MARES - A Methodology for Software Process Assessment in Small Software Companies

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ABSTRACT

Most software process assessment models and standards focus principally on medium and large companies, complicating their effective and efficient application in small software companies due to their specific characteristics and limitations. This article provides an overview on the MARES methodology being developed in order to support software process assessment in small organizations in conformance with the international standard ISO/IEC 15504. The methodology is based on our experience on assessing various small brazilian software companies.

Keywords: Standard ISO/IEC 15504, Software process assessment, Software process improvement

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1 Introduction

One of the first steps in a software process improvement program is to analyze the current state of the organization's software processes in order to identify strengths and weaknesses as a basis for the determination of efficient and effective improvement actions. Such an analysis can be done through a process assessment, which is a disciplined examination of the processes used by an organization against a reference model with the objective to determine the capability of those processes or the maturity of an organization in order to perform within quality, cost and schedule goals.
However, small software companies (with about 1- 49 employees) find it particularly difficult to run assessments in conformance with international standards or models, such as, ISO/IEC 15504, CMM/CMMI for software or ISO 9001 (including 9000-3) due the principal focus of these models and standards on medium or large organizations. However, characteristics and limitations typical for small software companies, such as, e.g., informal communication, which enable them to be creative, agile and innovative in order to achieve their business goals, require the adaptation of existing assessment methods. These adaptations demand a considerable amount of effort, time, infrastructure and experience - extremely limited resources in small software companies as, generally, their primary objective is to get the product out in order to survive.
Although, some customizations of existing assessment standards and models have been proposed, so far, only a small percentage of small software companies has performed assessments. This reveals a serious situation, considering, that in many countries a large share of software companies ranges typically from 3 - 20 employees indicating their great economic importance. Therefore, customizations of assessment models and methods are required, which provide ready support for their application at low costs in small organizations and provide reliable results in order to effectively guide process improvement with respect to their business objectives.

2 The International Standard ISO/IEC 15504

ISO/IEC 15504[1] is an international standard that provides a framework for the assessment of processes with two objectives:

- for process improvement to understand the state of the organization's processes using the results for the elaboration of improvement plans
- for capability determination to determine the suitability of the organization's processes for a specific requirement or contract.

Process assessment, as defined in 15504, is based on a two-dimensional model composed of a process and a capability dimension (see Figure 1).

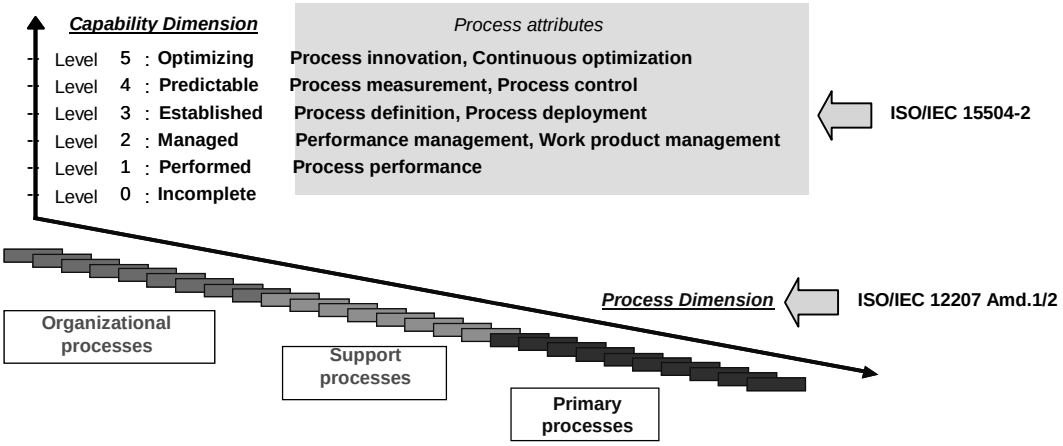

Figure 1. Dimensions of ISO/IEC 15504

The process dimension defines a set of processes. It is based on an external Process Reference Model, which defines a set of universal processes. This enables the flexible application of the standard directing the assessment to the characteristics of a specific context. For software processes, part 5 of the standard ISO/IEC 15504 contains an exemplar Process Assessment Model based upon the Process Reference Model defined in ISO/IEC 12207 Amd. 1/2[2].

The capability dimension is defined on a six point ordinal scale ranging from incomplete, to optimizing as described in the measurement framework in part 2 of ISO/IEC 15504. It provides a schema for characterizing the capability of a process with respect to a Process Assessment Model based upon a set of Process Attributes. Each of the Process Attributes defines a particular aspect of process capability (see Figure 1). The extent of process attribute achievement is characterized on a four point ordinal rating scale, ranging from N-not achieved to F-fully achieved and is being indicated through a set of Process Attribute Indicators associated to each Process Attribute. Concerning capability level 1, these indicators are related to the process dimension regarding the extent of achievement of the process purpose and outcomes. With respect to capability level 2 to 5, the indicators are related to activities, resources or results associated with the achievement of the respective process attribute's purpose. The assessment result consists of a set of Process Attribute ratings for each process assessed, denominated Process Profile. It may also include the capability level achieved by that process, which is determined based on the combination of the achievement of the Process Attributes.

3 Related Work

Today various models and standards for software process assessment exist. In the context of small software companies, the standard ISO/IEC 15504 offers a flexible model, covering a

broad scope of, not only, technical processes. Its applicability in this kind of organization has also been shown through the SPICE trials[3]. However, as the standard itself defines only a minimal set of generic requirements for an assessment, it does not provide in itself sufficient support for its ready application in a small software company. Adapting the standard to this specific kind of organization, some methods have been developed, such as:

- **RAPID (Rapid Assessment for Process Improvement for software Development)**[4] developed by the Software Quality Institute (Australia) defining an assessment method, which is intended for use by experienced ISO/IEC 15504 assessors for process improvement in small and medium enterprises.
- **SPINI (An approach for SPI Initiation)**[5] developed by Tampere University of Technology (Finland) for conducting SPICE-compatible assessments in small organizations with the objective of process improvement.
- **FAME (Fraunhofer Assessment MEthod)**[6] developed by the IESE (Germany) which allows to perform either a SPICE or BOOTSTRAP assessment focusing on improvement. In addition, especially for small software companies, a FAME Light Assessment can be done in a one-day workshop.
- **TOPS (Toward Organised Processes in SMEs) project**[7] as part of the ESPRIT/ESPINODE initiative for Central Italy resulted in the development of an assessment method for small and medium enterprises based on ISO/IEC 15504 focusing on process improvement.

An approach frequently applied in small software companies is to run an overview assessment in a one-day workshop focusing on a first diagnostic instead of assessing in detail various software processes. Others perform a 15504-conformant assessment of a small number of processes. These methods either pre-define a fixed set of processes, such as RAPID (limited to a set of eight processes) or TOPS (3 standard processes), or select a set of processes in correspondence with the characteristics of an organization. All 15504 conformant methods are, principally, based on the Process Reference Model as defined in ISO/IEC 15504-5. The structure of the capability dimension is identical to ISO/IEC 15504-2 focusing mostly on assessments up to level 3. The assessment process is strongly based on the requirements for performing a conformant assessment defined in 15504-2. Few methods include an initial step before the actual assessment in order to characterize the context and to guide the selection of the processes to be investigated. As a result of the assessments, key findings, including, the process profiles, strengths and weaknesses and, optionally, improvement recommendations, are reported. Tool support for the method FAME also enables the export of the assessment results as a basis for process modeling.

4 MARES - A Methodology for Software Process Assessment in Small Software Companies

In order to effectively and efficiently support process improvement in the context of small software companies, considering their specific characteristics and limitations, we developed in cooperation with the CenPRA a customized assessment methodology, denominated MARES, in conformance with the standard ISO/IEC 15504.

The assessment methodology is basically composed of (see Figure 2):

- a process assessment model based on the exemplar model of Part 5 of ISO/IEC 15504, including a process reference model and a measurement framework, as well, as a context-process model and a process-risk model.
- an assessment method that meets the requirements of the assessment process defined in 15504-2, including also guidelines for its application in small companies and document templates.

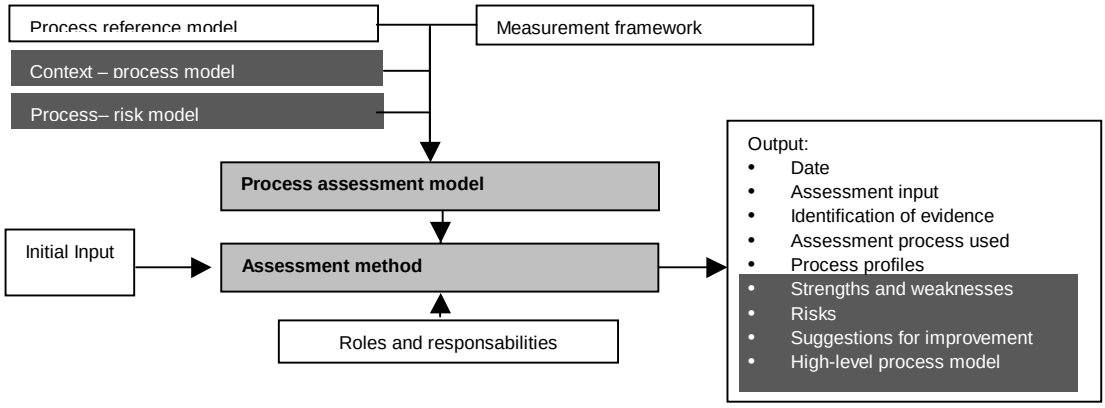

Figure 2. Overview on the MARES methodology

4.1 The MARES Process Assessment Model

In designing the MARES process assessment model, the exemplar assessment model of Part 5 of ISO/IEC 15504 is taken as a basis. The capability dimension is adopted as-is from capability level 0 up to level 3. Capability level 4 and 5 are not considered due to the, generally, low level of capability encountered in small software companies.

The MARES process dimension has also been developed based on ISO/IEC 15504-5. However, due to the characteristics of small software companies, some processes of the exemplar model have been disregarded as being irrelevant in most cases. For example, as most small companies do not have subcontractors, processes related to the Acquisition Process Group have not been considered. However, if any of these turns out to be an important process in a specific context, it can easily be re-integrated based on ISO/IEC 15504-5. In addition, some processes (e.g., Project Management and Risk Management) have been re-grouped into one process. The resulting subset of processes considered relevant in the context of small software companies is shown in the following table.

Process Category	Process Group	Process Identification	PAM Process Name	Comments
Primary Life Cycle Processes	Supply process group	**SPL.1**	Supplier tendering	
		SPL.2	Product release	
		SPL.3	Product acceptance support	
	Operation process group	**OPE.2**	Customer support	
	Engineering process group	**ENG.1**	Requirement Elicitation	
		ENG.4	Software requirements analysis	
		ENG.5	Software design	
		ENG.6	Software construction	
		ENG.7	Software integration	
		ENG.8	Software testing	
		ENG.11	Software installation	
		ENG.12	System and software maintenance	Limited to software maintenance
Supporting Life Cycle Processes Category	Configuration Control process group	**CFG.1**	Documentation	This process is generally assessed only until level 1.
		CFG.2	Configuration management	This process is generally assessed only until level 1.
		CFG.3	Problem resolution management	
		CFG.4	Change request management	
	Quality Assurance process group	**QUA.1** QUA.2 QUA.3 QUA.4	Quality assurance Verification Validation Joint review	The processes QUA.2/QUA.3/QUA.4 are only considered on a high-level directly as part of QUA.1. This process is generally assessed only until level 1.
Organizational Life Cycle Processes Category	Management process group	**MAN.3** MAN.4 MAN.5	**Project management** Quality management Risk management	The processes MAN.4/MAN.5 are only considered on a high-level directly as part of MAN.3. This process is generally assessed only until level 1.
	Reuse process group	**REU.1**	Asset management	
		REU.2	Reuse program management	
		REU.3	Domain engineering	

In addition, the process assessment model is enhanced by a context-process model, which helps the competent assessor to adapt the standard appropriately to a specific organization. The context-process model is composed of generic heuristics indicating the relevance of processes based on:

- context characteristics (e.g., if an organization does not provide any support, the process “Customer Support” may be irrelevant),
- business and improvement goals,
- well-known problems, and

- expected cost/benefit relation of improving a particular process.

The respective capability levels to be achieved are indicated based on heuristics related to growth patterns models[8], which represent a company's evolution through various stages on their transition process from start-up to maturity. For example, an organization in its existence phase may focus on finding customers and delivering products in order to become a viable business. Therefore, it may be sufficient to focus on achieving level 1 of relevant processes, such as, "Supplier Tendering".
An initial version of the context-process model is being defined based on our experiences[9] and literature[1,10,11,12]. However, as currently insufficient data and experiences are available, our major focus is on its continuous evolution by systematically capturing and analyzing assessment results and experiences over time.

In order to provide further support for process improvement, MARES also aims at the indication of process-related risks and improvement suggestions as an additional assessment result. Therefore, a process–risk model is currently being developed[13], which explicitly points out potential risks, causes and improvement suggestions related to the non-achievement of Process Attributes. For example, if, during the assessment of the Software Construction process, it becomes clear, that software units are not verified (non-achievement of base practice BP4 regarding the Process Attribute PA1.1 related to the performance of the process), a potential risk may be a low reliability of the software system being developed. A possible cause for the cancellation of the verification, may be time pressure as a result from unrealistic estimates. Consequently, an improvement suggestion could be to establish a systematic project management process.

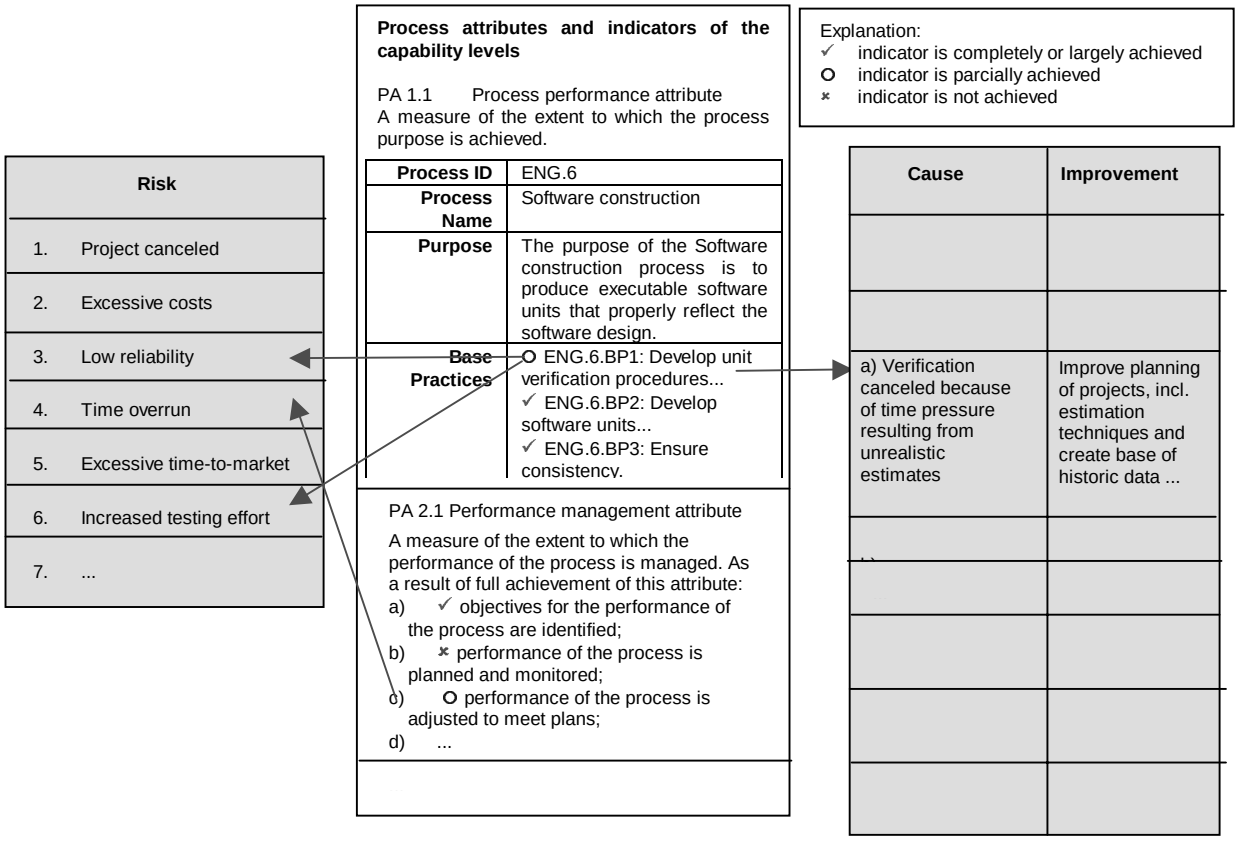

Figure 3. Process-risk model

The initial version of the model being developed is based on literature[1,14,15] and our experiences with emphasis on its continuous evolution.

4.2 The MARES Assessment Method

The MARES assessment method is based on the requirements for performing an assessment as defined in ISO/IEC 15504-2. In addition, a contextualization phase in the beginning of the assessment is added in order to characterize the company, to obtain a general understanding on the complete software process and to systematically support the selection of the processes to be assessed.

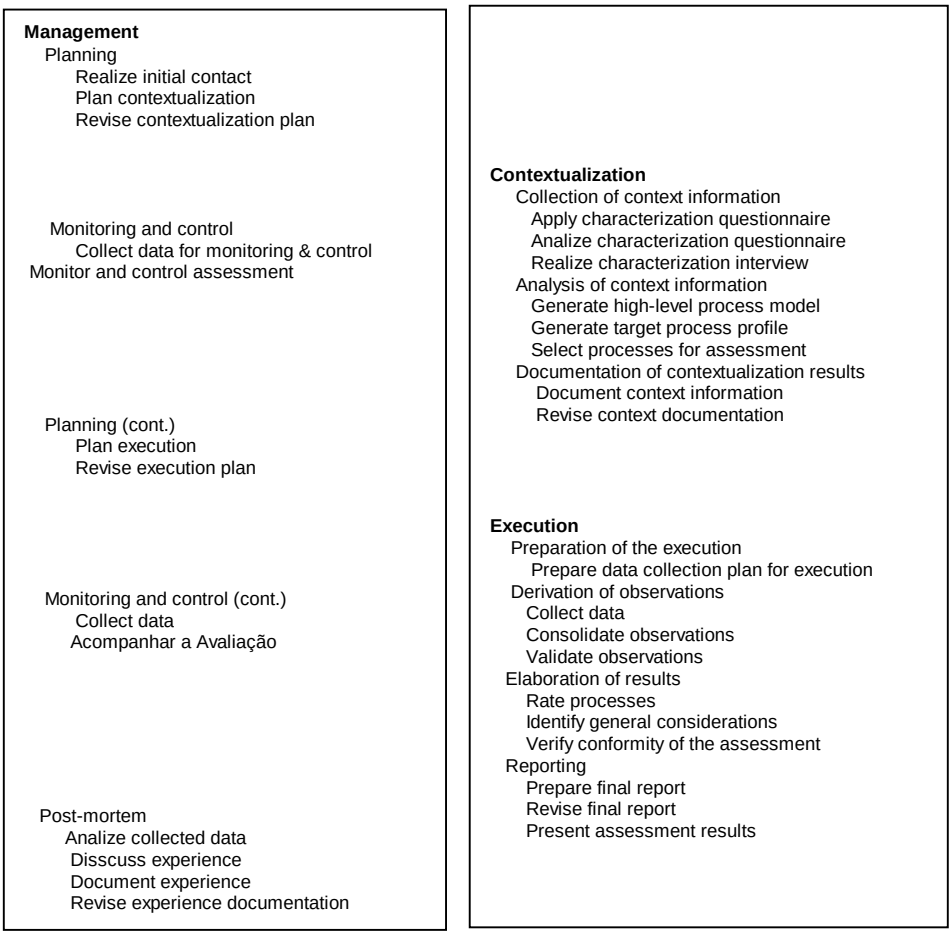

Figure 4. Overview on the MARES assessment process

Planning: During the planning phase, the assessment is organized and planned, including the definition of the purpose(s) for performing the assessment, its scope, available resources, constraints, schedule and the required output. In addition, participants and their responsibilities are identified. We suggest that an assessment is, in general, performed by an assessment team, composed of a competent lead assessor and a support assessor. Participants from the organization are the sponsor of the assessment and representatives involved in the software process.
The planning is divided into an initial phase in the beginning of the assessment and a refinement of the initial plan based on information obtained during the contextualization once the processes to be assessed have been selected. As a result, an assessment plan is explicitly documented and revised.

Contextualization: In the beginning of the assessment, the organization is characterized in order to understand its goals, software product(s) and the complete software process (see Figure 5). In our experience, such a general exploration is necessary, as most small organizations do not have an explicit understanding in advance. In order to collect general information, we recommend to first use a questionnaire. However, we observed, that, generally, the validity of the information collected by questionnaire might be quite low, due to a lack of software engineering knowledge often observed in the context of small companies. Therefore, we suggest to revise and complete the information by interviewing representatives of the organization. During this interview, the complete software process of the organization should be briefly discussed in order to obtain a high-level understanding. The importance of processes, improvement goals and quality aspects wrt. the business goals should be explored, as well, as the organization's current capability in executing these processes.
As results of this phase, target profiles are defined, indicating high-priority processes and their capability level to be achieved in order to meet the organization's goals. This may be supported by the context-process model explicitly pointing out relationships between identified goals, quality aspects and the organization's growth stage.
Based on a further analysis of the information using, for example, the SWOT analysis technique[12], principal strengths and weaknesses of the software process are identified. The obtained understanding is used in order to refine the assessment strategy and to systematically select the processes to be assessed. We recommend to select a small number of processes (e.g., 2-3) to be investigated in detail in order to keep the cost low. Based on our experience, limiting the scope still provides relevant results, as during the contextualization phase, a high-level view on the entire software process is obtained. Criteria for the selection are the importance of the process wrt. the business goals, its weakness, as well, as the expected cost/benefit relation wrt. improving the process.

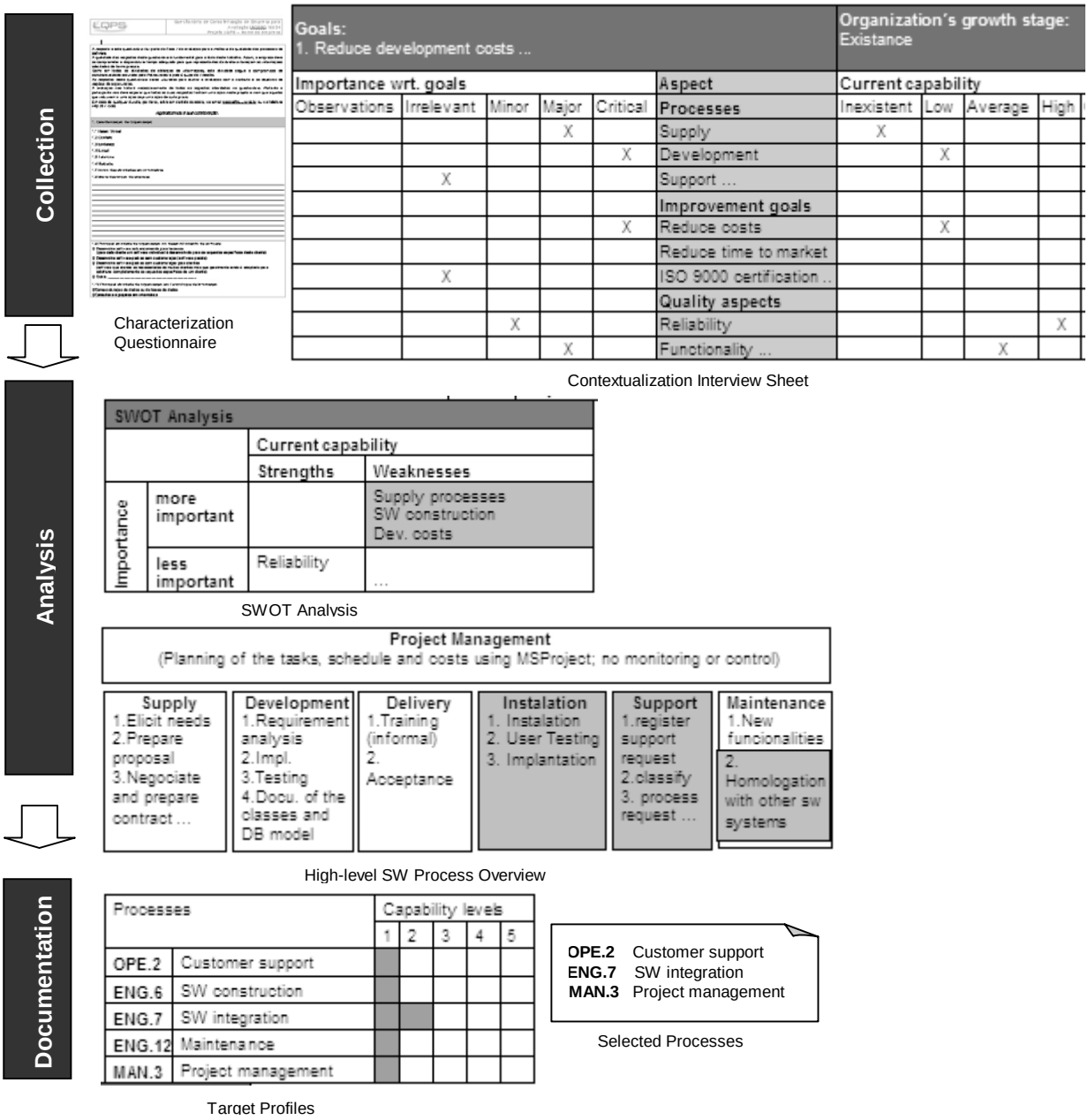

Figure 5. Overview on the contextualization process and related artifacts

All results of the contextualization phase are documented as part of the assessment report and revised. Based on the results of the contextualization phase, the assessment plan is updated and completed.

Execution: In the next phase, the selected processes are assessed in detail (see Figure 6). Therefore, the data collection is prepared, including the refinement of the strategy and techniques to be used for collection and analysis, as well, as the definition of process attribute indicators.
Then, the required data is collected by interviewing representatives of the organization from different points of view involved in the respective process(es) and by analyzing related artifacts.

Typically, the lead assessor moderates the interview and notes are taken by the support assessor using a specific form, which indicates also the sources of the data. Again, based on our experience, we discourage the usage of questionnaires, as often invalid data may be collected.
The collected evidence is then analyzed by the assessors mapping the data to the indicators of the process assessment model. This is explicitly documented by stating the consolidated observations and briefly indicating the level of achievement of the indicators in order to facilitate later on the rating for the process attributes.
The observations are then validated by representatives of the organization during a feedback session in order to ensure that they accurately represent the assessed process(es). In addition, the assessors validate them in order to ensure their objectivity, consistency and sufficiency wrt. the scope of the assessment.
Then, the capability of each process is rated unanimously by the assessors resulting in the definition of a set of assessed process profiles based on the validated evidence.
By comparing the assessed process profiles to the target profiles and considering the results of the contextualization phase, general strengths and weaknesses are identified. In addition, potential risks and improvement suggestions are identified by analyzing the gaps between the target and the assessed process profiles supported through the process-risk model[13].
All results of the assessment, including also the verification of the conformity of the assessment to ISO/IEC 15504, are documented in a report, which is revised and delivered to the organization. The results of the assessment are also presented to representatives of the company. During the presentation, the identified strengths, weaknesses and improvement suggestions are discussed in order to motivate and initiate the planning of improvement actions.

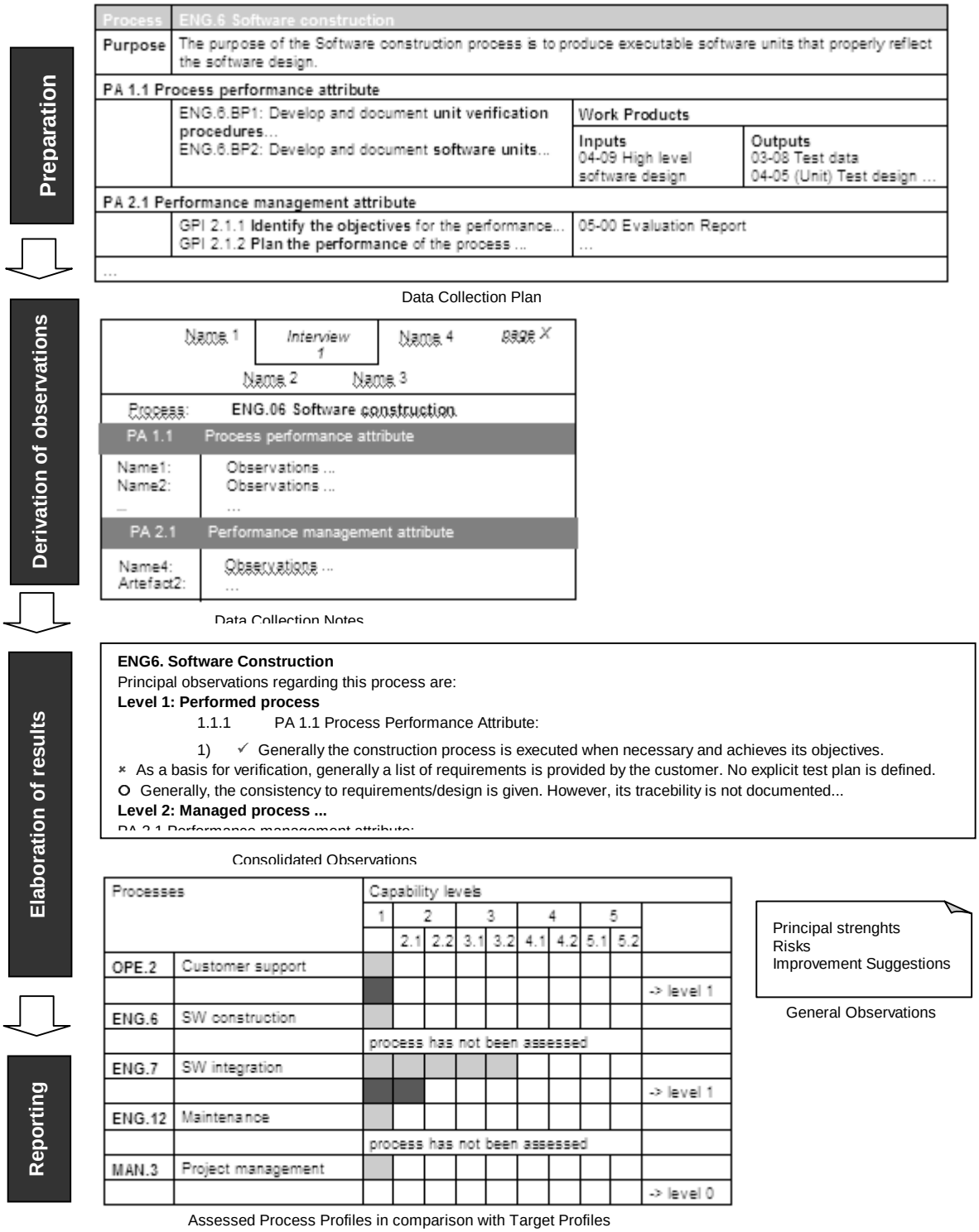

Figure 6. Overview on the execution process and related artifacts

Monitoring and control: All activities during the assessment are monitored and controlled wrt. the assessment plan. If necessary, corrective actions are initiated and the plan is updated accordingly.

Post-mortem: Once the assessment is finished, a brief post-mortem session is held among the assessors in order to discuss the performance of the assessment as a basis for the continuous improvement of the assessment method. Further feedback on the execution of the assessment, its results and benefits is also provided through a questionnaire to be answered by the assessment sponsor.

5 Conclusion

In this report, we present an overview on the MARES process assessment methodology for the assessment of software processes in small companies in conformance with ISO/IEC 15504. We enhanced the process assessment model basically by integrating a context-process model in order to support the selection of relevant processes and a process-risk model in order to support the identification of potential risk and improvement suggestions. In addition, we add a contextualization phase in the beginning of the assessment process in order to systematically support the characterization of the context and the selection of the processes to be investigated. Currently, we are also developing tool support for the MARES methodology[17]. So far, first applications in practice indicate its beneficial applicability in small software companies. Further case studies are planned in order to broaden the validation of the method.

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