A Method for Process Assessment in Small Software Companies

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Abstract

As part of the research project 15504MPE, an assessment method with the objective of process improvement adapted to small brazilian software companies based on the standard ISO/IEC 15504 is being developed. The objective of the customization is to facilitate the application of 15504 also in small software companies in order to enable quality and productivity improvement. The method includes an adapted and enhanced assessment model based on the ISO 15504 exemplar model. In addition, the assessment process has been adapted and refined in order to satisfy the specific requirements of small software companies and been detailed in order to provide ready support. Various assessments in small software companies were performed as a basis for the development of the method and, initiating the validation of the method, so far, one pilot assessment has been performed. [1]

1. Introduction

Today, the software industry is one of the most rapidly growing sectors. This situation incentives especially the constant creation of new small software companies, which play an important role in the economy. However, many of those small software companies are facing several problems regarding quality and productivity caused by organizational and administrative deficiencies, which may harm their competitiveness. Therefore, it is vital for the long-term success of these companies to identify problems and systematically establish improvement actions. In order to identify these particular strengths and weaknesses, process assessments have been used. These assessments are performed against process models. Various models and frameworks for software process assessments have been used, such as, ISO 9001, SW CMM/CMMI, ISO/IEC 15504 and others. In comparison, a principal advantage of ISO/IEC 15504 is its flexibility, which facilitates the adaptation of the standard to a specific context, such as, for example, small software companies. However, as 15504 in itself does not provide an assessment method, considerable effort and experience is still required in order to apply the standard in the context of a small software company. Therefore, the objective of this paper is to present an assessment method customized for the application of the 15504 standard in small software companies currently being developed in the research project 15504MPE [6] in cooperation with the UNIVALI and the CenPRA (Brazil).

2. Context: Small Software Companies

In general, there does not exist a unique definition of a small software company. In Brazil, a frequently used definition is the following one, which also separates micro from small companies [8]:

- Micro company: 1 to 9 employees
- Small company: 10 to 49 employees

However, as internationally usually a company with less then 50 employees is classified as small, without separating micro companies, we also use this classification of small software companies (SCs) in this paper.

A specific type of SCs are start-up companies, representing recently founded small companies. Small software development departments of medium or large companies also have similar characteristics to small

[1] This work has been realized with support of the CNPq, an entity of the Brazilian Government directed to scientific and technological development.

software companies. However, they are different, as they normally have access to organizational resources, e.g., SEPG, not available to SCs.

Small software companies develop a broad spectrum of application types in diverse domains and they are very important for an economy, especially in an emergent country, such as Brazil. Generally, they attend a share of the market not considered by large companies, build components for products of other companies, initiate the development of innovative products, or offer services or maintenance for products produced by others. Typically, their customers are the final users and the commercialization for the products is done in a direct, informal way. Most of those companies have one or few standard software products, which address the needs of multiple users and may be customized to fit additional customer requirements. This customization may vary from simple parametrization, assembling a tailored system from existing components to partial implementations for added requirements. The development may be based on existing components, either produced in-house or third party, such as COTS or open source components. Periodically, new versions of the product are released. Fewer companies offer services including the usage of a software system or develop individual software in a project-oriented context by building individual software for a specific customer. Most software developing SCs in Brazil also install their software systems and provide support. Generally, they do not have subcontractors.

Regarding the software process, we can observe that most SCs achieve only a low level of capability. In general, SCs develop software in an informal way, focusing on the construction of the software with the principal objective to get the product out in order to survive. Most SCs do not use a defined software process, nor use measurement.

Typically, SCs in Brazil are created with a small capital being financed basically by its owner(s) due to difficulties in their access to venture capital and, therefore, have only very limited financial resources. SCs also have only a small number of employees, which especially in the software sector require a high level of specialized education. They often assume various roles and work in different projects in parallel. Most SCs have a flat hierarchy with direct communication and coordination. This allows greater visibility and can enable the early detection of problems, as well, as the agile and efficient adaptation of the company to changes. On the other side, informality can turn the company more fragile, as well, as hinder its growth. Another characteristic, especially of start-up companies, is their lack of systematic management, as normally the owners of the companies have only limited administrative capacity and little software engineering knowledge. In general, small companies are very sensitive to external influences, such as investors, customers or the market and, therefore, constantly change to maintain competitive advantage. Thus, similar to any other type of software company, SCs frequently face problems related to the quality of their products and the duration and cost of their projects. However, generally SCs face these problems to an extreme due to their specific characteristics and limitations.

3. A Method for Process Assessment in Small Software Companies

Based on these typical characteristics of small software companies as described in the previous section and our experiences applying 15504 in this specific type of company, we identified the following requirements for a customized assessment method for SCs:

R1. Low assessment cost, which means low amount of effort spent in the assessment.

R2. Reliable assessment results that allow to take correct improvement actions.

R3. Detailed description of the assessment process including explicit guidance for its application in practice, its customization to a specific context, and document templates.

R4. Flexible assessment method wrt. the processes to be assessed and providing guidance for their selection.

R5. Detailed definition of the assessment model, including the measurement framework and a process reference model according to the specific characteristics of SCs.

R6. Support for the identification of risks and improvement suggestions as additional result of the assessment.

R7. Support for the description of a high-level model of the assessed processes as additional result.

R8. Conformity with ISO/IEC 15504.

R9. Not requiring any specific software engineering knowledge from the company representatives. (The assessors have, of course, to be competent in accordance with 15504).

R10. Supported by a software tool covering the complete assessment process.

R11. Integrated in an assessment methodology enabling the continuous improvement of the assessment method.

R12. Public availability.

In accordance with these requirements, a customized process assessment method is currently being developed as part of the MARES[2] methodology for process assessment in small software companies, which basically consists of:

- 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 relationship model and a process-risk relationship model.
- an **assessment process** that meets the requirements of the assessment process defined in 15504-2, including also guidelines for its application in SCs and document templates.
- an **assessor accreditation method**, which defines a procedure by which a formal recognition is given that a body or person is competent to carry out an assessment based on 15504-3.
- an **assessment monitoring method** which enables the constant monitoring of the assessment methodology as a basis for continuous improvement.

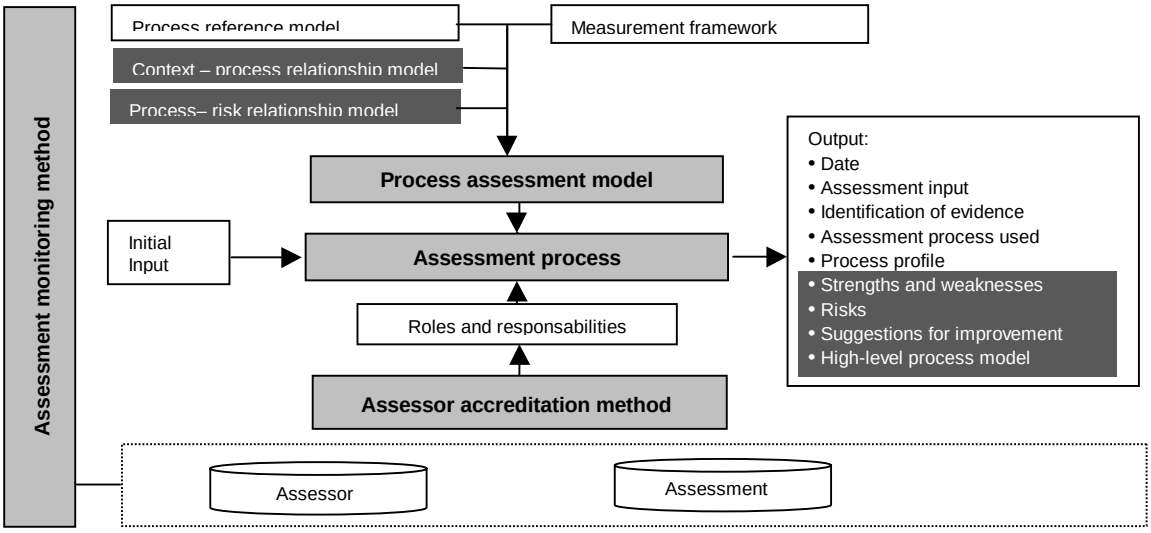

Figure 1. Overview on the MARES assessment methodology

The process assessment method is described in the following sections. As the focus of this paper is on the assessment method, we do not further detail the assessor accreditation method or the assessment monitoring method here.

3.1 The MARES Process Assessment Model

In designing the MARES process assessment model, the exemplar assessment model from Part 5 of ISO/IEC 15504 is taken as a basis. The capability dimension from the Part 5 exemplar assessment model is adopted as-is from level 0 to 3. The MARES process dimension has also been developed based on ISO/IEC 15504-5. However, due to the specific characteristics of SCs, several processes of the exemplar assessment model have been excluded as being irrelevant in most cases. For example, due to the fact that most Brazilian SCs do not have subcontractors, all processes related to the Acquisition Process Group have been excluded. However, if in a specific context this turns out to be an important process, it can easily be re-integrated based on ISO/IEC 15504-5. In addition, some processes (e.g., Supplier Tendering and Contract Agreement) have been unified into one process.

The process assessment model is also enhanced by the definition of a context-process relationship model, which models the relationship between the specific characteristics, known problems and business goals to relevant processes in form of heuristics. The model has been defined based on our experiences and literature [1,10,11,4]. The model serves as a support for the selection of the processes and capability levels to be assessed wrt. the specific characteristics of an organization.

To provide systematic support for a risk analysis integrated into the assessment, a process–risk relationship model is currently being defined. The model consists basically of a matrix (see Table 1), which indicates a generic relationship between the non-

[2] MARES – Metodologia de Avaliação de Processos de Software (in english: Software Process Assessment Methodology)

achievement of a certain level of capability with a risk in the software sector based on [5,7] and our experiences.

Table 1. Example of process/capability level - risk relationship matrix

+ strong relationship *o weak relationship* *- no relationship*		**Risk 1: Costs overrun**	**Risk 2: Error-prone sw**	**...**
Processes	**Capability level**			
...				
ENG 3.5. SW Design	Level 1	-	+	
	Level 2	+	o	
	Level 3	o	o	
...				
SUP1.4. Change request management	Level 1	+	-	
...				
MAN1.3. Project management	Level 1	+	o	

In addition, in order to provide support for detailed information in the assessment report, risk sheets are defined, providing further information on the particular risk, describing, e.g., root causes and associated problems. In order to also provide more concrete support for the planning of improvement actions, potential improvement actions are explicitly related to the respective risks in the risk sheet.

3.2 The MARES Assessment Process

The MARES assessment process (see Figure 2) is basically based on the process defined in ISO/IEC 15504, except to the contextualization in the beginning of the assessment, which aims at the characterization of the company to be assessed and to obtain a general understanding on the software processes.

Planning: During the planning phase, the assessment is organized and planned. This includes the definition of the assessment resources, constraints, schedule and the identification of the assessment participants and their responsibilities, as well, as the preparation of the required documents.

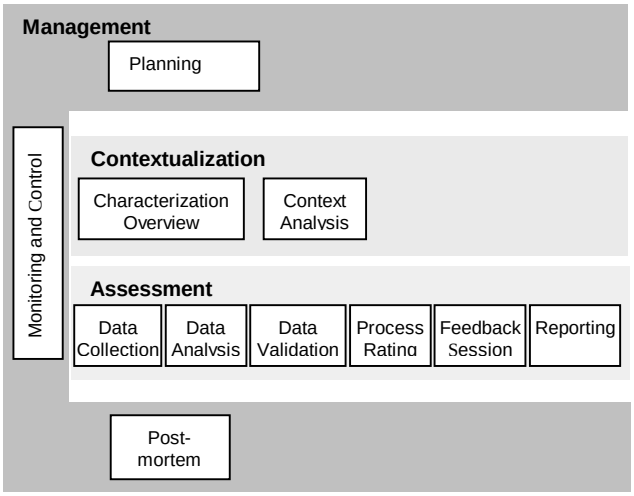

Figure 2. Overview on the MARES assessment process

Contextualization: In the beginning of the assessment, the company is characterized in order to understand the context and to gather a general understanding on the software processes. These results are also used to select the processes and the capability levels to be assessed. The contextualization is done using a questionnaire focusing on general information of the company. The gathered information is then revised and completed during an interview with representatives of the company, in which specifically the business goals and well-known problems of the company are discussed. In addition, all software processes are discussed briefly. This information is then analyzed by visualizing and describing the relevant processes in a kind of high-level process model indicating also specifically relevant or problematic processes (see Figure 3).

Using the SWOT analysis technique [13], the principal strengths and weaknesses of the company are identified and considering its business goals, target profiles for the company indicating the most important

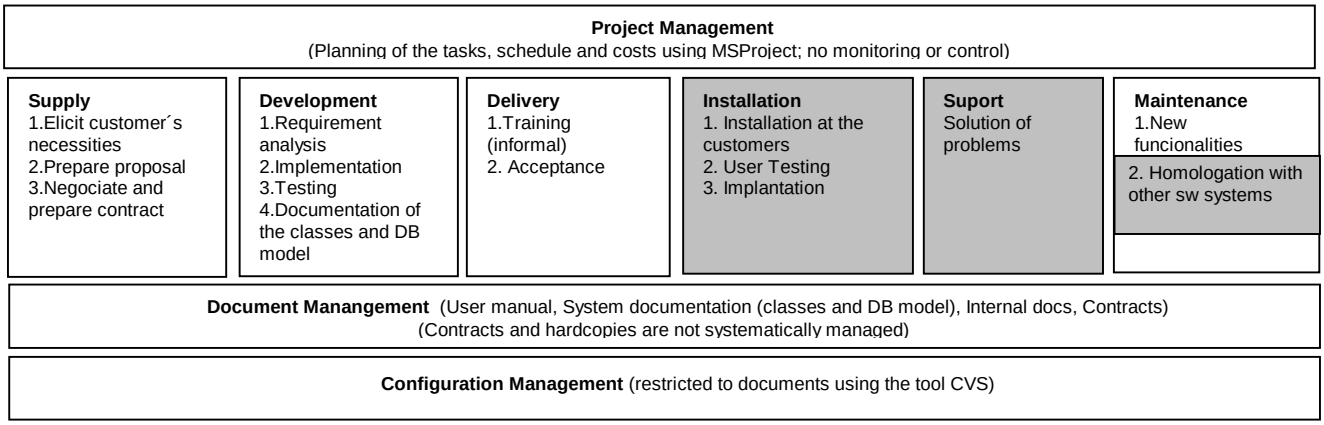

Figure 3. Example of a high-level process model visualization

key processes and their respective capability level are determined. The definition of the target profiles is further supported through the context-process relationship model. Based on these target profiles, 2-3 processes are selected to be investigated during the assessment. The principal criterion for the selection is the expected cost/benefit relation regarding the improvement of the processes.

Assessment: In the next step, the selected processes are investigated. This is done by interviewing representatives from different points of view of the company and analyzing documents related to the processes. The interview is structured by the indicators defined in the assessment model and supported by an interview plan, which briefly lists the items to be elicited. No specific questionnaire or checklist is used for the interview in order to allow the companies´ representatives to explain freely how the processes are being executed. The interview is typically moderated by the lead assessor and notes are taken by the support assessor. For taking notes a specific form has been used indicating in the header also the names of all interviewees in order to facilitate later the analysis.

Name 1	Interview 1	Name 4
Name 2	Name 3	page X
Process:	**ENG.06 Software construction**	
PA 1.1	Process performance attribute	
Name1: Name2: Name1:	**ENG.6.BP1 : Develop unit verification procedures** Observations ... Observations ... **ENG.6.BP2 : Develop software units**	
PA 2.1	Performance management attribute attribute	
Name4:	**Objectives for the performance of the process are identified** Observations ... **...**	

Figure 4. Example of data collection form

The collected data is then analyzed by the assessors mapping the observations to the indicators of the assessment model. In addition, the high level description of the processes being assessed is refined.

Representatives of the company then validate the analysis results in order to ensure that the collected evidence correctly represents the companies´ processes. In addition, the results are validated by the assessors in order to ensure their consistency and that sufficient data for the scope of the assessment has been gathered.

Then, based on the validated evidence, the processes are rated in consensus by the assessors resulting in the definition of the process profiles. By comparing them to the target profiles and considering the information gathered in the contextualization, strengths and weaknesses are identified. In addition, based on the assessment results using the process–risk relationship model, potential risks and improvement suggestions are identified.

The results of the assessment are then presented to representatives of the company. Risks and improvement suggestions are discussed in order to motivate improvement actions. All results are explicitly documented in a report, which is revised and then delivered to the company.

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

Post-mortem: Once the assessment is finished, a brief post-mortem session is done by the assessors in order to identify what worked and what not during the assessment as a basis for the continuous improvement of the assessment method.

The MARES assessment process is explicitly documented in form of an Electronic Process Guide by defining for each phase, its objective, entry/exit criteria, inputs/outputs, a breakdown of activities (including a description, guidelines and indicating tools and techniques used), roles/responsibilities and typical effort and duration information. In addition, for each work product a document template is defined.

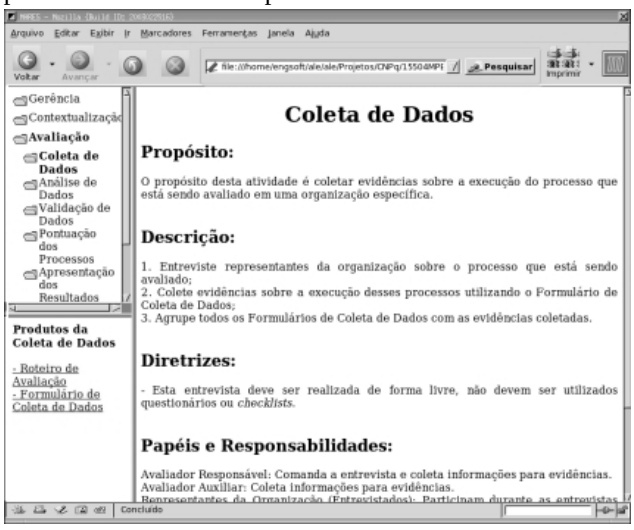

Figure 5. Example screen of the Electronic Process Guide

4. First Evaluation Results

Currently, a first version of the MARES process assessment method has been developed and we are starting to validate the method in replicated case studies. So far, we have applied the method in one small software company[3] in Florianópolis, Brazil. The company has been founded in 1999 including a total number of 8 people focusing on solutions for electronic information transmission principally in the health domain.

During the case study, the MARES assessment process has been applied as described in Section 3.2. As a result of the contextualization, a high-level process model identifying relevant processes in the context of the company has been described (see Figure 3). Based on this first understanding some principal strengths and weaknesses were already identified. For the assessment, 3 processes were selected: Software Integration, Software Installation and Customer Support. The assessment was done by 2 assessors and two representatives of the company participated.

Table 2 shows the effort spent during the assessment. Due to time conflicts, the assessment took place during a period of 3 weeks, but could have also been realized in 3 consecutive days.

Table 2. Effort distribution

Activity	**Effort (person-hours)**	
	Total effort of companies´ representatives (2)	**Total effort of assessors (3)**
Planning	1	2
Characterization overview	1	1.5
Context analysis	3.5	8.5
Data collection	5	9
Data analysis	--	6
Data validation	2	3
Process rating	--	4
Feedback session	2	3
Reporting	--	11.5
Monitoring & control	--	1
Post-mortem	--	1.5
Total		**65.5**

An analysis of the assessment method already indicates the benefits of the contextualization in the beginning of the assessment, which significantly helped to understand the context and provided already a good understanding of their software process as a whole, indicating principal strengths and weakness. This is especially important as due to cost restrictions only a very small number of processes are assessed in detail. However, a specific weakness regarding the contextualization, remains the identification of business goals, as typically SCs do not have a previous understanding on those goals. Therefore, the goals had to be carefully revised during the contextualization interview. The high-level process description as an additional result of the contextualization was considered useful by the assessors and also facilitated the selection of the processes to be assessed. In addition, the availability of document templates helped to reduce significantly the effort spent in preparation and reporting.

[3] For reasons of confidentiality, we are omitting the name of the company.

5. Related Work

ISO/IEC 15504 defines in a generic way a minimal set of requirements for an assessment in order to obtain relevant results. However, as the standard does not describe an assessment method, it does not provide in itself sufficient support for its application in a small software company. For such an adaptation, some methods have been developed, such as:

- **RAPID (Rapid Assessment for Process Improvement for software Development)** [12] 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)** [9] developed by Tampere University of Technology (Finland) for conducting SPICE-compatible assessment in small organizations with the objective of process improvement.
- **FAME (Fraunhofer Assessment MEthod)** [3] developed by the IESE (Germany), which allows to perform either a SPICE or a 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** [2] 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 in order to promote innovation.

These methods either provide a method for a fixed set of processes, such as RAPID (limited to a set of eight processes) or TOPS (3 standard processes), or in correspondence with the specific characteristics and goals of an organization select a set of processes to be investigated. Basically, all methods are 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 assessment process defined in 15504-2. However, some methods include an initial step before the actual assessment in order to characterize the context and to analysis their specific needs. This characterization also guides the selection of the processes to be investigated. As a result of the assessments, key findings, including, the process profiles and strengths and weaknesses, and optionally improvement recommendations, are reported. In difference to the other methods, FAME also provides support for the selection of the most relevant processes to be assessed based on the companies business goals. Tool support for this method also enables the export of the assessment results as a basis for the modeling of these processes.

Table 3. Comparison of assessment methods for SCs

(+ satisfies; o more or less; - does not satisfy; ? no information encountered)

Requirements	RAPID	SPINI	FAME	TOPS	MARES
Low cost	+	o	?	+	+
Reliable results	?	?	?	?	?
Detailed description of assessment process	?	+	?	o	+
Guidance for process selection	- (8 processes pre-defined)	-	?	- (3 processes pre-defined)	being developed
Detailed definition of assessment model	+	+	?	+	+
Support for identification of risks and improvement suggestions	-	o	o	o	being developed
Support for high-level process modeling	-	-	+	-	being developed
Conformity with ISO/IEC 15504	+	+	+	+	+
No specific SE knowledge required from companies' representatives	+	+	-	-	+
Tool support	- (only paper forms)	o (basically data collection, analysis and rating)	o (basically data collection, analysis and rating)	- (only paper forms)	being developed
Integrated in assessment methodology	?	?	?	?	being developed
Public availability	-	?	-	+ (TOPS web site)	+

In comparison with those methods, the MARES process assessment method is most similar to the SPINI method, although the assessment itself generally focuses on a smaller set of only 2-3 processes. In addition, further support for the selection of the relevant processes is being developed, as well, as for the indication of risks and improvement suggestions.

6. Conclusion

In this paper, we present the MARES process assessment method for the assessment of small software companies in conformance with ISO/IEC 15504. We enhanced the process assessment model basically by integrating a context-process relationship model in order to support the selection of relevant processes and a process-risk relationship 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. So far, a first application indicates 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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