bootstrap [Iversen et al., 1999], or the Project Management Body of Knowledge (PMBOK) Guide [Crawford, 2006].

New maturity models are presented in thirty-five of the seventy-six articles. In these articles, the development of new models is often grounded in existing ones. In particular, the CMM and the CMMI are frequently transferred to fields beyond software engineering, for example, IS education [Drinka and Yen, 2008], project management [Crawford, 2006], outsourcing management [Bahli, 2004], and IT-business alignment [Luftman, 2003]. Sometimes, existing maturity models are also integrated into a consolidated one. Teah et al. [2006], for instance, develop a “general knowledge management maturity model” on the basis of nine maturity models existing in the field.

While some models (especially those referred to as “stage models”) are sometimes considered theories (e.g., the one by Nolan), hardly any of the reviewed papers use existing theories as a foundation of research. Among the few exceptions is, for instance, Georgeon [2010], who bases his study on a theoretical model that explains why CIOs would follow different models of change agency during their tenure in office. Also, Dekleva and Drehmer [1997] apply the Rasch Calibration Psychometric Model to find out whether or not real-life software development practices follow the ones prescribed by the CMM. Further examples can be found in the field of IS education, where learning paradigms and theories inform studies on maturity models [e.g., Drinka and Yen, 2008; Saulnier et al., 2008].

Finally, only one study in our sample takes a meta-view on maturity model research. Solli-Sæther and Gottschalk [2010] use existing models to explain how to improve the development process of maturity models.

Implications

The above findings suggest that theories are notably under-represented in past IS research on maturity models. Until now, maturation, that is, the process of becoming more mature, has been understood rather vaguely as a term that is associated with organizational development toward the better. It is our belief that more fundamental theoretical approaches to studying the development and use of maturity models could shed new light on what constitutes organizational maturity, the process of maturation, and maturity models in general.

IS researchers who are planning to design a maturity model in the future (role 1) should accordingly make use of the existing body of theoretical knowledge to rigorously define both the maturing entity they study and the rationale of

maturation as such. The resource-based view (RBV) of the firm [Wernerfelt, 1984], for instance, could provide appropriate vocabulary to better define the maturing entity. The RBV sees organizations as collections of resources, which can be further distinguished into assets and capabilities [Wade and Hulland, 2004]. Assets are understood as anything tangible or intangible that can be used by an organization, and capabilities refer to the ability of an organization to perform a coordinated set of tasks for the purpose of achieving a particular end result [Wade and Hulland, 2004], which reflects the common definition of a process [Helfat and Peteraf, 2003]. Maturity models typically refer to these two types of resources when assessing the technical sophistication of certain systems (i.e., assets) or work practices (i.e., capabilities) within an organization. As far as the rationale of maturation is concerned, it could also be beneficial for maturity model designers to reflect on contingency and process theories. Teo and King [1997], for instance, introduced a contingency perspective into their staged model of business planning and IS planning integration that caters for the organizational and environmental characteristics that may influence the organization's evolution. Process theories can "provide explanations in terms of the sequence of events leading to an outcome (e.g., do A and then B to get C)" [Langley, 1999, p. 692] and have already gained significant attention in IS research [e.g., Burton-Jones et al., 2004; Crowston, 2000; Newman and Robey, 1992]. Maturity model designers can refer to research in the field in order to better explain the rationale behind the maturation process they intend to describe. We believe that the design of maturity models has been too often informed by existing models (e.g., the CMM and CMMI) instead of applying these meaningful theoretical approaches. That is, accepted models were taken as structural blueprints, which then were populated with contents from outside their original domains—appropriate or not.

On the contrary, organizational theorists (role 2) have a long tradition of theorizing organizational change processes. Their research may thus provide a theoretical basis for future research on maturity models in the IS domain. For example, the four ideal types of process theories for explaining organizational change that van de Ven and Poole [1995] describe can be used for theorizing about maturity models. It can be argued, for instance, that maturity models combine the perspectives of life cycle theory (organic growth) and teleology (goal formulation and implementation) to explain and predict the development of organizational capabilities [Lee and Kim, 2001]. Also, convergence and divergence theories [Meyer et al., 1975] can help to evaluate the usefulness of maturity models for guiding organizational development. While convergence theories propose that all systems of the same class develop toward a general "model" or "ideal" state, divergence theories postulate that such an ideal state does not exist, and that entities develop dependent on the choices made and the contingencies that occurred over time. The concept of path-dependency could thus be used to explain causal relationships between maturation events in time [Zhu et al., 2006].

What Is the Methodological Orientation of Maturity Model Research? (A.2)

Approach

With regard to research methodologies, a general distinction can be made between empirical and conceptual research. Empirical studies make use of a wide range of qualitative research strategies (e.g., case studies, action research, grounded theory), as well as quantitative strategies (e.g., surveys, experiments) [Creswell, 2003; Myers, 1997]. In contrast to empirical approaches, we understand conceptual studies as research, particularly design work, that is not grounded in empirical data, or only to a very small extent. As such, it can be considered the product of a researcher's creative endeavor or experiences.

Findings

We were able to identify both empirical and conceptual works in our sample, and some papers can also be regarded as a combination of both (Table 2). Thirty-nine papers mainly apply empirical methods, seventeen papers were considered purely conceptual, and nineteen papers combine conceptual and empirical elements (e.g., a conceptual maturity model design augmented by a qualitative case study). The fifty-eight (thirty-nine plus nineteen) empirical papers feature both qualitative and quantitative methods. Qualitative research strategies in the field are mainly case studies, but also expert interviews and action research studies. In contrast, the quantitative studies in our sample make use of only one particular research method, namely that of survey studies. It is important to note that we counted literature reviews and model comparisons as conceptual research.

Regarding the subset of papers that propose new maturity models (#35), we could likewise identify both empirical and conceptual research. We further found a considerable share of rather conceptual-normative studies (#9) in which maturity models are basically the result of the researcher's creativity and experiences and not so much grounded in empirical data. Twelve articles combine conceptual and empirical approaches, particularly case studies. Fourteen papers were considered to be mainly empirical. Papers that include empirical elements are predominantly qualitative in nature, that is, the use of qualitative methods appears to be the most dominant strategy for the design of empirically-grounded maturity models.

Table 2: Research Methods Used in Maturity Model Studies

Research method	Total number of papers	Papers that propose new maturity models
<i>Mainly conceptual work</i>	17	9
<i>Empirical and conceptual work</i>	19	12
Quantitative methods	2	2
Qualitative methods	16	10
Mixed methods	1	0
<i>Mainly empirical work</i>	39	14
Quantitative methods	18	4
Qualitative methods	18	9
Mixed methods	3	1
<i>n/a</i>	1 (book review)	0
<i>Total</i>	76	35

Implications

The above results support Solli-Sæther and Gottschalk [2010, p. 280], who write that “[t]he work related to stages of growth has to a large extent been conceptual.” The data further suggest that this applies to the development of new maturity models in particular. However, our findings also indicate that conceptual research is increasingly complemented by empirical work, most notably in the form of case studies that serve as a proof-of-concept. As such, the continuing calls for stronger empirical foundations in IS research [Benbasat et al., 1984; de Bruin et al., 2005; King and Kraemer, 1984; McCormack et al., 2009] seem to have reached the maturity model domain.

The analysis also reveals a number of studies that are of interest to the designers of maturity models (role 1). Specifically, IS researchers can make use of procedure models designed to guide maturity model development [Becker et al., 2009; de Bruin et al., 2005; Maier et al., 2009; Solli-Sæther and Gottschalk, 2010]. Interestingly, all of these guidelines exhibit a circular logic in the form of iterative loops of (re)defining and validating maturity model elements. As such, they appear especially suitable for steering the longitudinal research process of developing maturity models that are not only theoretically sound and empirically grounded, but at the same time applicable in practice. In addition, there seems to be a lack of quantitative and longitudinal empirical research, leading Solli-Sæther and Gottschalk [2010, p. 280] to conclude that “findings [regarding the empirical validity of maturity models] can only be considered preliminary.” To us, the sought-after quantitative survey studies seem a promising approach that maturity model designers should take into consideration more frequently [e.g., in Holland and Light, 2001].

In addition, organizational theorists (role 2) should engage in the longitudinal analysis of organizational change processes. In particular, they should identify critical change events on the maturation paths [Helfat and Peteraf, 2003] as well as contingencies and drivers of change along these paths [Teo and King, 1997], and further discuss possible equally advantageous paths toward maturity [Kazanjian and Drazin, 1989].

Which IS Research Areas Have Already Been Covered by Maturity Model Studies and Which Areas Are Still Under-Researched? (A.3)

Approach

IS research covers a diversity of problem areas related to the development, use, and impact of IT, and so far there is no common agreement on the core topics of the discipline. In our analysis, we referred to the results by Sidorova et al. [2008] who analyzed scholarly articles published in the latest twenty-two volumes of three top-tier IS journals. Based on their analysis, they distinguish five core areas of IS research: *IT and individuals*, *IT and groups*, *IT and organizations*, *IT and markets*, and *IS development*. On a more detailed level, they differentiate between 100 pivotal IS research themes (e.g., *IT adoption*, *IS planning*, *IT for competitive advantage*), which we applied together with the five core areas for categorizing our sample of articles. Obviously, there are possible overlaps in this categorization. For example, some of the research themes are relevant to more than one area (e.g., *IT adoption*, which plays a role at the market, organization, group, and individual levels). In the case that categorization issues emerged during the analysis, we decided on the best-fitting research area and theme, informed by both the articles’ research questions and the unit of analysis (i.e., the maturing entity under investigation). Dinter and Goul [2010], for instance, investigate the impact of national culture on business intelligence maturity models, which led us to locate their article in the area of *IT and organizations* and to define its main theme as *Culture*.

Findings

The area *IT and organizations* largely dominates past maturity model research (#44), followed by *IS development* (#19). The maturing entity in the first area is typically a specific type of information system (e.g., a business

intelligence system, knowledge management system, or enterprise system), which organizations can adopt at various levels of sophistication. As to the area of *IS development*, researchers in the field frequently study the development process of such systems as the maturing entity. We found only a few papers that focused on *IT and individuals* (#6) and *IT and markets* (#3), and we were unable to identify any study in the area of *IT and groups* in our sample (Table 3). Among the maturing entities in the area of *IT and individuals* are, for instance, CIO leadership [Chen et al., 2010], or the change agency model of CIOs [Gorgeon, 2010]. An example within the area of *IT and markets* is the IT service catalogue [Rudolph and Krcmar, 2009].

Table 3: Distribution of Articles Across Research Areas and Themes

Research area	#	Research theme	#
IS development	19	Software development and maintenance	14
		Systems development methodologies	2
		Control	1
		Cost-benefit analysis	1
		Measurement instruments	1
IT and individuals	6	Attitudes, change, and IT adoption	2
		Role of top management (CEO/CIO)	2
		Control	1
		HR issues in IS field	1
IT and markets	3	Critical success factors	1
		Economics of IT	1
		IT outsourcing	1
IT and organizations	44	IT adoption	5
		Knowledge management and knowledge transfer	5
		IT outsourcing	4
		Business process reengineering	3
		Critical issues in IS management	3
		ERP and IS implementation	3
		Information system planning	3
		Public sector	3
		E-marketplaces and their characteristics	2
		Strategic alignment	2
		Systems development methodologies	2
		Collaboration	1
		Culture	1
		Data and IS quality	1
		IS discipline	1
		IT project failure (management)	1
		MIS	1
Problem solving	1		
Research methodology	1		
The value of IT investments	1		
n/a	4	Learning and education	3
		IS discipline	1
Total	76		76

As to the specific themes covered within these research areas, *Software development and maintenance* is in the focus of IS researchers (#14)—a theme that in the majority of articles is investigated in the area of *IS development*. Other popular themes, especially in the area of *IT and organizations*, are, for example, *Knowledge management and knowledge transfer* (#5), *IT adoption* (#5), *Business process reengineering* (#3), and *Information system planning* (#3). In total, twenty-nine of the 100 research themes are covered by the seventy-six analyzed articles. As indicated, the categorization of research areas and themes is not straightforward, that is, some of the research themes are relevant to more than one area. The theme *Systems development methodologies*, for instance, is dealt with in four papers; two of these can be located in the area of *IS development*, and another two rather focus on the interplay with the organization (*IT and organization*). Similarly, the themes *Control* and *IT outsourcing* were found to be relevant for different research areas (*IS development* and *IT and individuals*; *IT and markets*, and *IT and organizations*).

Implications

The results indicate that maturity models are often developed and studied as a tool for organizational development, especially regarding the adoption, diffusion, and use of IT in organizations (*IT and organizations*), which is generally

one of the main research fields in the IS domain. The second main research area is *IS development*, which points to the roots of the maturity model concept, that is, the assessment of software development processes by means of the CMM and CMMI.

Considering the implications for maturity model designers (role 1), it might be argued that there is an inflation of maturity model research for the two perspectives of *IS development* and *IT and organizations* that may call for integration and consolidation efforts in the future. Examples for such maturity model integration projects are already visible from our sample [e.g., Teah et al., 2006]. Maturity model designers should at least first review the existing set of models in their research area before developing a new one from scratch. The other three core areas, *IT and individuals*, *IT and groups*, and *IT and markets*, can be regarded as under-researched from a maturity model perspective and as promising areas for future works by maturity model designers. For example, the capabilities of individuals and groups to use certain IT systems or the diffusion and exploitation of technology in a certain market could be examined. The question, however, is whether the notion of maturity, and maturity models respectively, is sufficiently applicable in these three areas. There may be other well-established concepts with a meaning similar to maturity like, for example, IT literacy of employees in the area of *IT and individuals*. Hence, IS researchers need to compare existing and established concepts before transferring the maturity model idea to individual and group progression or market developments.

For organizational theorists (role 2) the extensive set of maturity model papers on *IT and organizations* represents a valuable source for their future research. Especially when they are interested in the interrelation of IT and organizational change, the existing body of knowledge may provide components for theory building as well as concepts and items for testing process theories on organizational change and IT adoption.

V. PUBLICATION PERSPECTIVE

How Did the Academic Discussion in the IS Literature on Maturity Models Develop Over Time? (B.1)

Approach

There is about forty years of history behind the concept of staged maturity models [Mettler et al., 2010; Solli-Sæther and Gottschalk, 2010], with the term “stage model” already being used in the 1970s [Nolan, 1973, 1979]. While Crosby [1979] referred early on to a “maturity grid,” the notion of maturity models became especially popular with the emergence of the CMM in the late 1980s. It seems as if academic interest in developing and researching maturity models has grown continuously since then, and this is also supported by our literature analysis in which we further studied the number and distribution of maturity model articles per year. For that purpose, we not only considered the outlets these articles were published in, but also their research areas and methodological backgrounds again.

Findings

Our results indicate that the level of publication activity has generally been increasing over the past fifteen years. During the period 1996–1998 only eight maturity model papers were published in the IS domain, compared to thirteen from 1999–2001, fifteen from 2002–2004, twelve from 2005–2007, and twenty-eight from 2008–2010. 2008 was the year with the highest number of articles. In sum, the number of publications in journals and conference proceedings is equally distributed over this timeframe (Figure 1).

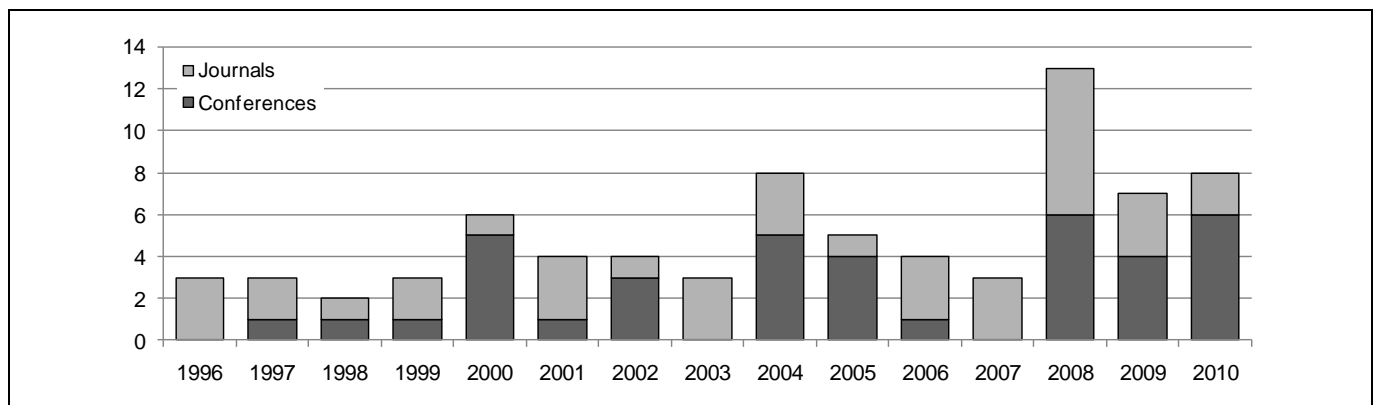


Figure 1. Distribution of Articles Across Journals and Conferences per Year

As to the contents of these articles, the generally very popular research area *IS development* was covered less frequently in more recent years. In contrast, the research theme *IT and organizations* has come into the focus of

maturity model research. The rare contributions in the fields of *IT and markets* and *IT and individuals* are more or less equally spread across the entire time frame of our analysis (Figure 2).

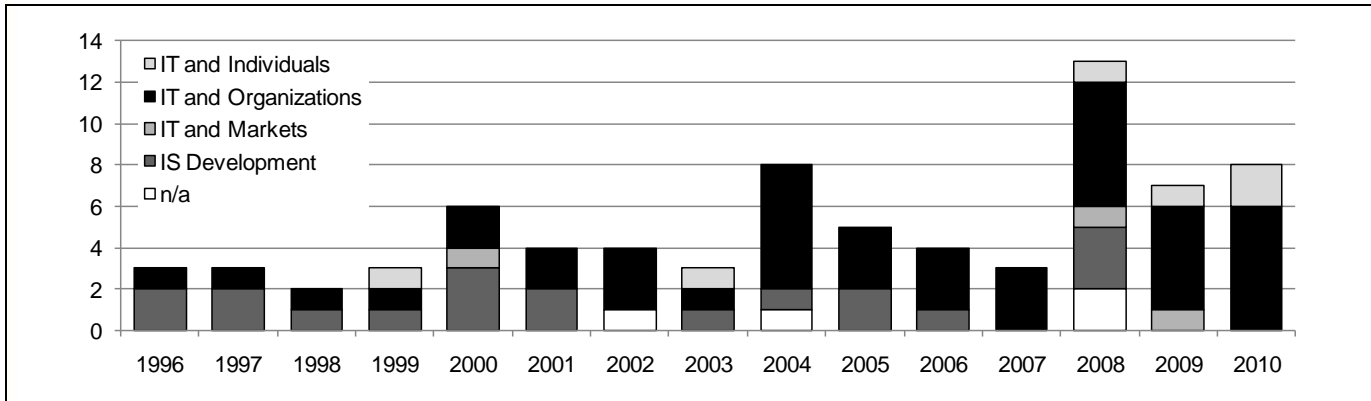


Figure 2. Distribution of the Articles' Research Areas per Year

As to their methodological backgrounds, the share of purely conceptual articles, which never amounted to more than two per year, has generally been decreasing in the recent past. Instead, empirical or conceptual-empirical works have gained momentum in IS research. In the years 2009 and 2010, there was not a single article without any empirical elements (Figure 3).

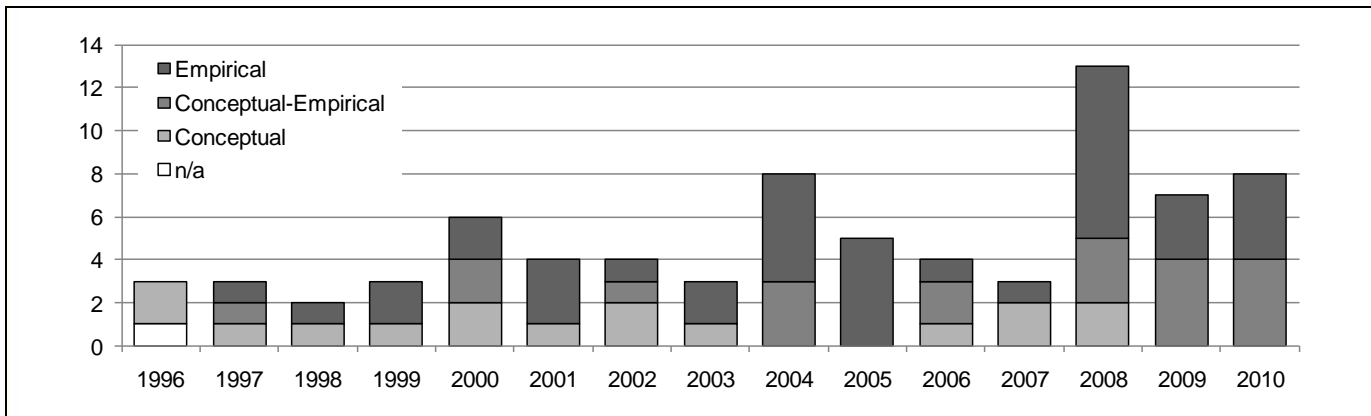


Figure 3. Distribution of the Articles' Methodological Backgrounds per Year

Implications

Our results confirm that maturity models are increasingly absorbing the interest of IS researchers, which perhaps indicates that the topic currently offers good prospects for authors in the field. The numbers might also connote an increasing interest on the part of journal editors, conference track chairs, and reviewers of the IS community in maturity models. However, although general interest has grown, one of the considered research areas seems to have become out-of-date, namely that of *IS development*. In contrast, *IT and organizations* has become the central topic in maturity model research. This trend confirms what Baskerville and Myers already termed in 2002 “a steady shift within IS from what was a techno-centric focus to a better balanced technology/organizational/management/social focus” [Baskerville and Myers, 2002, p. 11]. As *IS development* has become less attractive as a research area, purely conceptual work has abated, too.

Based on our findings, authors (role 3) can reflect if their intended publications are in areas of past (and thus possibly bygone), present, or future (and thus prospectively promising) interest. For example, the few existing studies on *IT and individuals* from the years 2008 to 2010 suggest that this may be a research area of growing interest and popularity among IS researchers. With regard to methodological issues, the findings indicate that rigorous research on maturity models is currently expected to include some kind of empirical proof. Authors in the field should accordingly substantiate their models with a theoretical foundation and empirical evidence.

Editors and reviewers (role 4) should both challenge and support authors in the above mentioned aspects. They can use the results to inform themselves about the theoretical and methodological state-of-the-art, which might help them to better assess submissions handed in and categorize them according to specific theoretical and



methodological standpoints. In this way, they can give authors helpful advice how to advance their papers on maturity models.

In Which Geographical Communities Is the Maturity Model Concept Discussed Most? (B.2)

Approach

North America and Europe can be considered the two continents that dominate the discipline of IS [Benbasat and Weber, 1996]. Both geographic regions have brought their own views on IS research into our community, and this has provided us with a broad range of research fields and various accepted ways of studying IS phenomena [Benbasat and Weber, 1996]. In order to identify where the discussion on IS maturity models is mainly located, we coded each article according to the country and continent of the first author's affiliation. We also tracked the location of additional authors and further examined the composition of the author teams (following the example of prior meta-analyses in the IS domain, e.g., Peffers and Hui [2003] and Wareham et al. [2005]).

Findings

As it is the case for IS research in general, North American and European researchers also dominate the discussion on IS maturity models (Figure 4). North Americans have contributed forty-one articles (54 percent) and Europeans twenty-two articles (29 percent). Contributions from other continents are rather scarce but have recently increased in number (Figure 5).

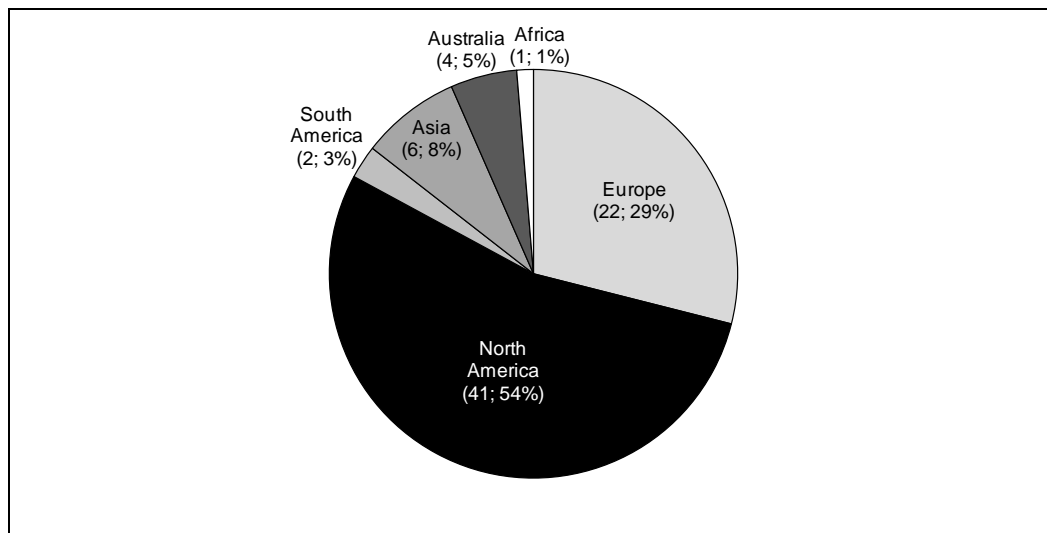


Figure 4. Distribution of Articles Across Continents

The study of maturity models is often a collaborative endeavor. Only sixteen of the identified papers are single-authored, while teams of two (#29) or three authors (#22) can be found most often. On top of that, there are also teams of four (#5), five (#2), and even six (#6) authors. Only ten papers have authors from different countries. In total, 184 IS authors from twenty-two different countries contributed to our sample of seventy-six articles.

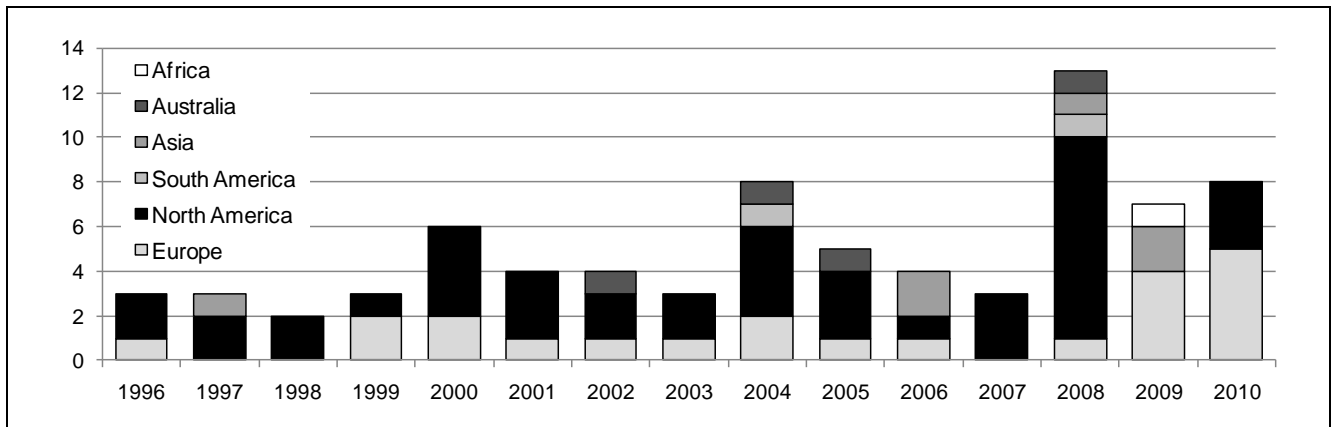


Figure 5. Distribution of Articles Across Continents per Year

Comparing the two dominant IS communities in Europe and North America with regard to research areas, we see that *IS development* is more popular in North America. In Europe, only two Danish studies, which were published in the second half of the 1990s, addressed this particular field of research. *IT and organizations* dominates maturity model research in both continents, but to a larger percentage in Europe (Figure 6).

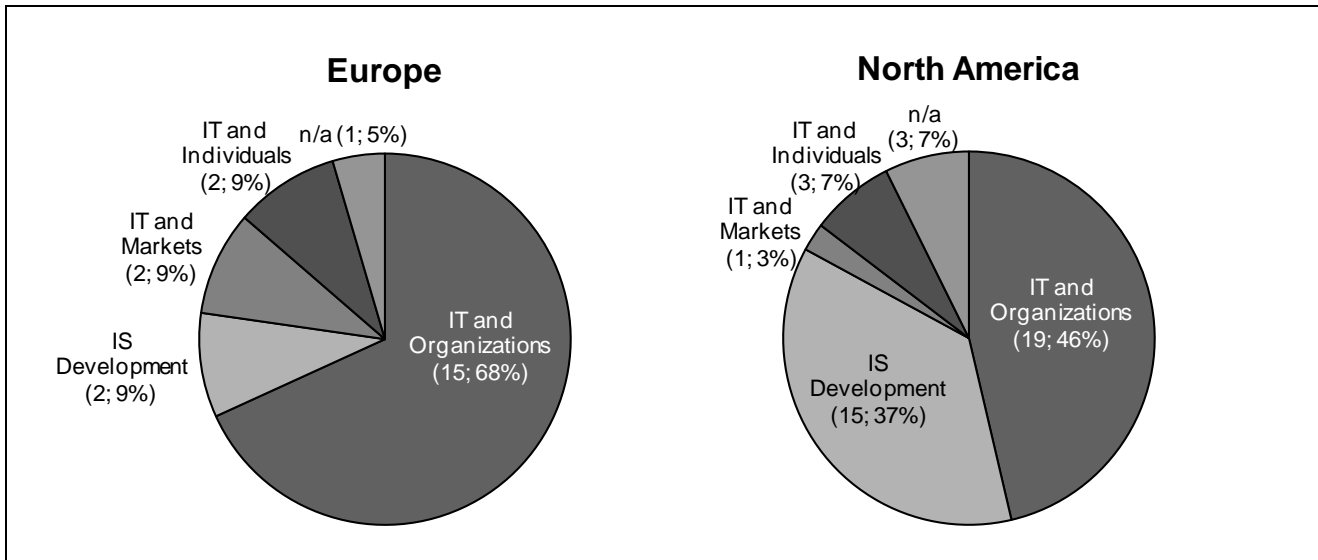


Figure 6. Distribution of Research Areas in Europe and North America

Implications

Our results indicate that in the late 1990s and early 2000s in particular, North American authors published extensively on the CMM and its influence on software project success. At that time, the concept of maturity models particularly gained momentum in the IS discipline and increasingly absorbed IS researchers' interest. Europeans, except for few Danish researchers, did not participate in this particular research stream. Later on, the maturity model concept was increasingly adopted by Europeans and North Americans alike. They also transferred the concept to other research areas, especially *IT and organizations*, and left the area of *IS development* behind.

Authors (role 3) have to reflect whether the notion of maturity models, which was obviously coined in North America, is easily transferable to other continents. We see potential for future publications of studies that examine whether maturity models (e.g., for software processes, business intelligence systems, or business process management) that were developed with a certain geographical background also fit other regions and cultures (e.g., emerging countries). In addition, maturity models that are similar as regards content but have different geographical backgrounds could be compared in order to analyze if there are varying views on desired ways of organizational change.

Editors and reviewers (role 4) should bear in mind that the applicability of maturity models may be dependent on the geographical background they were developed in, and, therefore, should require authors to define the boundaries of their research.

Which IS Publication Outlets Are Most Receptive to Maturity Model Research? (B.3)

Approach

There is a remarkable number of outlets that publish IS research. The journal ranking shared by the AIS and edited by Carol Saunders, for example, includes an impressive number of academic journals that IS researchers can submit their papers to [AIS, 2011]. Conferences also attract many IS researchers, enabling them to present and discuss their work at the venue and publish it in the conference proceedings. The outlets vary regarding preferred research themes, paradigms, and methods, and hence, they may also vary in their receptiveness of maturity model studies. We analyzed our sample accordingly.

Findings

Eleven of the seventy-six articles were published in journals within the AIS Senior Scholars' Basket [AIS, 2007], of which only one has not yet issued a paper on maturity models (*Journal of Strategic Information Systems*). Another five of Walstrom and Hardgrave's [2001] pure IS journals, namely the *ACM Transactions on Information Systems*, *Decision Support Systems*, *Information Systems*, *the Journal of Database Management*, and the *Journal of*



Information Technology Management, have not yet published maturity model research (Table 1). In absolute terms, *Information Systems Management (ISM)* has issued most maturity model articles (#10), followed by *Information & Management (I&M; #5)*. Regarding the conferences that were considered, twenty-seven papers were presented at the Americas Conference on Information Systems (AMCIS), while only eleven maturity model papers were included in the proceedings of the European (#5), International (#3), Mediterranean (#1) and Pacific Asian (#2) Conferences on Information Systems. Because this can also be due to the larger quantity of AMCIS papers shared by the AIS electronic library (as compared to its coverage of other conference proceedings), we further calculated the number of maturity model articles as a percentage. In percentage terms, *ISM* and the *Journal of Information Technology* published most maturity model papers (>1 percent). The IS conferences that have, as a percentage, published most maturity model research are the Mediterranean Conference on Information Systems (0.6 percent), the European Conference on Information Systems (ECIS; 0.5 percent), and the AMCIS (0.4 percent). Figure 7 charts the values of all IS outlets in which at least two articles on maturity models have been published.

Implications

The above results suggest that research on maturity models can be considered well-established in the IS discipline. Although the scope of our literature search was quite limited—we used only the search terms maturity model, stage model, and stages-of-growth model—we were able to identify a sample of articles that was substantially large (#76). Only a few of the outlets we searched have not yet published any articles on maturity models. In general, journals and conferences seem to be equally receptive to such papers. Furthermore, articles that suggest new models are almost equally distributed (thirty-five articles in total, seventeen in journals, eighteen in conference proceedings).

Authors (role 3) can make the decision on where to publish their maturity model research based on the presented findings. For example, the journals *ISM* and *I&M*, as well as AMCIS and ECIS, have a considerable history of works on this topic. At AMCIS alone, twenty-seven of the papers presented during the last fifteen years dealt with maturity models; eleven of them proposed new maturity models. In the same period, the *ISM* journal published ten research papers, five of which contained new maturity models. At ECIS comparatively many new models were suggested (in four out of five papers). This is, for example, different for the *I&M* journal, which also published five articles, but only one featured a new maturity model.

Reviewers and editors (role 4) can use these results to evaluate if articles under review have sufficiently referenced the existing body of knowledge on maturity models. In particular, they can assess to what extent the submitted work exceeds related studies on maturity models, especially of the outlet that was chosen for submission. They can also reflect to what extent their outlet has already participated in the academic discussion on maturity models and if this should be changed in the future.

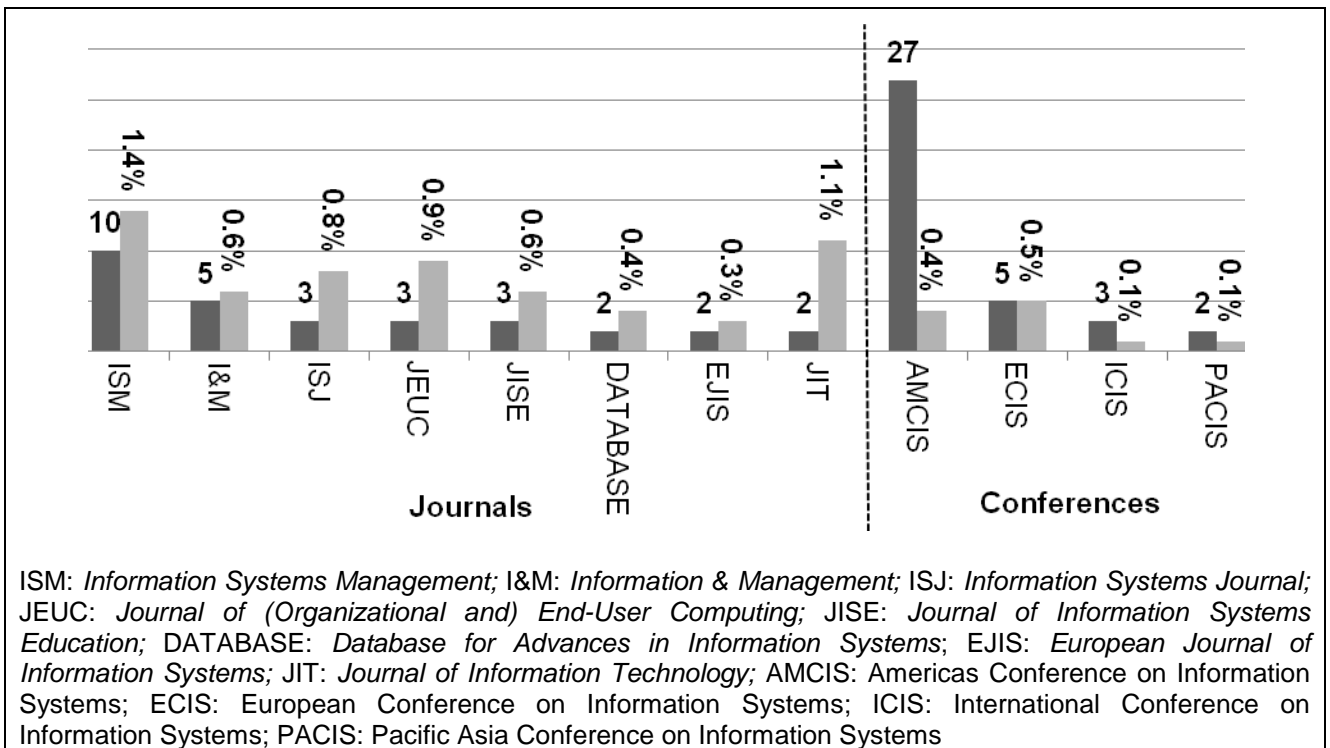


Figure 7. Absolute and Relative Numbers of Maturity Model Articles

VI. PRACTICE PERSPECTIVE

What Are the Practical Implications of Past Maturity Model Research? (C.1)

Approach

The previous chapters have already given a detailed overview about the last fifteen years of maturity model research in the IS discipline. In the following, we will distill the key insights from the academic discussion that are relevant for practice. As such, we go beyond the meta-analysis of the literature to review and synthesize the articles' implications for practice.

Findings

Our study discovered a variety of approaches to maturity model research in the IS domain. For instance, new maturity models are developed [e.g., Rosemann and de Bruin, 2005; Rudolph and Krcmar, 2009; Teah et al., 2006], the effectiveness of maturity models for assessing and improving organizational capabilities is examined [e.g., Jiang et al., 2004; Ramasubbu et al., 2008], or maturity models are taken as the basis for researching organizational change processes [e.g., Ply et al., 2008; Prananto et al., 2004]. Maturity models are developed especially in the areas of *IS development* and *IT and organization*. Within these areas, they address a wide range of domains, e.g., software engineering [CMMI Product Team, 2010; Paulk, 1995; Paulk et al., 1993; Vadapalli, 1998], project management [Crawford, 2006], or business process management [Rohloff, 2009; Rosemann and de Bruin, 2005]. Often, similar models are suggested for the same domain [Kulkarni and Freeze, 2004; Teah et al., 2006]. Against this background, the current academic discussion concentrates on questions of how to improve the theoretical grounding and empirical validity of maturity models [Solli-Sæther and Gottschalk, 2010]. Purely conceptual works are becoming less frequent as academia attempts to substantiate maturity models with case studies and surveys.

Implications

Maturity models have stimulated much research that, however, has resulted in inconsistent and conflicting findings [Prananto et al., 2003]. In spite of this, maturity models are still considered useful by many academics, they have been widely adopted, and they are constantly growing in number [Solli-Sæther and Gottschalk, 2010]. However, we also see a lack of ready-to-use documentation of maturity models. Academic articles often present new maturity models as a rough sketch that would not suffice for practical application. So far, academics often fall short in providing detailed guidelines and helpful (software-based or online) toolkits to support the practical adoption of models developed in academia.

Considering the many maturity models that are available for very different application domains, users in organizations (role 5) can be confident that they will find a model that addresses the area of organizational capabilities they are interested in. They may even find a multitude of potentially appropriate models. Therefore, the adopters of maturity models from practice often will have to carefully scan and evaluate what has already been published in academic journals and conference proceedings. However, users should also be careful, because some models may not have proven useful yet or do not provide sufficient assessment guidelines for application in practice. Therefore, one of the main challenges for users is to identify a reliable, fitting, and ready-to-use model.

Consultants and assessors (role 6) who adopt and develop maturity models in order to consult and assess organizations can also benefit from the ongoing academic discussion. Insights from academia can help them to better substantiate the models they use for providing consulting and certification services. Typically, they use maturity models as diagnostic tools at the beginning of a consulting project or for certifications of specific capabilities. In order to differentiate themselves from competitors, they often design new models instead of adopting existing ones. In this case, consultants can utilize the guidelines for maturity model development that have recently been published in academia [Becker et al., 2009; de Bruin et al., 2005; Maier et al., 2009; Mettler, 2010; Solli-Sæther and Gottschalk, 2010]. They may increase the popularity and acceptance of their models by adopting academic approaches and documenting how the models have been developed, and to which degree they have been checked for applicability [Rosemann and Vessey, 2008]. Furthermore, the results can help consultants and assessors to identify and evaluate existing models that they can adopt for providing consulting services. The analysis suggests that there are many maturity models for very different purposes. Accordingly, this would help to avoid the reinvention of existing maturity models and could also inform the advancement of available maturity models on the basis of the experiences gained through application.

What Are the Critical Aspects of the Maturity Model Concept That May Diminish Its Applicability in Practice? (C.2)

Approach

Maturity models have "not been untroubled by criticism" [Mettler, 2010, p. 78]. In particular, many IS researchers criticized maturity models for being "step-by-step recipes" [McCormack et al., 2009] that oversimplify reality and lack

empirical foundation [Benbasat et al., 1984; de Bruin et al., 2005; King and Kraemer, 1984; McCormack et al., 2009]. Despite this critique, maturity models still prosper in IS practice. The following intends to make practitioners aware about potential pitfalls that are observable from the papers we reviewed.

Findings

In our sample, the paper by Solli-Sæther and Gottschalk [2010] identifies three general challenges for IS research on maturity models: (1) the large extent of conceptual research, (2) the empirical assessment of stages, and (3) the practical nonexistence of one linear sequence of stages in organizational life. These aspects are in line with criticism that has also been expressed elsewhere [e.g., Becker et al., 2009; Benbasat et al., 1984; de Bruin et al., 2005; King and Kraemer, 1984; McCormack et al., 2009; Mettler and Rohner, 2009]. In all the other papers we reviewed, critical remarks refer directly to the applicability and reliability of existing models, especially the CMM and the CMMI respectively. Swinarski et al. [2008, p. 1], for instance, observe that “no consensus on how to best operationalize CMM-based process capability” has been reached, and call “for greater rigor in the measurement and conceptualization of CMM-based process capability in the academic literature.” Purvis et al. [1998] write that the CMM is less comprehensive than other models, as it neglects certain IS functions beyond software development. Huang and Han [2006, p. 297] claim that adopters of the continuous CMMI representation are left without guidance how to select a “suitable path that best meets their business objectives and mitigates the organization’s risk.” Jiang et al. [2004, p. 279] conclude that not all of the CMM levels demonstrate observable benefits, indicating that “greater caution is needed in the planning and implementation of the activities.” Khaiata and Zualkernan [2009, p. 151] indirectly criticize Luftman’s [2003] Strategic Alignment Maturity Model by developing a “simple, flexible and ... easy-to-deploy” instrument to make the model more applicable for practice.

Implications

As all articles in our sample deliberately deal with maturity models, it was difficult to identify any substantive critique on the maturity model concept in general. An exception is the paper by Solli-Sæther and Gottschalk [2010], who point to problems of conceptual research, lacking empirical validity, and the possible misfit between one single maturation path and the truth of organizational change.

Model users (role 5) should take existing criticism into account when selecting a maturity model for assessing their organization. They can, for instance, take the critical aspects we identified in this review as selection criteria, for example, the empirical validity and the availability of ready-to-use assessment instruments. A model’s positive empirical validation would support a claim that assessments can provide reliable interpretations and allow for the reasonable identification of improvement measures alike. Users should also be aware that high-level models may not be able to respect organization-individual settings per se [Mettler and Rohner, 2009]. They should accordingly apply a critical perspective on existing models and interpret maturity assessment results against their individual background, strategy, and organizational environment.

Consultants and assessors (role 6) who adopt and develop maturity models for providing consulting services should reflect on the critique that is present in IS research, too. They might want to utilize the advice IS researchers give for model development and application. For example, when creating their own models, they could think about including a contingency perspective to organizational change [Teo and King, 1997]. On the other hand, they can make valuable contributions to the critical discussion of maturity models in IS research themselves. In particular, they can help to reflect on the design of maturity models as well as on their application success, disclosing what actually makes a maturity model successful in practice.

VII. CONCLUSIONS

The intention of this literature analysis was to inform both researchers and practitioners about the current state of maturity model research in the IS domain. We took three perspectives on the analysis of the literature and outlined a set of research questions that deserve attention for each of these perspectives. A summary of the key findings and implications regarding the three perspectives (P) and the considered research questions (R) is given in Table 4.

Hopefully, our results can stimulate and guide future research in the field and inform the development and usage of theoretically sound maturity models in practice. As to the research perspective, we informed maturity model designers (role 1) and organizational theorists (role 2) about theoretical and methodological aspects of maturity models, as well as about the areas and themes that can still be considered under-researched. Researchers can use these findings for the development of maturity models that are better grounded in theory, result from a well-thought research methodology, and cover as yet under-researched areas and themes. Also, the longitudinal analysis of organizational change processes and their mapping to maturity models could come into the focus of fellow researchers. As to the publication perspective, which reflected the views of potential authors (role 3)

Table 4: Study Findings and Implications

P	R	Findings	Implications
A. Research	A.1 Theory	<ul style="list-style-type: none"> • CMM and its successor CMMI are the dominant foundations of past maturity model research. • Only a few of the reviewed papers refer to existing theories as a foundation of research. 	<ul style="list-style-type: none"> • <i>Maturity model designers</i> should to a greater extent refer to the existing body of theoretical knowledge for defining both the maturing entity and the rationale of maturation. • <i>Organizational theorists</i> should advance the theoretical basis for future research on maturity models.
	A.2 Methodology	<ul style="list-style-type: none"> • Maturity model research features both empirical (#39) and conceptual (#17) works; some papers are a combination of both (#19). • 35 out of 76 papers propose new maturity models. • Qualitative methods are the dominant strategy for the design of empirically-grounded maturity models. 	<ul style="list-style-type: none"> • <i>Maturity model designers</i> should take into account available guidelines for the design of maturity models. • <i>Organizational theorists</i> should engage in the longitudinal analysis of organizational change processes which are described by maturity models.
	A.3 Content	<ul style="list-style-type: none"> • The area <i>IT and organizations</i> dominates past maturity model research (#44), followed by <i>IS development</i> (#19). • There are only few papers with a focus on <i>IT and individuals</i> (#6) and <i>IT and markets</i> (#3); there are none in the area of <i>IT and groups</i>. • 29 of the 100 IS research themes identified by Sidorova et al. [2008] are covered by the 76 considered articles. 	<ul style="list-style-type: none"> • <i>Maturity model designers</i> should pursue integration efforts in the most popular research areas and further engage in as yet under-researched domains. • <i>Organizational theorists</i> can refer to concepts and items discussed in past maturity model research for building and evaluating theories of organizational change and IT adoption.
B. Publication	B.1 Development	<ul style="list-style-type: none"> • Publication activity has generally been increasing over the last fifteen years. • While the interest in the area of <i>IS development</i> has been decreasing, <i>IT and organizations</i> has come into the focus of researchers. • The number of purely conceptual articles is decreasing. 	<ul style="list-style-type: none"> • <i>Authors</i> are increasingly required to augment their models with empirical evidence and should reflect if an intended publication is in an area of past, present, or future interest. • <i>Editors and reviewers</i> should evaluate submissions based on the theoretical and methodological state-of-the-art in the field.
	B.2 Geography	<ul style="list-style-type: none"> • Researchers from North America and Europe dominated the past discussion on maturity models in the IS domain. • The area of <i>IS development</i> has been more popular in North America than in Europe. 	<ul style="list-style-type: none"> • <i>Authors</i> should reflect whether maturity models are transferable to different geographical regions (e.g., emerging countries). • <i>Editors and reviewers</i> are well-advised to assess maturity model articles against the geographical and cultural background.
	B.3 Outlets	<ul style="list-style-type: none"> • 11 articles on maturity models were published within the AIS Senior Scholars' Basket of Journals. • As for the considered journals, ISM has published most articles (#10), followed by I&M (#5). • As for the considered conferences, 27 papers have been presented at AMCIS and 5 papers at ECIS. 	<ul style="list-style-type: none"> • <i>Authors</i> can check if their intended publication outlet is receptive to maturity model research. • <i>Editors and reviewers</i> can use the provided overview of maturity model articles across years and outlets to reflect on the current state of the academic discussion in the field.
C. Practice	C.1 Implications	<ul style="list-style-type: none"> • Maturity models have been widely adopted in practice and are constantly growing in number. • In some application domains very similar maturity models exist. • The academic discussion currently concentrates on how to improve the theoretical grounding and empirical validity of maturity models. 	<ul style="list-style-type: none"> • <i>Maturity model users</i> are increasingly challenged to identify a reliable, fitting, and ready-to-use model for their organizations because of the vast number of existing models. • <i>Consultants and assessors</i> should consider guidelines from academia for maturity model design and application in practice.

Table 4: Study Findings and Implications – Continued

C. Practice	C.2 Critique	<ul style="list-style-type: none"> • The applicability and reliability of maturity models is subject to criticism. • The results support Solli-Sæther and Gottschalk [2010] who identify three major shortcomings of maturity model research: the large extent of conceptual research, the empirical assessment of stages, and the practical nonexistence of one linear sequence of stages in organizational life. 	<ul style="list-style-type: none"> • <i>Maturity model users</i> may apply the identified critical aspects as criteria for maturity model selection (e.g., the empirical validity of a model and the availability of ready-to-use assessment instruments). • <i>Consultants and assessors</i> can make a valuable contribution to theory and practice by giving their feedback on the design of maturity models and their application success.
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as well as editors and reviewers (role 4) of maturity model articles, we analyzed the number and distribution of academic articles in the IS domain, which hopefully will support more efficient reviewing and publication processes in the future. Finally, as to the practitioner’s perspective, which covered aspects relevant to maturity model adopters (role 5), as well as consultants and assessors (role 6), future research should aim at providing better support for the selection and application of maturity models. It might also be beneficial for IS researchers to establish a constant dialogue with practitioners, who can make a valuable contribution to theory by reflecting on the design process and application success of maturity models.

We are confident that our analysis can help interested parties from all the three considered perspectives to better understand the variety of extant maturity model research. IS research on maturity models is by far not limited to the popular examples of Nolan’s Stage Theory and the CMM(I) that both have heavily impacted research and practice. We identify maturity model research in the IS discipline as a study field of great relevance to practice that still bears a wide range of research potentials to be exploited. Indeed, IS research increasingly tries to develop theories, conceptualizations, methods, and models of maturity independent from existing popular blueprints. Against this background, we believe that our study provides a helpful starting point for the various directions of future research on maturity models in IS.

The findings presented here are confronted with certain limitations. First, because we intended to focus on IS publications with our study, we searched in specific journals and conferences only. It is very likely that a database search without such a restriction would reveal additional publications that are potentially relevant. However, it should be noted that we also considered some seminal papers from other than the selected outlets, which attracted our attention in our prior research on maturity models (e.g., guidelines on the design of maturity models [Becker et al., 2009; de Bruin et al., 2005], reflections on the empirical validity of maturity models [King and Kraemer, 1984; McCormack et al., 2009], or research on configurable maturity models [Mettler and Rohner, 2009]). Because we examined a considerable set of IS journals and conference proceedings, we believe that the extent of our search is well capable of providing a solid depiction. Nevertheless, there is potential for extending the literature search to other than the selected IS publication outlets (e.g., non-AIS-affiliated conferences and additional IS journals). We are confident that we selected appropriate search terms for discovering the majority of relevant contributions on maturity models in the considered outlets. Nevertheless, additional search phrases could increase the total number of hits and might uncover a few more relevant papers. Moreover, during the course of analyzing our sample, categorizing the papers was not always simple. We believe that we selected and justified well-founded categorizations that delivered valuable insights into the spectrum of IS research on maturity models. Admittedly, other categorizations would have led to diverging results. Finally, we approached the literature analysis with specific perspectives, research questions, and roles in mind. We believe that these perspectives, and the assigned roles respectively, fairly represent the typical stakeholders of such a literature analysis. However, our intention was neither to claim that this selection is mutually exclusive and exhaustive, nor to exclude other parties that are potentially interested in the topic.

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1. These links existed as of the date of publication but are not guaranteed to be working thereafter.

2. The contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
3. The author(s) of the Web pages, not AIS, is (are) responsible for the accuracy of their content.
4. The author(s) of this article, not AIS, is (are) responsible for the accuracy of the URL and version information.

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APPENDIX A: RESULTS OF THE KEYWORD SEARCH

Table A-1: List of Relevant Articles

Authors	Title	Year	Publication
O. Adelakun	IT Outsourcing Maturity Model	2004	<i>Proceedings of the European Conference on Information Systems (ECIS)</i> , Turku, Finland
F. Alonso-Mendo, G. Fitzgerald, E. Frias-Martinez	Understanding Web Site Redesigns in Small- and Medium-sized Enterprises (SMEs): A UK-Based Study on the Applicability of E-commerce Stage Models	2009	<i>European Journal of Information Systems</i> (18)3, pp. 264–279
Y.L. Antonucci, G. Corbitt, G. Stewart, A.L. Harris	Enterprise Systems Education: Where Are We? Where Are We Going?	2004	<i>Journal of Information Systems Education</i> (15)3, pp. 227–234
N. Ashrafi	The Impact of Software Process Improvement on Quality: In Theory and Practice	2003	<i>Information & Management</i> (40)7, pp. 677–690
J. Avritchir, R. Prikladnicki, R. Evaristo, J. Audy	A Maturity Model for Offshore Insourcing: A Research Proposal	2004	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , New York, NY
B. Bahli	Toward a Capability Maturity Model for the Management of Outsourcing Information Services	2004	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , New York, NY
B. Bahli	A Capability Maturity Model of Information Technology Outsourcing Relationships: A Vendor Perspective	2010	<i>Proceedings of the Mediterranean Conference on Information Systems (MCIS)</i> , Tel-Aviv, Israel
S.A. Becker, R. Gibson	An Information Abstraction Model for End User CASE Support	1997	<i>Journal of End User Computing</i> (9)1, pp. 28–34
L.J. Calloway, P.G. W. Keen	Organizing for Crisis Response	1996	<i>Journal of Information Technology</i> (11)1, pp. 13–26
D.Q. Chen, D.S. Preston, W. Xia	Antecedents and Effects of CIO Supply-Side and Demand-Side Leadership: A Staged Maturity Model	2010	<i>Journal of Management Information Systems</i> (27)1, pp. 231–272
J. Chen, R.J. McQueen	Factors Affecting E-Commerce Stages of Growth in Small Chinese Firms in New Zealand	2008	<i>Journal of Global Information Management</i> (16)1, pp. 26–60
S. Conger, M.A. Winniford, L. Erickson-Harris	Service Management in Operations	2008	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Toronto, Canada
I. Cottam, P. Kawalek, D. Shaw	A Local Government CRM Maturity Model: A Component in the Transformational Change of UK Councils	2004	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , New York, NY
J.K. Crawford	The Project Management Maturity Model	2006	<i>Information Systems Management</i> (23)4, pp. 50–58
J. Damsgaard, R. Scheepers	Managing the Crises in Intranet Implementation: A Stage Model	2000	<i>Information Systems Journal</i> (10)2, pp. 131–149

Table A-1: List of Relevant Articles – Continued

Authors	Title	Year	Publication
R.M. Davison, M.G. Martinsons, C.X.J. Ou, K. Murata, D. Drummond, Y. Li, H.W.H. Lo	The Ethics of IT Professionals in Japan and China	2009	<i>Journal of the Association for Information Systems</i> (10)11, pp. 834–859
S. Dekleva, D. Drehmer	Measuring Software Engineering Evolution: A Rasch Calibration	1997	<i>Information Systems Research</i> (8)1, pp. 95–104
B. Dinter, M. Goul	The Impact of National Culture on Business Intelligence Maturity Models	2010	<i>Proceedings of the International Conference on Information Systems (ICIS)</i> , St. Louis, MO
D. Drinka, M.Y.M. Yen	Controlling Curriculum Redesign with a Process Improvement Model	2008	<i>Journal of Information Systems Education</i> (19)3, pp. 331–342
A. Duane, P. Finnegan	Managing Empowerment and Control in an Intranet Environment	2003	<i>Information Systems Journal</i> (13)2, pp. 109–206
C.A. Estay-Niculcar, J.A. Pastor-Collado	A Maturity Model for Information Systems Action-research Project Management	2002	<i>Proceedings of the European Conference on Information Systems (ECIS)</i> , Gdansk, Poland
A. Gorgeon	Evolution of the Role of Change Agent for CIOs During Their Time in Office	2010	<i>Proceedings of the International Conference on Information Systems (ICIS)</i> , St. Louis, MO
P. Gottschalk, V.K. Khandelwal	Stages of Growth for Knowledge Management Technology in Law Firms	2004	<i>Journal of Computer Information Systems</i> (Summer 2004), pp. 111–124
P. Gray	IS Productivity	1996	<i>Information Systems Management</i> (13)2, pp. 92–95
N. Gronau, P. Heinze, J. Bahrs	Iterative Development of Professional Knowledge Intensive Business Processes	2010	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Lima, Peru
V. Grover, A.H. Sears	An Empirical Evaluation of Stages of Strategic Information Systems Planning: Patterns of Process Design and Effectiveness	2005	<i>Information & Management</i> (42)5, pp. 761–779
R. Hackney, J. Kawalek, G. Dhillon	Strategic Information Systems Planning: Perspectives on the Role of the “End-user” Revisited	1999	<i>Journal of End User Computing</i> (11)2, pp. 3–12
B. Hardgrave, A.R. Taylor, J.A. Kidd	The Long Road to Software Process Improvement: A Chronology of One Company’s Efforts	2000	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Long Beach, CA
S. Hassan, K. Sherdil	A Contingency Based Capability Maturity Model for Developing Countries	1997	<i>Proceedings of the Pacific Asia Conference on Information Systems (PACIS)</i> , Brisbane, Australia
P. Hawking, J. Fisher	The State of Play of the Websites of Large Australian Companies	2002	<i>Proceedings of the European Conference on Information Systems (ECIS)</i> , Gdansk, Poland
A. Hochstein, Y. Zhu	ICT Transformation in China After Its WTO Entry: Lessons from the Tobacco Industry	2008	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Toronto, Canada
C.P. Holland, B. Light, P. Beck, Y. Berdugo, R. Millar, N. Press, M. Setlavad	An International Analysis of the Maturity of Enterprise Resource Planning (ERP) Systems Use	2000	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Long Beach, CA
C.P. Holland, B. Light	A Stage Maturity Model for Enterprise Resource Planning Systems Use	2001	<i>Database for Advances in Information Systems</i> (32)2, pp. 24–45
S.-J. Huang, W.-M. Han	Selection Priority of Process Areas Based on CMMI Continuous Representation	2006	<i>Information & Management</i> (43)3, pp. 297–307
Z. Huang	A Comprehensive Analysis of US countries’ e-Government Portals: Development Status and Functionalities	2007	<i>European Journal of Information Systems</i> (16)2, pp. 149–164

Table A-1: List of Relevant Articles – Continued

Authors	Title	Year	Publication
J. Ingalsbe, D. Shoemaker, V. Jovanovic	A Metamodel for the Capability Maturity Model for Software	2001	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Boston, MA
J. Iversen, P. Nielsen, J. Norbjerg	Situated Assessment of Problems in Software Development	1999	<i>Database for Advances in Information Systems</i> (30)2, pp. 66–81
M. Janssen, J. Gortmaker, R.W. Wagenaar	Web Service Orchestration in Public Administration: Challenges, Roles, and Growth Stages	2006	<i>Information Systems Management</i> (23)2, pp. 44–55
A. Jeyaraj, A. Sengupta, V. Sethi	Stages in Adoption of RFID Innovations by Organizations: Identifying Facilitators and Inhibitors	2008	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Toronto, Canada
J.J. Jiang, G. Klein, H.-G. Hwang, J. Huang, S.-Y. Hung	An Exploration of the Relationship Between Software Development Process Maturity and Project Performance	2004	<i>Information & Management</i> (41)3, pp. 279–288
T. Keim, J. Malinowski, T. Weitzel	Bridging the Assimilation Gap: A User Centered Approach to IT Adoption in Corporate HR Processes	2005	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Omaha, NE
M. Khaiata, I.A. Zuelkarnan	A Simple Instrument to Measure IT-Business Alignment Maturity	2009	<i>Information Systems Management</i> (26)2, pp. 138–152
C. Kruger, R. Johnson	Enablers of South African Knowledge Management Maturity: Issues, Principles and Policies	2009	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , San Francisco, CA
S.B. Lee, S. Shiva	Comparing Agent Software Development Methodologies Using the CMMI Engineering Process Model	2005	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Omaha, NE
M. Leih	The Impact of the Sarbanes-Oxley Act on IT Project Management: A Case Study	2005	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Omaha, NE
J. Luftman	Assessing IT-Business Alignment	2003	<i>Information Systems Management</i> (20)4, pp. 9–15
S.R. Magal, P. Koslage, N.M. Levenburg	Towards a Stage Model for E-Business Adoption Among SMEs: Preliminary Results for Manufacturing and Service Firms	2008	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Toronto, Canada
A.M. Magdaleno, C. Cappelli, F.A. Baiao, F.M. Santoro, R. Araujo	Towards Collaboration Maturity in Business Processes: An Exploratory Study in Oil Production Processes	2008	<i>Information Systems Management</i> (25)2, pp. 302–318
L. Mathiassen, C. Sørensen	The Capability Maturity Model and CASE	1996	<i>Information Systems Journal</i> (6)3, pp. 195–208
E. McGuire	Software Team Development in the Capability Maturity Model	1999	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Milwaukee, WI
E.G. McGuire, E.A. McKeown	A Case Study of Strategic Metrics Use in a CMM-Based Outsourcing Environment	2000	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Long Beach, CA
N. Mehta, S. Oswald, A. Mehta	Infosys Technologies: Improving Organizational Knowledge Flows	2007	<i>Journal of Information Technology</i> (22)4, pp. 456–464
M.H. Ofner, K.M. Hüner, B. Otto	Dealing with Complexity: A Method to Adapt and Implement a Maturity Model for Corporate Data Quality Management	2009	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , San Francisco, CA
D.D. Phan	Software Quality and Management	2001	<i>Information Systems Management</i> 18(1), pp. 56–67
J.K. Ply, J.E. Moore, J. Thatcher	Impact of the Journey: IS Employee Attitudes and Perceptions as Organizations Climb the CMM Ladder	2008	<i>Proceedings of the International Conference on Information Systems (ICIS)</i> , Paris, France
R.L. Purvis, J. Santiago, V. Sambamurthy	An Analysis of Excluded IS Processes in the Capability Maturity Model and Their Potential Impact	1998	<i>Journal of End User Computing</i> (10)1, pp. 20–29

Table A-1: List of Relevant Articles – Continued

Authors	Title	Year	Publication
D. Raffo, W. Harrison, J. Settle, N. Eickelmann	The Role of Defect Potential in Understanding the Economic Value of Process Improvements	2000	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Long Beach, CA
D. Raffo, W. Harrison	Moving Toward CMM Levels 4 and 5: Combining Models and Metrics to Achieve Quantitative Process Management	2000	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Long Beach, CA
P. Rajagopal	An Innovation–Diffusion View of Implementation of Enterprise Resource Planning (ERP) Systems and Development of a Research Model	2002	<i>Information & Management</i> (40)2, pp. 87–114
N. Ramasubbu, S. Mithas, M.S. Krishnan, C.F. Kemerer	Work Dispersion, Process-based Learning, and Offshore Software Development Performance	2008	<i>MIS Quarterly</i> (32)2, pp. 437–458
R.L. Raschke, L.R. Ingraham	Business Process Maturity’s Effect on Performance	2010	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Lima, Peru
M. Rohloff	Process Management Maturity Assessment	2009	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , San Francisco, CA
M. Rosemann, T. de Bruin	Towards a Business Process Management Maturity Model	2005	<i>Proceedings of the European Conference on Information Systems (ECIS)</i> , Regensburg, Germany
S. Rudolph, H. Krcmar	Maturity Model for IT Service Catalogues An Approach to Assess the Quality of IT Service Documentation	2009	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , San Francisco, CA
S. Russell, M. Haddad, M. Bruni, M. Granger	Organic Evolution and the Capability Maturity of Business Intelligence	2010	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Lima, Peru
B.M. Saulnier, J.P. Landry, H.E. Longenecker Jr., T.A. Wagner	From Teaching to Learning: Learner-Centered Teaching and Assessment in Information Systems Education	2008	<i>Journal of Information Systems Education</i> (19)2, pp. 169–174
J.E. Scott	Mobility, Business Process Management, Software Sourcing, and Maturity Model Trends: Propositions for the IS Organization of the Future	2007	<i>Information Systems Management</i> (24)2, pp. 139–145
H. Solli-Sæther, P. Gottschalk	The Modeling Process for Stage Models	2010	<i>Journal of Organizational Computing and Electronic Commerce</i> (20)3, pp. 279–293
W.K. Suchan	The Organizational Information Infrastructure Maturity Model: Implications for IT	2002	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Dallas, TX
M. Swinarski, E. Jackson, R. Kishore	Conceptualization and Measurement of the Capability Maturity Model (CMM): An Examination of Past Practices and Suggestions for Future Applications	2008	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Toronto, Canada
H.Y. Teah, L.G. Pee, A. Kankanhalli	Development and Application of a General Knowledge Management Maturity Model	2006	<i>Proceedings of the Pacific Asia Conference on Information Systems (PACIS)</i> , Kuala Lumpur, Malaysia
R. Urwiler, M.N. Frolick	The IT Value Hierarchy: Using Maslow’s Hierarchy of Needs as a Metaphor for Gauging the Maturity Level of Information Technology Use Within Competitive Organizations	2008	<i>Information Systems Management</i> (25)1, pp. 83–88
A. Vadapalli	Software Reuse Management: Development of a Model in the Context of the Capability Maturity Model	1998	<i>Proceedings of the Americas Conference on Information Systems (AMCIS)</i> , Baltimore, MD

Table A-1: List of Relevant Articles – Continued

Authors	Title	Year	Publication
P. Vitharana, M. A. Mone	Measuring Critical Factors of Software Quality Management	2008	<i>Information Resources Management Journal</i> (21)2, pp. 18–37
H. Watson, T. Ariyachandra, R.J. Matyska Jr	Data Warehousing Stages of Growth	2001	<i>Information Systems Management</i> (18)3, pp. 42–50

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