

Business process maturity models: a systematic literature review

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Business Process Maturity Models: A Systematic Literature Review

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Abstract

Context: *The number of maturity models proposed in the area of Business Process Management (BPM) has increased considerably in the last decade. However, there are a number of challenges, such as the limited empirical studies on their validation and a limited extent of actionable properties of these models in guiding their application. These challenges hinder the widespread usage of the maturity models in the BPM field.*

Objective: *In order to better understand the state of the research on business process maturity models (BPMMs) and identify opportunities for future research, we conducted a systematic literature review.*

Method: *We searched the studies between the years 1990 and 2014 in established digital libraries to identify empirical studies of BPMMs by focusing on their development, validation, and application. We targeted studies on generic models proposed for business process maturity, business process management or orientation maturity, and selected 61 studies out of 2899 retrieved initially.*

Results: *We found that despite that many BPMMs were proposed in the last decade, the level of empirical evidence that reveals the validity and usefulness of these models is scarce.*

Conclusion: *The current state of research on BPM maturity is in its early phases, and academic literature lacks methodical applications of many mainstream BPMMs that have been proposed. Future research should be directed towards: (1) reconciling existing models with a strong emphasis on prescriptive properties, (2) conducting empirical studies to demonstrate the validity and usefulness of BPMMs, and (3) separating the assessment method used to evaluate the maturity level from the maturity model which acts as the reference framework for the assessment.*

Keywords: Business process management, business process orientation, maturity model, systematic literature review.

1. Introduction

Many organizations realize the importance of business processes in delivering high-quality products and services [1], [2]. However, it is still difficult to manage business processes as the basic enablers in sustaining an organization's existence. One of the primary reasons for this is the diversity of concerns, such as Business Process Reengineering, Process Innovation, Business Process Modeling, and Business Process Automation/Workflow Management, under the title of Business Process Management (BPM) [3]. In addition, a business process also requires the incorporation of an organizational focus, as it cannot create business value without aligning itself with the business strategy of the organization. These issues lead to the question of how advanced different organizations are in the development of their BPM capabilities [3].

The notion of *maturity* was first proposed by Phillip Crosby [4] and is defined as 'the state of being complete, perfect, or ready' [5]. A maturity model is a conceptual model that consists of a sequence of discrete maturity levels for a class of processes in one or more business domains, and represents an anticipated, desired, or typical evolutionary path for these processes [6]. Some disciplines adopted the concept of a maturity model as a way to appraise and improve their competence. For example, Capability Maturity Model Integration (CMMI) [7] in the area of software engineering emerged at the start of 1990s as a means to improve software development processes to achieve higher quality, and has been used since then by hundreds of organizations worldwide.

The success of CMMI inspired the development of several maturity models in other domains, including BPM. In the last decade, researchers and practitioners in the BPM field have proposed maturity models with varied focus and depth [8], [9]. The Business Process Orientation Maturity Model [10], the BPM Capability Framework [11], the Process and Enterprise Maturity Model [12], and the OMG standard Business Process Maturity Model [13] are among the ones commonly referred to in the literature.

Yet, despite the substantial number and broadened scale of available models [14] and the promising accomplishments of using maturity models in other domains (e.g. [15], [16]), the use of business process maturity models (BPMs) has still not gained widespread acceptance in practice or in research. There is only a handful of studies in the literature examining the adoption of these models and their achieved benefits [9]. Furthermore, recent surveys report a decline in the attention shown by industry to certain maturity models [17]. Researchers and practitioners in this field indicate underlying challenges, such as the scarcity of empirical works confirming the validity and usefulness of the models [18], limited extent of prescriptive properties of the models impeding their application [9], [19], and the lack of a clear distinction between the maturity model and the assessment model that is applied to evaluate the level of maturity [20]. With the purpose of extensively investigating these arguments, we targeted at a systematic review of the literature to obtain an overall understanding of the existence, characteristics, and use of maturity models in the BPM discipline. A systematic literature review (SLR) is a means of evaluating and interpreting all available research relevant to a particular research hypothesis, topic area, or phenomenon of

interest [21] and a literature review represents the foundation to strengthen the research in a particular field of study [22]. In the last decade, SLRs served as unified, verifiable, and trustable sources for further research [23]. An SLR can be applied to identify any gaps in current research in order to suggest areas for further investigation [22]. In software engineering, using SLRs helped to identify diversity in the models adopted [24] as well as to investigate motivations [25] or synergies [26] for adopting them. Similarly, using an SLR would allow us to pinpoint gaps in research related to maturity models in the BPM field.

In reviewing the existing literature, we elicited up-to-date model development, application, and evaluations, as well as the studies regarding model comparison and classifications in a bottom-up manner. We searched and examined the studies performed between the years 1990 and 2014 in a comprehensive set of academic digital libraries. We initially retrieved 2899 studies; 61 of which were finally selected in accordance to our selection procedure and criteria.

The remainder of the paper is organized as follows. Section 2 overviews the related work. Section 3 provides the review protocol and the classification scheme that were developed and applied for the SLR. Section 4 presents the results and discussions, and final section concludes with a summary of findings, contributions and limitations.

2. Related work

There are few studies that extensively analyze the literature on BPMMs. In this section we focus on the existing, comprehensive ones that describe and compare multiple BPMMs or that clarify the concepts related to BPM and its maturity.

Poeppelbuss et al. [18] reviewed 76 articles published in leading information systems journals and conference proceedings that report on the maturity models in the broad field of information systems. The authors investigate the maturity models from the perspectives of research, publication, and practitioner and report that theories on the design and adoption of maturity models are distinctly rare.

In a systematic mapping study on the maturity models proposed in diverse domains, Wendler [14] provides an analysis of 237 articles published between 1999 and 2010. The study reveals that the maturity model research is dominated by the studies in the software engineering field and that most studies deal with the development of maturity models, where evaluations and validations are scarce. It delivers an initial systematic summary of maturity model research, but fails to offer an overview of the state-of-the-art research in this area. The study reports only 4 studies on BPM maturity models ([11], [27], [28], [29]), which are based on only 2 out of 20 maturity models identified by this SLR.

Poeppelbuss and Roeglinger [19] propose a well-founded framework of general design principles justified by existing literature and grouped by typical purposes of use, and demonstrate the framework using an exemplary set of maturity models in the field of BPM. A follow up study in [9] provides a review of a set of BPMMs by focusing on their applicability and usefulness. It provides an analysis of a sample of ten BPMMs with respect to a framework of general design

principles. Accordingly, these models sufficiently address the basic design principles as well as principles for a descriptive purpose of use. However, the design principles for a prescriptive use (which also covers assessment method) are largely unmet. These studies provide important contributions to the literature by providing means to understand the requirements of an applicable and useful BPMM. However, they focus on the properties of a selected set of available maturity models and do not offer a systematic review of related literature.

With the intention to develop grounded criteria to compare maturity models for BPM, Van Looy et al. [8], [20] point out the lack of a comprehensive definition for BPMM and highlight the gaps regarding the scope, terminology, and design. The authors identify three umbrella terms based on a literature review: business process (BP), business process management (BPM), and business process orientation (BPO). As to scope, BP is enclosed by BPM, which is further enclosed by BPO. The authors also identify six BPMM components falling under these terms: modeling and deployment (under BP), optimization and management (under BPM), culture and structure (under BPO). These components are used to compare and classify 61 maturity models, some of which with a particular focus on different domains or fields, such as supply-chain management, logistics, collaboration, and software development [8]. In a follow-up study [30], the authors add further design elements to their comparative framework by conducting a content analysis of 69 maturity models, and transform the identified 14 design elements into a questionnaire that practitioners can use to find the maturity model that best fits their needs. The book authored by Van Looy [31] also provides a comprehensive overview of the framework and the 69 maturity models. The study provides contributions to the literature through extensive reviews and comparisons of existing BPMMs, including their structural characteristics and points of focus, such as assessment and improvement. However, the authors do not offer systematic mappings and reviews to provide a thorough understanding of the maturity models' development process, or empirical studies on their application and validation.

Our analysis of existing works that review current BPMMs pinpoints specific issues and challenges that demand further investigation in this research field. The early findings signal an unbalanced emphasis on model development over empirical validation. In addition, the works listed above present a narrow perspective on the prescriptive properties of the models, which makes BPMMs less actionable and hinders their potential to guide process improvement efforts. With the aim to clarify these concerns, our study provides a systematic literature review on BPMMs by focusing on existing theoretical and empirical studies of their development, validation, and application. To the best of our knowledge, this is the first SLR that explores generic BPMMs in this way.

3. Research design

In our research, we focus on the models addressing business process management or orientation in an all-inclusive manner rather than with a narrow viewpoint that centers on a specific domain or aspect of BPM (e.g., knowledge management, supply chain management, etc.). The hypotheses that we defined for this research are given in Table 1.

Table 1. Research Hypotheses (RHs) for the systematic literature review

No	Hypothesis
RH1	The BPM academic community has put more effort and emphasis on developing maturity models than empirically evaluating them.
RH2	There is a lack of studies validating that an increased process maturity level of an organization with respect to a BPMM leads to an improved business performance.
RH3	Most BPMMs display descriptive rather than prescriptive characteristics.
RH4	The distinction between a maturity model and an assessment model is not well defined in the BPMM research.

Our first hypothesis has been built upon the findings of previous studies such as [14] and [18], which assert the high number of maturity models but also the scarcity of reported evaluations and validations of these. The first and second hypotheses are closely related, since both involve empirical studies on the application or evaluation of BPMMs. However, in the second we elaborate on the studies that aim to explicitly *validate* a particular BPMM by demonstrating a relation between the maturity level and business performance. The existence of evidence for this relationship is indeed an indicator of a maturity model's practical utility. Our previous work [32] provides an early indication for the scarcity of this evidence. The current work extends the previous study with additional hypotheses and related findings from an extended coverage of studies. The third hypothesis concerns the dominance of the *assessment view* in BPMMs to identify a current level of maturity over the *guidance view* to move to a desired level of maturity [9], [19]. The assessment view is based on descriptive characteristics of a maturity model, which is used to identify the current level of maturity. The guidance view is based on prescriptive properties of a maturity model, and is used to sketch an improvement path towards a desired level of maturity [33]. The fourth hypothesis is defined to investigate the distinction between the terms 'maturity model' and 'assessment model' in the BPMM research [20], which we would not consider completely clear.

In conducting the SLR, we used [21] and [22] as our guideline for gaining a comprehensive insight into the existing literature. The literature search was performed for the studies published in academic journals and conference proceedings between the years 1990 and 2014 (Oct.), as made available through the digital libraries of (in alphabetical order); ACM, Ebsco, Emerald, ScienceDirect, Scopus, SpringerLink, Web of Science, and Wiley. The numbers of studies initially retrieved and identified from these libraries are given in Table 2. Out of 2899 studies that were retrieved in this way, we identified 147 studies that were deemed relevant for the purpose of this study. Eliminating the duplicate works, we targeted 88 studies for a thorough analysis.

Table 2. Number of studies initially retrieved and selected in the electronic libraries

Digital Library	# Initially retrieved	# Initially selected
Scopus	946	48
SpringerLink	666	37
Web of Science	494	40
ScienceDirect	229	8
Emerald	218	12
Wiley	193	1
ACM	90	0
Ebsco	63	1
Total	2899	147

We studied the primary sources of publications and reports that introduce the BPMMs, and explored the publications (e.g. Roeglinger et al [9] and Van Looy et al [30]) that provide comparative analyses of such models and are commonly referred to in this research field. We worked on keywords and terms that these studies use to specify essential concepts of relevance to business process maturity. For the retrieval in the digital libraries, the string given below was derived and taken as a basis, which was applied to the title, keywords, and abstracts of publications:

*(‘process maturity’ OR ‘process management maturity’ OR ‘BPM maturity’ OR ‘process management capability’ OR ‘BPM capability’) OR
 (‘business’ AND (‘maturity model’ OR ‘capability model’)) OR
 (‘business maturity’ OR ‘business capability’) OR
 (business AND (‘process orientation’) AND maturity)*

Some electronic libraries (such as Web of Science and SpringerLink) do not provide advanced search options that allow for the use of the search string as is. For these sites, we either extended the context of the search (e.g., in Topic in Web of Science) or separated the search into several sub-searches (e.g., in SpringerLink) preserving the initial search context.

The following steps were derived from the guidelines for performing SLRs in software engineering [21] and applied as a procedure in systematically searching and selecting the relevant studies:

1. Define research objective and hypotheses.
2. Conduct several example searches; review the scopes.
3. Revise research hypotheses; define the search string; identify inclusion and exclusion criteria.
4. Conduct initial search.
5. Review the title, abstract, and keywords of the initially retrieved studies.
6. Revise inclusion and exclusion criteria; select potentially relevant studies.
7. Remove duplicate studies.
8. Review potentially relevant studies selected; discuss any issues.
9. Review the entire content of initially selected studies (including the references section for identifying the studies that are potentially missed); identify relevant ones.
10. Review relevant studies selected; discuss any issues.
11. Identify the final set of relevant studies.

All steps were conducted with the involvement of at least two authors. In selecting the relevant studies in steps 6, 9, and 11 of the search and selection procedure described above, we applied the inclusion criteria as ‘the studies that propose, apply, validate, classify, or thoroughly analyze one or more *generic* maturity models for BPM or BPO’. We took Becker et al.’s definition of ‘maturity model’ [6] as the basis in identifying and labeling a generic maturity model (given in Section 1). Steps 8 to 11 were carried out independently by two authors, and conflicts were resolved after each step. Independent analysis results were documented in spreadsheets, which were then compared

and merged by one of the authors. Conflicts were noted for discussion, which were held before the joint authors continued with the subsequent step.

The initial number of studies retrieved in step 4 was 2899 and after step 5, we selected 284 studies out of these for further investigation. We revised inclusion and exclusion criteria while working on these studies and at the end of step 6, we came up with 147 studies. In step 7 we removed duplicate studies within this set and identified 88 studies for a thorough analysis. In steps 8 and 9, we went over these studies in detail, discussed and resolved conflicts, and identified 67 studies for a deeper review. We had final discussions at steps 10 and 11 for the inclusion of several studies, and reached 63 and finally 61 studies, respectively.

While reviewing the studies in steps 5, 8, and 10 of the search and selection procedure, we excluded the following studies:

- Studies that refer to (i.e., propose, apply, validate, classify, or thoroughly analyze) a maturity model that focuses only on specific business domains (e.g., software development, supply-chain management).
- Studies that refer to a maturity model that focuses on a particular aspect of BPM or on a related field (e.g., business-IT alignment, knowledge management, and information technology).
- Studies that propose or apply a method for measuring an organization's level of BPM or BPO maturity, but do not refer to a generic model that complies with the definition of maturity model that we adopted (such works include, for example, [34] and [35]).
- Studies that refer to a process or quality management model (e.g., European Foundation of Quality Management (EFQM) and ISO 9001) without a direct emphasis on BPM or BPO maturity.

Figure 1 shows the refinement steps in our SLR procedure and the resulting number of articles. As the result of trimming the 88 studies with these exclusion criteria, we identified 61 studies relevant for our research hypotheses, which are listed in Appendix A.

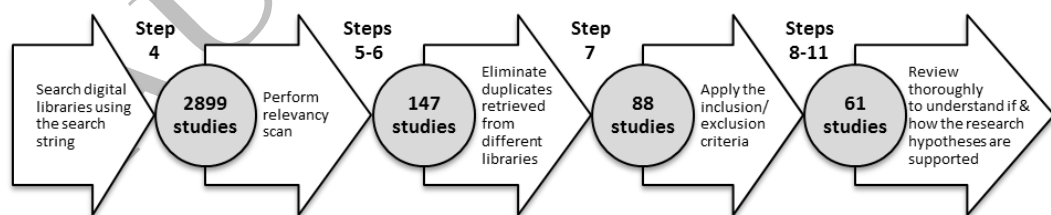


Figure 1. The refinement steps in the SLR procedure and resulting number of articles

We should re-state that the search was conducted only over the academic literature, and excluded publications such as white papers, expressions of opinion, experience papers, or success stories as reported in non-academic journals and magazines. We also excluded dissertations and industrial and technical reports with the assumption that important results from these were already published in academic journals or conference proceedings. Finally, we excluded books, because it is generally difficult to determine how robust their findings are and whether they have been

subjected to peer review. Still, distinct chapters from books that are compiled as scientific articles or conference proceedings were included in the SLR.

We should also note that investigating validity of the research hypotheses RH1 and RH2 would be possible directly from the search context of our SLR. However, the validation of RH3 and RH4 would require a deeper analysis of the BPMMs in terms of aim, structure, and description when the SLR context was considered. Therefore, in order to investigate the validity of these two hypotheses we referred to the primary sources that proposed the BPMMs, in addition to the findings of the SLR.

3.1. Classification scheme

By following a concept-centric approach, we analyzed the identified articles and iteratively developed a categorization scheme for structuring them. We developed a *concept matrix* [22], in which each article is grouped into one or more concepts. We took the work in [14] as our basis for the initial version of the scheme, which was then gradually refined with the new or modified concepts during the categorization process. With each modification of the scheme, the articles that had been categorized with the outdated version of the scheme were rescanned and categorized according to the new version. Four iterations were performed before all the articles were classified accordingly.

Ultimately, the resulting scheme has 3 main categories, two of which have sub-elements as presented in Figure 2. The main categories are: (i) research content, (ii) main research focus, and (iii) developed/used BPMM. The sub-categories under ‘main research focus’ (development, application, validation, and meta-analysis) are mutually exclusive. We assumed that an article should have at most one primary research focus. However, the articles can be categorized into more than one concept over the remaining two categories. For example, an article may introduce (release) a BPMM and include empirical studies for its validation.

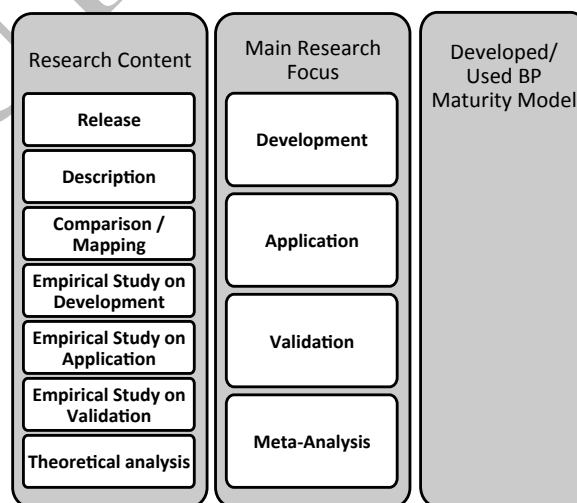


Figure 2. Article classification scheme

The following paragraphs elaborate on the categorization scheme.

Research Content: A brief description of each content-related concept is given below.

- *Release:* Articles in which a maturity model that has been constructed or developed is introduced.
- *Description:* Articles in which existent (released) maturity models are described for presentation purposes or as applicable methods.
- *Comparison/Mapping:* Articles in which existent maturity models are compared and mapped to each other or to other maturity related concepts.
- *Empirical Study on Development/Application/Validation:* Articles in which an empirical study (qualitative, quantitative, or mixed) has been conducted for the purpose of developing, applying, or validating a BPMM, respectively.
- *Theoretical Analysis:* Articles in which theoretical considerations are presented (e.g., the theoretical benefits of maturity models, applicable theories, design considerations, and principles).

Main Research Focus: In addition to the concepts for the research content, we were also interested to signify the main research focus of the article in terms of its relationship with the BPMM. The conceptual framework for the maturity model research [14] distinguishes 4 categories of concepts, which we adapted to characterize the main research focus of an article. Accordingly, each article was classified into a single category:

- *Development:* Articles in which the release or a description of a maturity model is the main focus.
- *Application:* Articles that have the main focus of applying the maturity model (mostly for assessment purposes) in different business domains or contexts.
- *Validation:* Articles in which a model is applied for model validation purposes (i.e. evaluating that progressing towards a higher maturity level brings about business benefits).
- *Meta-Analysis:* Articles in which the emphasis is on surveying or comparing existing maturity models, providing guidance on model selection, or presenting other theoretical reflections.

Developed/Used Business Process Maturity Models: To gain insight into the development and usage of the maturity models, we analyzed the specific BPMMs that the articles refer to (i.e., by proposing, applying, validating, classifying, or thoroughly analyzing that BPMM).

4. Results and Discussions

In this section, we present and discuss the results that outline the distribution of the articles and provide answers to the research hypotheses given in Table 1.

Figure 3 shows the distributions of the articles by year (from 2001 to 2014) and publication type (journal, book section, and conference proceeding). The distribution over years indicates that the topic has picked up interest from 2007, with the year 2009 displaying the highest number (13 studies). In terms of publication type, the studies published in conference proceedings hold the

majority by 48%, followed by journal articles (41%, 25 articles), and book chapters (11%, 7 articles).

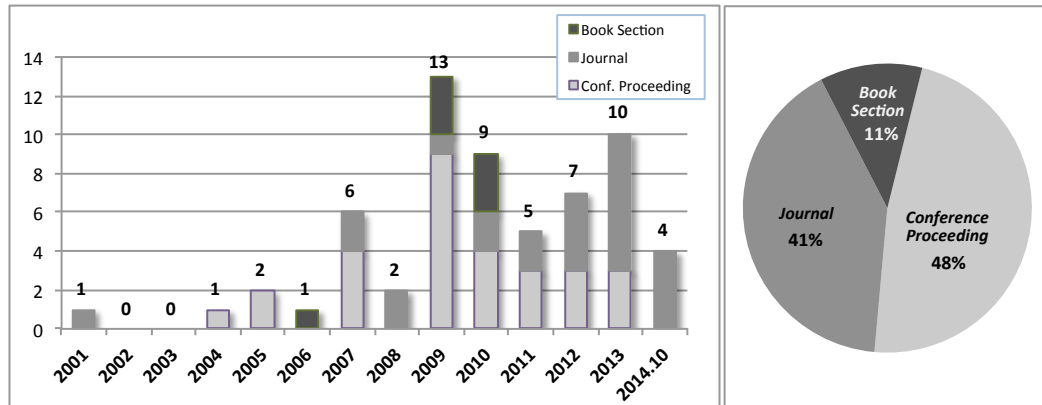


Figure 3. Distribution of articles by year (on the left) and type (on the right)

The numbers indicate that there was not a single, relevant study between the years 1990 and 2001. Also, the research on this topic has only become substantial in the research community in the last decade. This might be particularly attributed to the increased academic research in the field of BPM and to the emergence of success stories of the Capability Maturity Model and its derivatives in the software engineering field.

4.1. Business Process (Management) Maturity Models

Our first research hypothesis (RH1) relates to the unbalanced focus in BPM community on model development in favor of their empirical evaluation. In verifying this argument, we investigated the generic maturity models that have been proposed for BPM based on the studies reported in the scientific literature. Table 3 lists 20 maturity models that were identified; 9 of which were considered ‘leading’ with respect to the attention they acquired in the academic research. A BPMM is classified under ‘OTHER’ in the table when the model is not referred to (i.e. applied, validated, classified, or thoroughly analyzed) in at least two other articles with authors that are different than those that developed/released the model. Therefore, about half of the BPMMs identified in Table 3 do not demonstrate notable evidence of reference according to our criteria.

Table 3. Business Process Maturity Models referred in the academic literature

Abbreviation	Business Process Maturity Model (BPMM)	Primary Source
(1) BPM-CF	Business Process Management Capability Framework	[11], [36]
(2) BPMM-FIS	Business Process Maturity Model	[37]
(3) BPMM-HR	Business Process Maturity Model	[38]
(4) BPMM-OMG	Business Process Maturity Model	[13]
(5) BPO-MF	Business Process Orientation Maturity Framework	[39]
(6) BPO-MM	Business Process Orientation Maturity Model	[10]
(7) PEMM	Process and Enterprise Maturity Model	[12]
(8) PMMA	Process Management Maturity Assessment	[40]
(9) vPMM	Value-based Process Maturity Model	[41]
OTHER	Process Management Maturity Model	[42]
	Process Safety Degree	[43]
	Process Maturity Continuum –PMC	[44]
	Maturity Model for Knowledge-Intensive Business Processes	[45], [46]
	Business Process Maturity Model –BPMM	[47]
	Maturity Estimation Model	[48]
	Model for Business Process Maturity Assessment	[49]

Abbreviation	Business Process Maturity Model (BPMM)	Primary Source
	Business Maturity Assessment Model	[50]
	Process Management Maturity (PMM) Model	[51]
	Process-Structure Development Model (PSDM)	[52]
	Business Process Maturity Model for Public Administration	[53]

Figure 4 shows the *leading* BPMMs and the numbers of articles that refer to (i.e., propose, apply, validate, classify, or thoroughly analyze) these models. Please note that an article may address more than one BPMM. Accordingly, Rosemann and De Bruin's BPM-CF [11], McCormack and Johnson's BPO-MM [10], and OMG's BPMM [13] are the models that were the most studied and referred to in the academic literature (with 18, 17, and 13 studies, respectively).

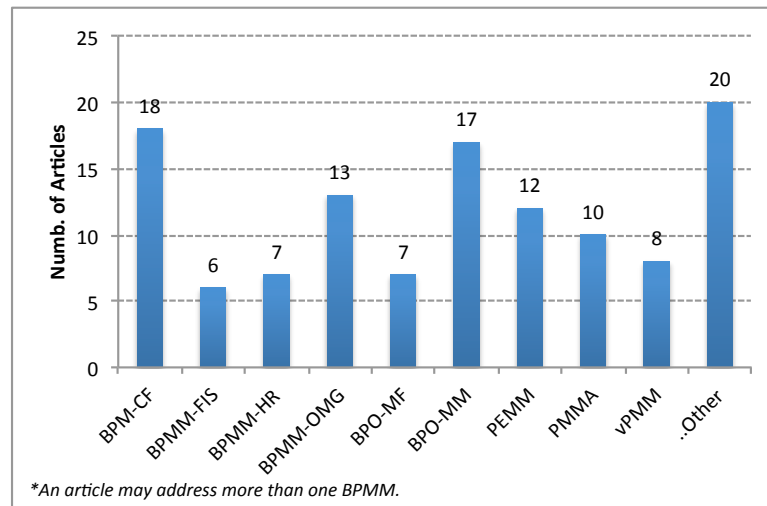


Figure 4. Number of articles that refer to a BPMM

In order to determine the level of empirical research on these BPMMs, we further analyzed the articles in terms of the *research content* and *main research focus* using the classification scheme that we developed (Appendix-B presents the details of the classification for each article). Figure 5 and Figure 6 show the number of articles per BPMM by research content and by main research focus, respectively.

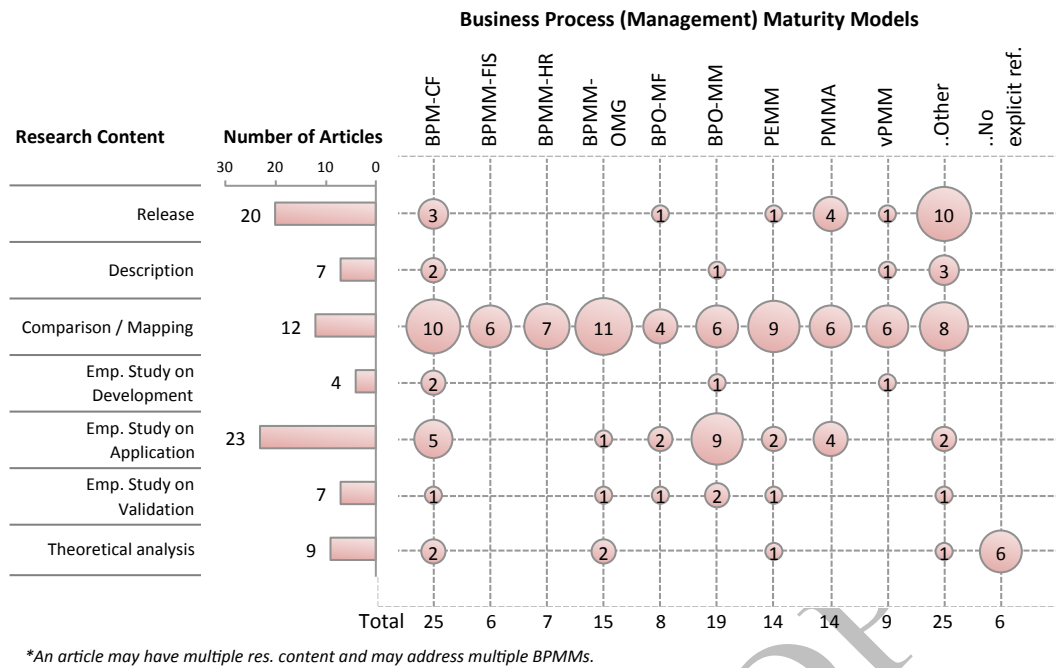


Figure 5. Number of articles per BPMM by Research Content

Considering research content, the studies that release a model, the studies on the application of the models, and those that present a structured comparison of different models take the lead in terms of the number of studies. By contrast, empirical works on the development of maturity models are scarce (4 studies), which indicates that only few models come up with studies reporting on the grounds upon which these models are built. Only 7 out of 61 present empirical work on the validation of the models, which partially support our first hypothesis.

Out of 23 empirical studies on the application of a model, 9 studies present the application of the BPO-MM, which makes it the most popular model based on the number of studies that report on its testing in a business environment. BPM-CF follows by 8 empirical studies in total that report on empirical works on the development, application, and validation. Only these 2 leading models (out of 9) have been subjected to empirical works in all categories (development, application, and validation). Furthermore, over half of the empirical research content (56%) on BPMMs relate to these two models (20 out of 36 empirical research content).

It is notable that 4 out of 9 leading maturity models have not been subjected to an empirical validation reported in the existing literature at all (see also Section 4.2). For instance, there is only a single empirical study that refers to BPMM-OMG –the OMG’s industry standard for business process maturity. These numbers indicate that there is very limited empirical evidence on the use and the usefulness of the maturity models.

The results presented in Figure 6 on the main research focus of the articles are closely aligned with the results depicted in Figure 5, as expected. Model *development* is in the forefront with over 40% of the studies (24 articles) reported, while studies that focus on model *validation* are scarce with less than 10% (5 articles). Essentially, the relatively high number of studies on the development or release of a maturity model may indicate that the authors develop these models without carefully

reviewing existing models and research. Out of 11 models that are categorized under the ‘Others’ in Table 3, only one model (by Gardner in [S11]) was issued before the leading models were released.

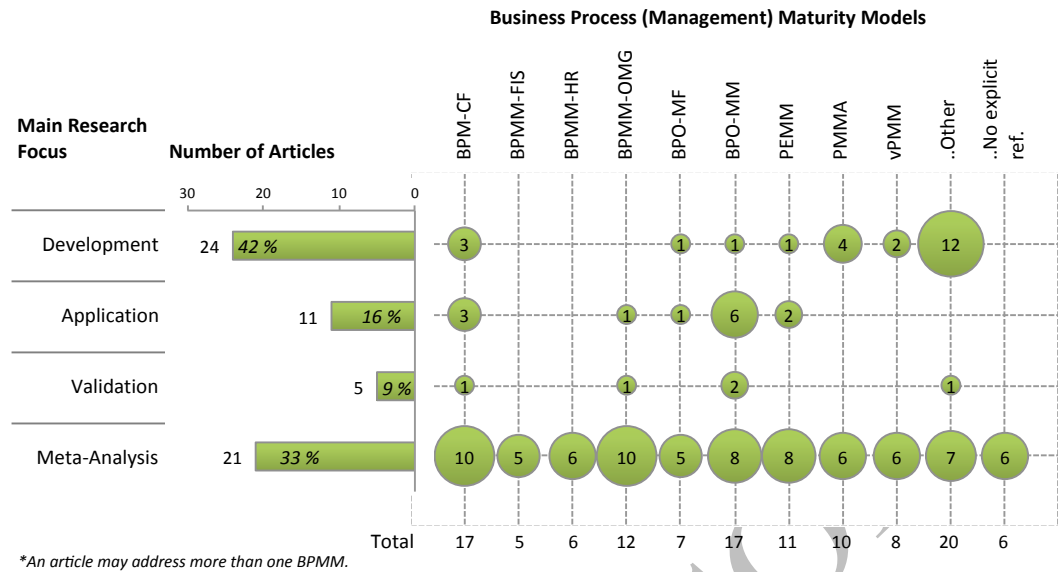


Figure 6. Numeric distribution of articles per BPMM by Main Research Focus

One-third of the works (21 articles) focus on meta-analysis of models, that is, on comparisons, classifications, and theoretical analyses. Despite this relatively high number, such studies usually center on design-related properties and underlying purposes, and rarely touch their practical offerings and content.

BPO-MM and BPM-CF are the only leading models that have studies reporting both on their application and validation as their main focus of interest. On the other side of the spectrum, BPMM-FIS and BPMM-HR are two leading models that were merely the subject of meta-analysis studies, and had no empirical studies reported on their development, application or validation.

4.2. Evidence on Improved Maturity and Increased Business Performance

Our second research hypothesis (RH2) contends that there are insufficient studies that empirically validate an increased process maturity of an organization (with respect to a particular BPMM) leads to an improved business performance. Out of 61 studies that refer to a BPMM, only 7 provide empirical evidence on that matter ([S2], [S33], [S35], [S39], [S41], [S44], [S45]). Within these studies, 4 of them refer to BPO-MM, which has the highest number of studies that provide objective evidence on its validity. BPM-CF and OMG's BPMM each have only a single empirical study on the link between the maturity level and business performance.

The chart in Figure 7 shows the number of articles that investigate the relationship between BPMM and business performance. These studies demonstrate the relation between a higher level of maturity and several aspects of an organization's performance. However, the majority of these studies rely on a self-assessment of maturity level by a single survey participant. This poses risks to the internal validity of the research, as maturity assessments often require viewpoints of

different organizational parties involved in diverse processes and functions. A key finding in this regard is the scarcity of the works that relate business process, BPM or BPO maturity of an organization to its business performance in broad terms.

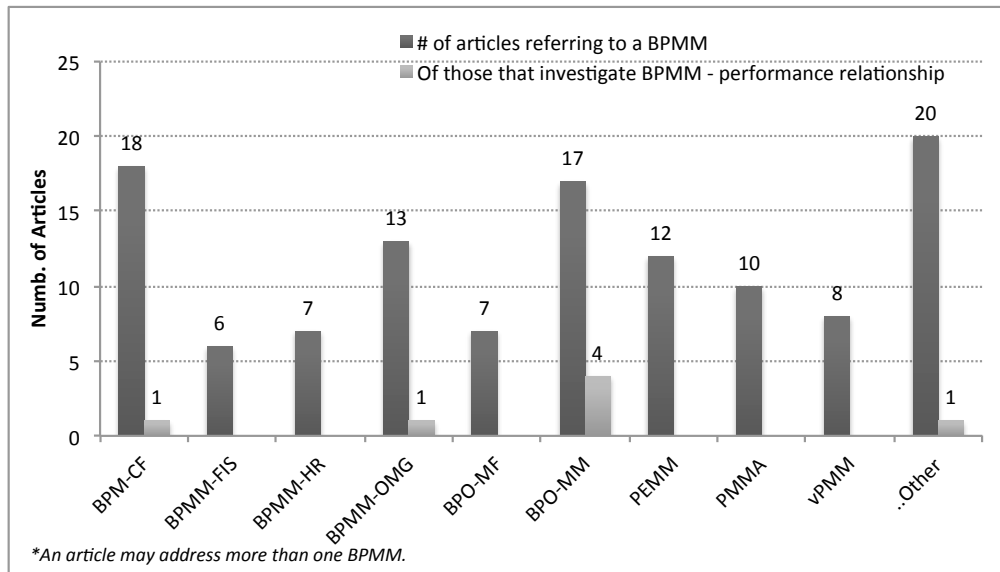


Figure 7. Number of articles that refer to a BPMM and business performance

The three models mentioned above, namely BPO-MM, BPM-CF, and BPMM-OMG, are the only leading models that were the subject of such studies that claim the connection of their usage to increased business performance. This finding means that a very limited set of models (3 out of 9 leading BPMMs) has been subjected to empirical research on the relation between increased process maturity and higher business performance. We should also note that none of the BPMMs suggest a negative link between BPM maturity and business performance.

4.3. Descriptive vs. Prescriptive Purpose of Use

Our third research hypothesis (RH3) states that most BPMMs have descriptive characteristics but provide only limited properties for prescriptive purpose of use. Our analysis indicates that most of the leading maturity models follow a descriptive approach (i.e. intended to understand the existing situation) and lack prescriptive properties (i.e. defined practices through the maturation path, and guidance on how to get from a lower maturity state to a higher one).

According to the information provided by the primary studies that propose the BPMMs; BPM-CF, BPM-FIS, and BPMM-OMG have strong level of descriptive properties whereas BPMM-HR, BPO-MF, PEMM, and PMMA possess only basic descriptive properties. The latter models either completely lack or only offer limited guidance on how these models can be applied in improving process capabilities or how they can be configured for different domains and organization-specific situations. For instance, PEMM describes how various aspects of an enterprise characterize different stages of process maturity, but does not provide an improvement roadmap of practices for progressing to higher levels. Consequently, the use of such models is primarily diagnostic.

However, we should also note that this finding might be a side-effect of focusing on generic BPMMs only and that the validity of the finding needs be assessed at domain-specific levels.

Standing out as to its extensive documentation that describes five maturity levels, each with specific process areas, goals, best practices, and measures of achievements, BPMM-OMG is the only model that has strong level of prescriptive properties that can be taken as the base for maturity improvements. However, mainly due to the wide scope and all-inclusive approach, the effort required to adopt this model specifically for descriptive purposes is considerable, which also poses risks and difficulties on its adoption in practice.

4.4. Maturity Model vs. Assessment Model

Our fourth research hypothesis (RH4) refers to the vagueness around the use of two concepts in the BPMM research community: the maturity model and the assessment model (or method). *Process assessment* investigates strong, weak and/or missing points in the definition and application of a process with respect to a *reference framework* [33]. In assessing the maturity level of an organization, the maturity model acts as the reference framework, against which the current status is appraised using an assessment model or method. The assessment provides an understanding about current process situation and enables rating about process quality based on this understanding. Findings from a process assessment are usually used to derive the gap with respect to the framework, which, in turn, is input into developing a roadmap for process improvement.

With [13] and [41] as exceptions, the majority of the leading BPMMs referred to in the literature makes no explicit distinction between the ‘maturity model’ and the ‘assessment model’. This distinction, however, is crucial for a number of reasons. *First*, a maturity model represents an improvement path and is therefore assumed to take a guiding perspective, while assessment model takes an inquiring view and asks for a reference model to evaluate against. In software engineering, for example, CMMI [7] serves as the reference model, while SCAMPI [54] serves as the assessment method prior to process improvement. These two perspectives -as disjoint as they are- have different but complementary roles. *Second*, unless specified and required by the maturity model, the assessment model is not necessarily unique. An assessment against a *single* maturity model can be performed using different assessment methods with varying scope, detail, and precision. For example, a model can be designed for self-assessment (e.g. PEMM) or for use by a second party to assess an organization’s maturity (e.g. OMG’s BPMM). Likewise, it can address an organization as a whole or a specific part of it [33]. *Third*, the lack of a well-defined distinction between these two perspectives may lead to flawed designs for maturity models [9] and confusion in the community [20].

5. Conclusions

The comprehensive nature of BPM brings some challenges and, partly in response to these, has triggered the development of a wide variety of models for its implementation. A set of best

practices can be useful to enable BPM and ultimately business success. As such, a maturity model can be an effective reference for process improvement initiatives.

Although a rich set of maturity models for the BPM field exists, their use in practice is limited. We speculated that the empirical evaluations of the BPMMs are actually scarce, that the models are designed mostly for descriptive purpose of use (which limits their target to guide process improvements), and that there is some notable confusion as to what constitutes a maturity model and an assessment model. In order to substantiate these contentions and understand the state of research on maturity models in the BPM field, we conducted a systematic literature review.

Table 4 presents a summary of the key findings regarding our research hypotheses for the SLR. Examining 61 studies, we identified 20 BPMMs that have been proposed in the literature, 9 of which were considered as leading with respect to the extent they have been studied in the literature. Only 2 out of 9 leading models (BPO-MM and BPM-CF) have been referred to by studies that involve empirical works on their development, application, and validation. The number of validation studies (7 out of 61) reveals that there is limited evidence indicating an increased process maturity level leads to an improved business performance and that only a handful of models are subject to empirical works in this regard. An in-depth analysis of the leading models confirms the reflections by Poeppelbuss and Roeglinger [19] that the majority of the proposed models possess descriptive properties and show limited, prescriptive features. The review also indicates that only two leading models (BPMM-OMG and vPMM) make a distinction between the maturity model and the assessment model. There is no clear distinction between these terms, which supports the arguments for the inadequate foundation for the notion of BP maturity in terms of scope, terminology, and design [20]. Overall, these findings firmly validate our four research hypotheses.

Table 4. Summary of the findings with respect to research hypotheses

Hypothesis	Result	Evidence
RH1: The BPM academic community has put more effort and emphasis on developing maturity models than empirically evaluating them.	Largely Supported	Around one-third of the studies introduce a BPMM (20 models in 61 studies). Only 2 out of 9 leading models are referred to by studies that involve empirical works on their development, application, and validation.
RH2: There is a lack of studies validating that an increased process maturity level of an organization with respect to a BPMM leads to an improved business performance.	Partially Supported	Only 7 out of 61 studies confirm that an increased process maturity level leads to an improved business performance.
RH3: Most BPMMs display descriptive rather than prescriptive characteristics.	Largely Supported	The majority of the proposed models possess descriptive properties and show limited prescriptive features.
RH4: The distinction between a maturity model and an assessment model is not well defined in the BPMM research.	Largely Supported	Only 2 out of 9 leading models make a distinction between the maturity model and the assessment model.

Among the leading maturity models in the BPM field, BPO-MM and BPM-CF are two models that stand out in terms of being referred to in the academic literature. However, the numbers do not

point to a single model that has been commonly accepted in academia and widely applied in practice.

Our analysis with respect to the research content and main focus of articles reveals that the attention in research has been at the development and release of models, while empirical works on the validation of these models are few and far between. Therefore, we suggest to the members of BPM community to direct their focus more on model evaluation rather than creation. More research work is needed to go beyond the conceptual development of maturity models and eventually demonstrate their usefulness. The field also requires theoretical studies and reflections to establish and enhance a strong ground for future research. There is a significant number of meta-analytic studies that focus on comparisons or classification of models based on their general characteristics. These studies typically focus on high-level and extrinsic characteristics of the models (such as, structure, number of levels, scope, etc.). They hardly show an attempt to offer a ‘content-wise mapping’. Such works would pave the way for a unified and integrated model, around which domain-specific extensions and bodies of improvement practice can be devised [55].

Considering the relatively high number of models proposed and proliferated in the field, only a small number of articles refer to these models. The perspectives on the purpose of use and the assessments are unclear, so we can argue that the research in this field is still in its infancy. The limited number of works on model application and validation makes it difficult for practitioners to build a business case for potential applications, which negatively influences the widespread acceptance of models in practice. There is a distinct need for refining existing BPMMs to become more actionable.

Researchers in the BPM field should consider our study as a comprehensive source that offers pointers and a basis for future research. Our findings identify several gaps in the existing research where there is a potential for major, new contributions. Such contributions may include (1) the empirical evaluation of existing BPMMs rather than the development of new ones, (2) the validation of the relationship between the use of models and business performance, (3) the refinement of prescriptive properties of existing BPMMs, and (4) a review (and re-definition, if need be) of the distinction between the assessment and guidance views in the models.

Practitioners may find this study valuable in their attempts to evaluate existing models and understanding their limitations. Those willing to adapt a maturity model for process improvement will tend to prefer models that have been applied and rigorously validated. We suggest practitioners to collect data about their BPM improvement efforts, such that the effectiveness of the model they have adapted can be studied.

This study has various limitations, chiefly with regard to the underlying research method. We based our research on the theoretical and empirical studies of generic maturity models and their assessment methods in the BPM field, and not directly on the studies of business process maturity assessment. However, we think that the existence of the studies that report maturity assessments of business processes are highly dependent on the maturity models used as the base for their assessments. As described in Section 3, our systematic review of literature focuses on certain types

of publications and aims to review the academic literature. Several works that are published as (non-academic) books, white papers in the grey literature reporting on model applications through case studies and surveys were not considered in this study. This is in line with the aim of the study, but poses risks for its completeness and for the validity of the findings. Limitations also exist due to the inclusion and exclusion criteria used in selecting works. Particularly, keeping the maturity models developed for specific domains out of the scope of this paper poses a threat to the generalizability of our findings. Future research may broaden the scope of the review to include studies on domain-specific models and contributions in the grey literature to provide a broader understanding on the use of these models. One of the main limitations of this research study is the lack of empirical evidence based on the state-of practice. We acknowledge a limited understanding of the use of these models in industrial settings, which is a threat for the validity of our conclusions. Therefore, future work should involve conducting industry surveys to gain further insight on the factors contributing or hindering the use and success of BPMMs in practice.

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Appendix-A. Complete list of studies included in the systematic review

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Appendix-B. Categorization of the studies

Artc.	Research Content						Main Research Focus				BPM											
	Release	Description	Comparison / Mapping	Emp. Study on Development	Emp. Study on Application	Emp. Study on Validation	Theoretical Analysis	Development	Application	Validation	Meta-Analysis	BPM-CF	BPM-FIS	BPM-HR	BPM-OMG	BPM-MF	BPM-MM	PEMM	PMMA	vPMM	OTHER	No explicit ref.
[S1]			x								x	x									x	
[S2]					x				x								x					
[S3]	x							x													x	
[S4]		x			x				x			x										
[S5]		x				x				x		x										
[S6]							x				x											x
[S7]	x			x				x				x										
[S8]					x				x									x				
[S9]					x				x						x		x	x				
[S10]							x				x											x
[S11]		x						x													x	
[S12]	x					x		x										x				
[S13]	x							x													x	
[S14]	x							x													x	
[S15]					x				x								x					
[S16]	x							x													x	
[S17]	x							x													x	
[S18]			x								x				x					x		
[S19]		x						x												x		
[S20]	x			x				x												x		
[S21]		x		x				x									x					
[S22]	x							x													x	
[S23]					x				x			x										
[S24]					x				x			x										
[S25]	x							x													x	
[S26]		x						x													x	
[S27]		x				x				x											x	
[S28]			x				x				x	x			x			x				
[S29]						x				x					x							
[S30]			x								x	x	x	x	x		x	x	x	x		
[S31]	x				x			x											x			
[S32]	x				x			x											x			
[S33]	x				x			x											x			
[S34]	x				x			x											x			
[S35]			x								x	x		x	x			x			x	
[S36]	x							x				x										
[S37]	x			x	x			x				x										
[S38]	x				x			x													x	
[S39]						x				x							x					
[S40]	x							x													x	
[S41]					x	x				x							x					
[S42]					x				x								x					
[S43]					x				x								x					
[S44]					x				x								x					
[S45]							x				x	x										
[S46]					x				x							x						
[S47]							x				x											x
[S48]			x								x	x	x	x	x	x	x	x	x	x	x	
[S49]							x				x											x
[S50]							x				x											x
[S51]			x								x	x	x	x	x	x	x	x	x	x	x	
[S52]							x				x											x
[S53]							x				x											
[S54]			x								x	x	x	x	x	x	x	x	x	x	x	
[S55]			x								x	x	x	x	x	x	x	x	x	x		
[S56]					x						x						x					
[S57]					x						x						x					
[S58]			x								x	x			x			x	x		x	
[S59]	x					x		x								x						
[S60]					x						x					x						
[S61]	x		x		x			x				x	x	x	x			x			x	