

Business process maturity assessment : state of the art and key characteristics

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Business Process Maturity Assessment:

State of the Art and Key Characteristics

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Abstract—Business processes are basic enablers in sustaining an organization’s existence in delivering high-quality products and services. A maturity model is an instrument to assess and continually improve business processes. For example, Capability Maturity Model Integration for Development (CMMI-Dev) in software domain has been used to assess and improve software processes in thousands of organizations worldwide since 1990s. Inspired by CMMI in the last decade, researchers and practitioners have proposed generic maturity models for business processes with varied focus and depth. However, the use of these models has not gained widespread acceptance in the Business Process Management (BPM) field. One of the reasons is the lack of a clear distinction between a maturity model and its assessment model. The objective of this study is twofold: First, to discuss challenges of business process assessment with regard to generic maturity models reported in scientific literature, and second, to identify key characteristics of a business process assessment model that would facilitate the use of maturity models in the BPM field.

Keywords—business process, process maturity, software process, process assessment, assessment model, assessment tool

I. INTRODUCTION

The notion of ‘maturity’ was first proposed by Phillip Crosby [1] and is defined as “the state of being complete, perfect, or ready” [2]. 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 [3]. Maturity models can be used as an instrument to improve processes to achieve higher product and service quality [4][5][6], and there are many success stories in the use of such models in several domains. For example, Capability Maturity Model Integration for Development (CMMI-Dev) [7] in the area of software engineering emerged at the start of 1990s as a mean to improve software development processes to achieve higher quality, and has been used since then by thousands of organizations worldwide.

The success of CMMI inspired the development of several maturity models in other domains, including Business Process Management (BPM). In the last decade, researchers and practitioners in the BPM field have proposed maturity models with varied focus and depth [8][9]. However, the use of business process maturity models (BPMMs) has not yet gained widespread acceptance in practice [10] or in research

[11][12]. Underlying challenges include the scarcity of empirical works confirming the validity and usefulness of the models, limited extent of prescriptive properties of the models impeding their applications, the lack of a clear distinction between a maturity model and an assessment model that is applied to evaluate the level of maturity, and the scarcity of practical guidance and/or supporting tools to motivate business process assessments and improvements.

In this study, we focus on the confusion between a maturity model and its assessment model in the BPM field with the suspicion that the lack of clarity between these concepts hinders the proper design and usage of BPMMs as the base to understand and improve the current state of maturity in the organizations. An assessment model is a well-defined guidance to assess the process maturity or capability based on a reference model [13], and the reference model is considered as a BPMM in our study. We examined the characteristics of maturity models that have been more frequently referenced in the BPM field as reported in the scientific literature, from an assessment perspective. We selected 9 BPMMs, which were characterized by our previous research as ‘leading’ when considering studies on their application and validation [11]. More specifically, we address two research questions (RQs) in our work: (1) What are the characteristics of leading BPMMs (and their suggested assessment models) from an assessment perspective? (2) What are the key characteristics of a business process assessment model that would foster the use of BPMMs in practice?

The remainder of the paper is organized as follows. Section 2 summarizes the maturity models and their assessment models in the software domain as successful examples that guide process appraisal and improvement. Section 3 overviews related work on the business process maturity models and their assessment methods and tools. Section 4 highlights the key characteristics of a business process assessment model as we propose. Section 5 concludes with the contributions and limitations of this study, and our plans for future work.

II. SOFTWARE PROCESS MATURITY AND ASSESSMENT

For the purpose of presenting an example domain in which there is a clear distinction between a maturity model and an assessment model, we overview two widely known models for software engineering: CMMI-DEV [7] and ISO/IEC 12207

[14]. These models are commonly considered as reference for process improvements in the software domain. Their corresponding assessment models, namely SCAMPI [15] and ISO/IEC 15504 [16] are used to identify current maturity or capability of software developing organizations or software processes. The assessments using these models are typically supported by tools, and therefore, we also provide an overview of the tools reported in scientific literature for software process assessments in this section.

A. *Capability Maturity Model Integration for Development (CMMI-DEV) and SCAMPI*

CMMI-Dev is a process reference model that was developed by the Software Engineering Institute (SEI) of Carnegie Mellon University. It addresses the development and maintenance activities applied to both system and software products and services. This model could be used for improving processes, and measuring the capability of a process or the maturity of an organization. In CMMI for Development [7], all system and software development processes are addressed by 22 process areas such as Project Planning, Requirements Development, Technical Solution, and etc. under five organizational maturity levels.

SCAMPI (Standard CMMI Appraisal Method for Process Improvement) is a process assessment method designed to evaluate compliance with CMMI models and to perform assessments [15]. The SCAMPI process assessment includes three different methods; Class-A, Class-B, and Class-C. Class-A assessment is the most comprehensive SCAMPI assessment, and completely satisfies the requirements of CMMI assessment method [17]. In Class B assessment, interviews performed with people and documents are collected as objective evidence. Class C assessment is the least comprehensive SCAMPI assessment analyzing deficiencies within processes. In this class of assessment, only interviews performed with people or document may be classified as evidence. Certification is possible only at the end of SCAMPI Class A assessment.

B. *ISO/IEC 12207 Software Life-Cycle Processes and ISO/IEC 15504 IT - Process Assessment*

ISO/IEC 12207 [14] is an international standard for software life cycle processes. It includes processes, activities and tasks to be implemented during acquisition, supply, development, operation, and maintenance processes of a software product that is stand-alone or a part of a larger system [14]. ISO/IEC 12207 is in full compliance with ISO/IEC 15288 [18] that describes system life-cycle processes. These two standards provide process reference models that support process assessments compatible with ISO/IEC 15504 [16].

ISO/IEC 15504: Information Technology - Process Assessment is an international standard created for process assessment [16]. It is designed to meet needs of process assessors, suppliers, and procurers. ISO/IEC 15504 defines the term process assessment as “the systematic evaluation of an organization’s processes against a process reference model”

[13]. The standard makes a clear distinction between two terms below:

- A *Process Reference Model* comprises definitions of processes in a life cycle described in terms of process purpose and outcomes, together with an architecture describing the relationships between the processes.
- A *Process Assessment Model* is suitable for the purpose of assessing process capability, based on one or more Process Reference Models.

A PRM provides a framework for the establishment of processes in an organization by providing a list of processes and stating their requirements as specific to the domain of application. A PAM, on the other hand, is expected to describe the framework (e.g., procedure, role and responsibilities, criteria, and rating scheme) for performing the assessment with respect to the reference model [16].

The fundamental elements of a PRM are the descriptions of the processes within the scope of the model. The process descriptions in the PRM incorporate a statement of the purpose of the process which describes at a high level the overall objectives of performing the process, together with the set of outcomes which demonstrate successful achievement of the process purpose [16].

A PAM is based on the process descriptions provided in one or more PRMs. It forms the basis for the collection of evidence and rating of process capability. A PAM provides a two-dimensional view of process capability. In one dimension, it describes a set of process entities that relate to the processes defined in the specific PRM(s); this is referred to as the process dimension. In the other dimension, the PAM describes capabilities that relate to the process capability levels and process attributes defined in ISO/IEC 15504; this is referred to as the capability dimension. The relationship is shown diagrammatically in Fig. 1 [16].

A PAM contains a definition of its purpose, scope and elements; its mapping to the measurement framework and specified PRMs; and a mechanism for consistent expression of results. The PAM is based on a set of indicators that explicitly addresses the purposes and outcomes, as defined in the selected PRM. These indicators demonstrate the achievement of the process attributes within the capability level scope of the PAM, and focus attention on the implementation of the processes in the scope of the model [16].

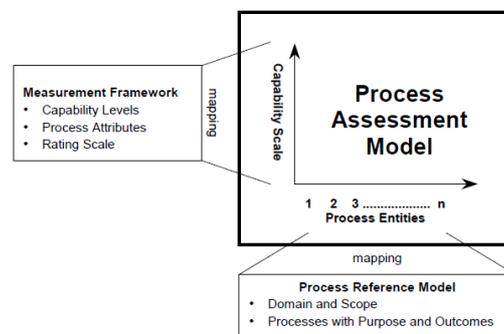


Fig. 1. Process Assessment Model relationships [16]

ISO/IEC 15504 also provides in its part-3 an exemplar documented assessment process that conforms to the requirements that are specified in part-2. This process includes the steps of; initiation, planning, pre-assessment briefing, data collection, data validation, process rating, and reporting the assessment result.

C. Software Process Assessment (SPA) Tools

There are several software process assessment tools reported in the scientific literature, and Gazel et al. provide a list of these tools in [19]. Reviewing the latest versions of the tools, we compared their attributes in Table I with respect to: assessment method supported, availability of free or demo version, type of the application (stand-alone or web-based), and support for self-assessment.

TABLE I. A COMPARATIVE LIST OF SPA TOOLS

Name	Description	Assessment method supported	Free (or demo) version?	Stand-alone or Web-based?	Support for self-assessment
Appraisal Assistant [20]	Developed by Software Quality Institute of Griffith University. Supports assessment of organizational maturity and process capability. Models and mapping data are stored in a Microsoft Access database.	SCAMPI, SPICE	Yes	Stand-alone	No
CMMiPal v1.0 [21]	Developed by Chemuturi Consultancy. Enables manual mapping of an organization's processes to CMMI practices. Model and mapping data are stored in a Microsoft Access database.	Closer to SCAMPI	Yes	Stand-alone	No
CMM-Quest v1.3 [22]	Developed by HM&S IT-Consulting to support process assessments based on CMMI-Dev v1.3. Provides functionalities for selecting process areas and target levels as preparation, text-based screens for data collection, graphics for data analyses, and Microsoft Word and HTML based reporting facilities.	ISO/IEC 15504	Yes	Stand-alone	Yes
SPICE 1-2-1 [23]	Developed by HM&S IT-Consulting to support process assessments in accordance with ISO/IEC 15504.	ISO/IEC 15504	Yes	Stand-alone	Yes
SPICE-Lite Tool [24]	Developed by HM&S IT-Consulting to assess conformance of organizational processes to ISO/IEC 15504 requirements. Assessment data are stored in a relational database.	ISO/IEC 15504	Yes	Stand-alone	Yes
Model Wizard [25]	A Windows-based application developed by Integrated System Diagnostics Incorporated. Enables users to store their process models in a relational database.	Not applicable	Yes	Stand-alone	No
Appraisal Wizard [26]	A Windows-based product developed by Integrated System Diagnostics Incorporated. Can cooperate with Model Wizard. Aimed to support management of planning, preparation, data collection, merging, and reporting activities as related to process assessments and process audits. Data from assessments and audits are stored in a relational database.	SCAMPI, SCE, CPA IPI	Yes	Stand-alone	Yes

III. BUSINESS PROCESS MATURITY AND ASSESSMENT

A. Business Process Maturity Models and Assessment

The study by Röglinger et al. [9] provides a review of a set of BPMMs that focuses on their applicability and usefulness. It provides an in-depth 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 maturity model use. However, the design principles for their prescriptive use (which also covers assessment method) are largely unmet. The lack of prescriptive properties of the models causes difficulties in their applicability as a guiding approach. The study also reveals that the proposed BPMMs provide only limited guidance for assessment – i.e., identifying desirable maturity levels, and for implementing improvement measures.

The study by Van Looy et al. [8] compares and classifies 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, in accordance to a framework that they developed. The book authored by Van Looy [27] provides a comprehensive overview of the framework and the 69 maturity models. The study provides extensive reviews and comparisons of existing BPMMs, including their structural characteristics and point of focus, such as assessment and improvement.

Considering the two studies above and having an extensive search in basic digital libraries of scientific literature, we identified the generic maturity models that have been proposed for BPM. The literature search was performed for the studies published in academic journals and conference proceedings between the years 1990 and 2014 (October), as made available through the digital libraries of (in alphabetical order); ACM, Ebsco, Emerald, ScienceDirect, Scopus, SpringerLink, Web of Science, and Wiley. For retrieval from the digital libraries, the following string was taken as the 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*)).

The string aimed at retrieving all studies that refer to a BPMM (i.e., by proposing, applying, validating, classifying, or thoroughly analyzing that BPMM). In selecting relevant works, we targeted at studies using generic models proposed for business process maturity, business process management maturity, or business process orientation maturity.

Table II lists 9 maturity models that we selected out of 20 and considered 'leading' with respect to the attention they acquired in the academic research, as reported by a recent study of ours [11]. A BPMM is included in the table when the model is referred to (i.e. applied, validated, classified, or thoroughly analyzed) in at least two other articles with distinct authors that are different than those that have developed/released the model.

TABLE II. LEADING BUSINESS PROCESS MATURITY MODELS MOST REFERRED IN ACADEMIC LITERATURE [11]

Abbreviation	Business Process Maturity Model (BPMM)	Primary Source
(1) BPM-CF	Business Process Management Capability Framework	[28], [29]
(2) BPMM-FIS	Business Process Maturity Model	[30]
(3) BPMM-HR	Business Process Maturity Model	[31]
(4) BPMM-OMG	Business Process Maturity Model	[32]
(5) BPO-MF	Business Process Orientation Maturity Framework	[33]
(6) BPO-MM	Business Process Orientation Maturity Model	[34]
(7) PEMM	Process and Enterprise Maturity Model	[35]
(8) PMMA	Process Management Maturity Assessment	[36]
(9) vPMM	Value-based Process Maturity Model	[37]

Taking the studies referenced in the rightmost column of Table II as the primary source, we evaluated the BPMMs and their suggested assessment models/methods for; prescriptive and descriptive properties they hold, characteristics of the maturity model, characteristics of the assessment model, the separation of the assessment model from the maturity model, empirical evidence of usage provided by the primary source, and weaknesses and strengths of the models. Considering the framework of general design principles suggested by Röglinger et al. [9], we rated prescriptive and descriptive properties of the studies within four values in ordinal scale: None, Weak, Medium, and Strong. Table IV provides details of this evaluation. From the table we infer the following findings:

- Only two studies (regarding BPMM-OMG and vPMM) make a distinction between the maturity model and the assessment model.
- Only two studies (regarding BPMM-OMG and PEMM) refer to models that are publicly accessible.
- Four studies (regarding BPMM-FIS, BPMM-HR, BPMM-OMG, and BPO-MM) do not present empirical evidence for application or validation of their models.
- Prescriptive properties of the models are weaker in comparison to descriptive properties of the models.
- BPMM-OMG is the only model that has strong prescriptive and descriptive properties.
- BPM-CF, BPMM-HR, and BPO-MM have no prescriptive properties, but imply process improvement through their maturity levels.
- Though BPO-MF proposes a theoretical construct for Business Process Orientation (therefore included in our review), it defines neither a maturity model nor an assessment model - hence, prescriptive and descriptive properties are *not applicable*.

When we review the primary sources of the BPMMs listed in Table II in detail, we derive the following findings as specific to their assessment models/methods:

- Self-assessment is supported only by PEMM.
- Results provided by the assessments do not imply a specific level of business performance.
- The way the assessments are carried out is highly related to the prescriptive and descriptive properties of the models. The more detailed descriptive properties are, the more straightforward it is to carry out assessments. The more granular prescriptive properties are, the more straightforward it is to use the models as the base to carry out not only assessments but also process improvements.
- As an extension of the previous finding, the value of the results generated by the assessments might vary. The results may serve to understand the current level of maturity only or to draw an improvement path towards target maturity level.
- Being strong in both prescriptive and descriptive properties does not necessarily result in an easier application of a model. For example, BPMM-OMG is strong on both prescriptive and descriptive properties, yet its use by an enterprise operating in a specific domain (such as healthcare, finance, or manufacturing) is challenging due to the size, extensive coverage and generic content and structure. A well-defined adoption and assessment guidance for different domains can help to reduce the effort required for its use and assessment. Likewise, rated as medium on prescriptive and descriptive properties, PEMM is easier to apply by using two questionnaires incorporated in the model, which are essentially used to assess the maturity of each process in the enterprise and the enterprise-wide characteristics (such as the culture and leadership) of the organization as a whole.

B. Business Process Assessment (BPA) Tools

There are only few studies that report tools intended for business process assessment in the scientific literature. Table III summarizes the tools proposed by these studies with respect to: assessment method supported, availability of free or demo version, type of application (stand-alone or web-based), and support for self-assessment. The low number of studies that propose BPA tools can also be considered as an indicator of lack of assessment practice in the BPM field.

TABLE III. A COMPARATIVE LIST OF BPA TOOLS

Name	Published in Journal or Conference	Assessment method supported	Free (or demo) version?	Stand-alone or web-based?	Support for self-assessm.
The CIRCA CI Self-Assessment Tool v3.0 [38]	Journal (1999)	Continuous Improvement (CI) Capability Model	No	Stand-alone	Yes
Implementation Strategy, and a Generic Planning and Guidance Tool [39]	Journal (2003)	EFQM Framework	No	Stand-alone	Yes
The Intelligent Maturity Model-Tool [40]	Conference (2014)	BPMM-OMG, PEMM, etc. (extensible)	No	Stand-alone	No

TABLE IV. LEADING BUSINESS PROCESS MATURITY MODELS AND THEIR ASSESSMENT MODELS/METHODS

BPMM	Prescriptive properties	Descriptive properties	Maturity Model (MM) Details	Assessment Model (AM) Details	Separation of AM from MM	Empirical Evidence Reported	Weaknesses	Strengths
(1) BPM-CF	None (implicit to levels)	Strong	Aims toward the development of a holistic and widely accepted BPM maturity model, which facilitates the assessment of BPM capabilities. Has five maturity stages (1-5). Three levels are supported by the model are: Level 1 – the six factors; Level 2 – capability areas within each of the factors; and Level 3 – detailed questions to measure each capability area. 5 capability area for each of the 6 factors (a total of 30 capability areas)	References to Rosemann and de Bruin [28]. Assessment results are related to maturity via 'maturity stage' which is used to quantify and summarise the evaluation for one factor/scope/time item on a well-defined scale.	No	Pilot testing occurred in a small number of Australian organisations.	No empirical evidence for the correlation between the factors of the BPMM model and BPM success. Pilot testing of the BPMM model has only occurred in a small number of Australian organisations.	The dimensions of the model have been mainly derived from a comprehensive review of the literature on BPM. Model development utilizing a series of Delphi studies.
(2) BPMM-FIS	Medium	Strong	Has two dimensions. Dim-1 (The five levers of change): Strategy, control, process, technology, people -- that need to be aligned for each maturity state. Dim-2 (States of process maturity): 1. Siloed, 2. Tactically Integrated, 3. Process Driven, 4. Optimized Enterprise, 5. Intelligent Operating Network.	A 5x5 matrix combining the Levers of Change and the States of Maturity. The "Five Levers of Change" dimension provides the components about which we can assess the capabilities of any particular organization. As those capabilities advance, the company can progress through the second dimension of the model; that is, the States of Process Maturity.	No	No information	Companies rarely find themselves in a consistent state across all five Levers of Change. This can be problematic in that in order to achieve the benefits of being at a particular state, there must be alignment in terms of capabilities across Strategy, Controls, People, Process, and Technology. Lower levels of capabilities in one or more of these areas will inhibit the ability to achieve the maximum benefits that could be achieved at each state in the maturity model.	Provides clear direction to a company in this condition as to what needs improvement in order to reach the desired state.
(3) BPMM-HR	None (implicit to levels)	Medium	Has five maturity levels and defines general characteristics of each level. Uses the basics of process management; highlights vertical and horizontal alignment of measures, management and resources; and uses SCOR model of supply-chain management domain.	A Checklist for Evaluating the Maturity of an Organization/ Process. Using this checklist, you can look at processes and assign them a level, and make some notes about features the process has or doesn't have.	No	No information	Informal. Considers generic characteristics for the assessment.	Audits are informal and brief. Consultants usually ask managers to fill out questionnaires and then visit the site, review documentation, and ask questions to selected managers. The entire analysis effort takes from one to two weeks.
(4) BPMM-OMG	Strong (refers to SCAMPI method of appraisal [15])	Strong	Has five maturity levels and a number of process areas at each level (a total of 30 process areas).	SCAMPI method of appraisal that uses a well-defined rating mechanism.	Yes	No information	Measuring satisfaction of process areas and maturity levels is not a direct indicator of business performance or results. Process improvement against a maturity model can enhance business performance, but there are other factors that can also improve business performance, for example workforce development and management, use of technology, and refinement of the organization's business strategy. These different factors are inter-dependent. However, without paying attention to measures of the overall business performance and results, it is likely that different parts of an organization will work at cross purposes and the organization will suffer.	There are four primary ways in which the BPMM will be used and each will have different requirements for appraisals: <ul style="list-style-type: none"> - Guiding business process improvement programs - Assessing risk for developing and deploying enterprise applications - Evaluating the capability of suppliers - Benchmarking
(5) BPO-MF	Not applicable	Not applicable	Not applicable (Based on the holistic view, a theoretical construct for Business Process Orientation was developed. Has eight dimensions: Customer-orientation; process-view; organizational structure; process performance; culture, values and beliefs; people management; information technology; supplier perspective.)	Not applicable (Hypothesis testing to validate BPO constructs is applied.)	Not applicable	Yes (by a survey involving 30 companies)	Not applicable	Not applicable

BPM	Prescriptive properties	Descriptive properties	Maturity Model (MM) Details	Assessment Model (AM) Details	Separation of AM from MM	Empirical Evidence Reported	Weaknesses of AM	Strengths of AM
(6) BPO-MM	None (implicit to levels)	Medium	Has five maturity levels [41]. Defines a linear relationship between BPO and process maturity via BPO Maturity Attributes: Process view: definition, documentation, understanding. Process structures: team, collaboration, integration. Process jobs: ownership, authority, influence. Process measures: definition, ownership, linkage. Process values/beliefs: customer focus, credibility, trust.	Defines a total of 34 survey questions under the attributes of: <ul style="list-style-type: none"> - Process View - Process Jobs - Process Management & Measurements Systems - Interdepartmental Dynamics/ Interdepartmental Conflict - Interdepartmental Connectedness - Organizational Performance/ Measures of Esprit de Corps - Overall Performance 	No	No information	No information	A simpler composite list or survey instrument that offered easy use in measuring BPO within an organization.
(7) PEMM	Medium	Medium	Two distinct groups of characteristics that are needed for business processes to perform well and to sustain that performance: Process enablers (design, performance, owner, infrastructure, metrics) and enterprise enablers (leadership, culture, expertise, governance). The enablers are mutually interdependent: If any are missing, the others will prove to be ineffective.	Tables to assess maturity of the process and the enterprise. A total of 13 sub-items exist under each enabler. One can evaluate the maturity of a business process and determine how to improve its performance by using Process Assessment table. To determine if an organization is ready to support a process-based transformation, evaluate the statements in Enterprise Assessment table.	No	A number of improvement stories is provided (including Port Arthur, Shell, Clorox, and Schneider National).	Does not make the road to process transformation easy to traverse.	It identifies the characteristics that any process and every enterprise should have in order to design and deploy high-performance processes. The model's simplicity allows people to apply it themselves rather than rely on experts or consultants; employees are more likely to believe in and act on such assessments.
(8) PMMA	Weak (maturity level 3 achievements are provided as an example)	Medium	The Process Management Maturity Assessment (PMMA) follows the principle structure of the CMMI but provides a holistic assessment of all areas relevant for BPM based on a comprehensive set of criteria. As an indicator for process maturity, a five step model is applied. Consists of nine categories with one to three sub-categories each which correspond to the implementation topics of the Process Management Implementation Guide: Process Portfolio & Target Setting; Process Documentation; Process Performance Controlling; Process Optimization; Methods & Tools; Process Management Organization; Program Management, Qualification, Communication; Data Management; IT-Architecture.	For a sub-category, all defined criteria of a maturity level must be met to achieve the respective level. The overall result of a PMMA will be stated in a maturity level grade (e.g. 3,2). The PMMA result can be documented in a radar chart showing the level achievement for each category.	No	Yes (from Siemens)	A limitation is the consolidation of criteria to a single maturity level which may result in misleading interpretations.	Overall the PMMA not only provides a detailed analysis for BPM implementation factors but also increases the awareness for BPM success factors and for a sustainable management support. Since the PMMA is based on the principal structure of CMMI using defined maturity levels, structured questionnaires and work sheets, it is easy to use and an assessment of a respective organizational unit can be undertaken in a limited timeframe.
(9) vPMM	Medium (limited information is provided in [37])	No information (refers to Value-Based Agile Assessment)	The vPMM consists of 5 maturity levels, 23 KPAs, 52 specific goals and 5 generic goals for institutionalization.	Value-Based Agile Assessment (VBAA) -- A guideline for assessing the vPMM conformance (no detailed description is provided for VBAA).	Yes	Surveys by 12 representatives of the companies (called Voice of Customer)	No information	A model that can be used to determine the maturity of an organization's current business process practices by considering an organization's business value creation capability as well. It helps the organization set priorities for improving its operations for products/services (P/Ss) using a proven strategy and developing the capability required to accomplish its business values.

IV. KEY CHARACTERISTICS OF BP ASSESSMENT

As discussed in previous sections, the benefits of using process assessment in the BPM field have not yet been reaped. This is partly because the research on business process maturity is in its immature state and there is only few domain specific maturity models (e.g. supply chain management maturity model [42]) proposed in the BPM field. Another reason is the lack of practical guidance and/or tools for business process assessment or self-assessment. Considering the background provided in Sections 2 and 3 and specifically in Table IV, in this section we highlight the key characteristics of a business process assessment model/method and describe the basic requirements of an assessment tool that would facilitate business process assessments.

An assessment model should satisfy the needs of the assessors with diverse purposes. An assessment can be aimed internal or external to an organization (e.g. self-assessment vs. audit), planned as quick or detailed (e.g. half-day vs. a week), or carried out to evaluate high-level concerns or domain-specific ones (e.g. governance vs. healthcare process enactment). Therefore, such a model is expected to support assessments by considering different perspectives regarding assessment scope, body, and resources.

The flexibility mentioned above, however, comes with a trade-off and a related issue to consider is the degree of the independence of the assessment model from the *attributes* to be evaluated. These attributes are being called *factors, levers, enablers, dimensions, categories, capability areas* or *process areas* in the leading BPMMs shown in Table II. The more independent the assessment model from the attributes being evaluated, the more generic it is and the more challenging its usage would be. For example, SCAMPI is a generic assessment method suggested to carry out business process assessments based on OMG's BPMM. This makes the method flexible for different purposes of use, but also makes its understanding and adaption difficult in practice. The usage of a domain-specific maturity model might be helpful in this regard. Our proposition is that the more dependent the assessment model to the attributes being evaluated, the more specific it is for the intended purpose and also the easier it is to understand and use.

A business process assessment model should define and guide through the basic steps of process assessment to be carried out. Existing tools typically support the process artifacts as evidences of a particular capability but fail to provide guidance regarding the overall flow of the assessment process. Relevant assessment steps that can potentially be supported include the initiation, planning, preparation, data collection, data validation, attribute rating, gap analysis, results reporting, and information sharing. The granularity of data collection and attribute rating can influence the reliability of the results (e.g., the results driven by the process enactment data vs. by expert judgement). We propose that the rating scheme should be specific enough to support not only objective evaluation but also pragmatic use. We also propose that the reporting of the results with respect to the attributes in question is best represented using different

abstraction layers, from high-level to the evidence-based views.

Practical self-assessment of the business processes by the organizations themselves is another feature that should be considered for an assessment method. The organizations should be able to self-assess the maturity of their specific processes or the overall organization pragmatically with limited effort and without the need of external expertise. This would provide significant help in overcoming the initial resistance and barriers towards adopting business process maturity models in practice. The pre-requisites of the self-assessment should be carefully investigated and addressed by additional mechanisms for information sharing and process automation.

Although the term performance is used regularly in the leading BPMMs, the relation between BPA results and business performance is not directly addressed [11]. We find the consideration of this issue important while defining a BPMM and its BPA method to advocate the benefits of process assessments. The assessments and performance measurements can be repeated at different points in time, and the business performance in relation to the improved maturity can be established as a justification of the maturity model-based process improvement initiatives.

Since the practice and theory are interdependent in the process management, we argue that a tool that addresses the characteristics and concerns discussed above would facilitate and improve the state of the assessment practice in the BPM domain. Based on the discussions above, we provide a list of basic tool features as a continuation of our discussion:

- Maintain general assessment info (date, sources, etc.).
- Maintain the information regarding the organization/org. unit being assessed.
- Support the planning of the assessment.
- Support the mapping of organizational attributes to the attributes of the maturity model.
- Support self (quick) assessment.
- Support elaborated assessment.
- Support effective and practical rating of attributes.
- Support the gap analysis between the current state of the org. attributes and the attributes of the maturity model according to the targeted maturity level.
- Report assessment results at different levels of detail.
- Support the sharing and discussion of the assessment results within the organization.
- Provide overall guidance on the assessment process steps and artifacts.

V. CONCLUSIONS AND FUTURE WORK

Process-orientation helps organizations to improve the effectiveness and efficiency of their business practices. Business process assessment is a step to take in order to understand the current maturity level of these practices prior to drawing a roadmap for improvement. In this study, we outlined the current state of the process assessments as reported in the studies in the scientific literature; and as a response to our RQ1, we concluded that process assessment

in the BPM field is in its immature state. We identified key characteristics of a BPA method as a response to our RQ2, and provided a set of basic characteristics and features to consider when defining the basic requirements of a BPA tool.

A limitation of our study is that we based our analysis on the studies retrieved for the empirical applications of generic maturity models and their assessment methods in the BPM field, and not directly on the studies retrieved for business process 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.

Our future work will involve the requirements specification and development of a business process assessment tool, and the verification and application of its usability and efficacy in different business domains.

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