Faculdade de Engenharia da Universidade do Porto


# Process Assessment Modeling

**Nuno Salvaterra**

Project Report

Master in Informatics and Computing Engineering

Supervisor: Ana Cristina Paiva (PhD)

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# Resumo

Este relatório descreve o desenho, validação e utilização generalizada de um simples Modelo de Avaliação de Processos, adaptado à realidade de uma empresa de desenvolvimento de software de média dimensão, baseado em CMMI e ISO 15504. O seu objectivo era criar um modelo que permitisse frequentes avaliações internas de processos com pouco esforço associado. Para validar esta abordagem, foi realizada uma avaliação-piloto, tendo sido corrigidos todos os problemas detectados. É mostrado que através deste modelo podem ser realizadas avaliações internas de processos de uma forma rápida e eficiente, para obter melhor visibilidade sobre os processos da organização. Esta informação prática da capacidade do processo pode então ser usada como indicação para a melhoria dos processos do ciclo de vida do software, melhorando assim a Qualidade de Software como um todo na organização.

# Abstract

This report describes the design, validation and deployment of a simple Process Assessment Model, adapted to the reality of a medium software development enterprise, based on CMMI and ISO 15504. Its objective was to create a model which permitted frequent internal process assessments with little associated effort. To validate the approach, a process assessment trial was took place, and every detected issue was corrected. It is shown that through this model, quick and effective internal process assessments can be performed to provide better visibility of the organisation's processes. This practical information on the process capability can then be used as input for the improvement of software life cycle processes, thus enhancing Software Quality as a whole in the organisation.

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Nuno Salvaterra

*"If you don't know where you are*
*how can you choose where to go?"*

Anonymous

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# Abbreviations

| | |
|---|---|
| CA | Corrective Action |
| CMM | Capability Maturity Model |
| CMMI | Capability Maturity Model Integration |
| CSW | Critical Software, SA |
| CVS | Concurrent Versions System |
| ECS | Enterprise Critical Solutions |
| HLM | High(er) Level Management |
| IS | Improvement Suggestion |
| ISO | International Organization for Standardization |
| NC | Non-Conformance |
| PA | Preventive Action |
| PMO | Project Management Office |
| SCS | Safety Critical Systems |
| SPA | Software Product Assurance |
| SPAE | Software Product Assurance Engineer |
| SPAM | Software Product Assurance Manager |
| QA | Quality Assurance |
| QMS | Quality Management System |
| WO | Work Order |

# Glossary

| | |
|---|---|
| Higher level management | The person or persons who provide the policy and overall guidance for the process, but do not provide the direct day-to-day monitoring and controlling of the process. |
| Measurement Repository | A repository used to collect and make available measurement data on processes and work products, particularly as they relate to the organization's set of standard processes. This repository contains or references actual measurement data and related information needed to understand and analyse the measurement data. |
| Objectively evaluate | To review activities and work products against criteria which minimize subjectivity and bias by the reviewer. An example of an objective evaluation is an audit against requirements, standards, or procedures by an independent quality assurance function. |
| Organisational Policy | A guiding principle typically established by senior management that is adopted by an organization to influence and determine decisions. |
| Process Assessment | An examination of a process that an organization does internally for the purposes of process improvement. |
| Process Asset library | A library of information that is used to store and make available process assets that are useful to those who are defining, implementing, and managing processes in the organization. This library contains process assets that include process-related documentation such as policies, defined processes, check-lists, lessons-learned documents, templates, procedures, plans, and training materials. |

| | |
|---|---|
| Process Assets Artefacts | that relate to describing, implementing and improving processes (e.g., policies, measurements, process descriptions and process implementation support tools). (See also "process asset library.") |
| Process Compliance | The conformance of a process to a specification or policy, standard or law that has been clearly defined. |
| Process Description | A documented expression of a set of activities performed to achieve a given purpose. A process description provides an operational definition of the major components of a process. The description specifies, in a complete, precise, and verifiable manner, the requirements, design, behaviour, or other characteristics of a process. |
| Process Performance | A measure of actual results achieved by following a process, characterized by process measures and product measures. |
| Quantitative Objective | Desired target value expressed as quantitative measures. |
| Stakeholder | A group or individual that is affected by or is in some way accountable for the outcome of an undertaking (e.g., project members, suppliers, customers, and end users). |
| Standard Process | An operational definition of the basic process that guides the establishment of a common process in an organization, i.e., the process definition on the QMS. |
| Tailoring Guidelines | Guidelines that enable projects, groups, and organizational functions to appropriately adapt standard processes for their use. Tailoring guidelines are defined at organizational level and describe what can and cannot be modified and identify process components that are candidates for modification. |
| Work Product | A useful result of a process. This can include files, documents, products, parts of a product, services, process descriptions, specifications, and invoices. A key distinction between a work product and a product component is that a work product is not necessarily part of the product. |

# Chapter 1

# Introduction

## 1.1 Context

This project focuses on the definition of a Process Assessment Model and fits within the Software Quality body of knowledge, a discipline of Software Engineering. It was developed at Critical Software, a Portuguese software development company that provides solutions, services, and technologies for mission and business critical information systems across several markets. Probably best known for its projects with NASA and ESA, it is for the 4th year in a row one of Europe's 500 fastest growing companies – and one of only five Portuguese companies in the 2007 index.

> "Quality has been a strategic issue at Critical since its foundation in 1998. Throughout time, the continuous improvement of software development processes in accordance with ISO 15504 standard, has allowed the company to reach a level of singular maturity in Portugal, and to certify its Quality Management System (QMS) in accordance with ISO 9001:2000 standard using TickIT Scheme, becoming the only Iberian company with this certification. Critical was also the first Portuguese IT company to achieve the NATO/AQAP 2110 and AQAP 150 Certification and CMMI Maturity level 3." [CS08, Quality]

## 1.2 Project

This project intends to define, validate and implement a simple and effective process assessment model that provides Critical Software with relevant information concerning its processes capacity. The model should take into account several standards and define a solution that best fits the organisation's needs. The output of the actual process assessments should provide useful information for process improvement activities.

The project was comprised of six main phases, planned before the Kick-Off Meeting.

On the first phase, that would last a month, the author was expected to understand the theoretical concepts behind the problem and to become familiar with the relevant standards in the area.

On the second phase, lasting two weeks, the first version of the solution would be devised.

The third phase would be a trial, also lasting two weeks, to check the solution for problems and improvement possibilities.

The trial and its results would be validated, and the solution would be corrected and improved accordingly in the fourth phase, lasting just one week.

During the fifth phase the procedure would be deployed to the organisation and two process assessments, using the final solution, would take place. This phase was planned to happen during a month.

The final phase was the production of the project report i.e., this document, planned to last another month.

## 1.3 Motivation and Objectives

When completed, this project should have defined a process assessment model – including the actual process assessment procedure and templates to support the performance of the process assessment –, establishing the means to perform internal process assessments at Critical Software.

Results of the performance of one or more process assessments should also be presented, demonstrating the visibility achieved by the defined model.

## 1.4 Report Structure

This report is composed by five chapters, focusing on the work done during the project, and five appendixes that provide secondary information.

In chapter 1, a brief overview of the project and of this report is provided.

In chapter 2, the state of the art is presented, including the relevant standards in the area and the established process assets at Critical Software.

In chapter 3, the problem is explained and the final solution is presented.

In chapter 4, both the trial and the deployment of the solution are explained in detailed, together with the presentation of the objective results obtained.

In chapter 5, a summary of what was accomplished is shown, hinting at possible future developments.

Appendix A contains the Measurement Framework, the component within the solution that defines the possible ratings of a process under assessment.

Appendix B contains the Guidelines for Evaluation, which establish the rules that an assessor should follow to correctly generate the outputs of the process assessment.

Appendix C contains the Measurement Framework Traceability Matrix, created to explain the links between the defined Measurement Framework and other relevant standards.

Appendix D shows the Process Assessment Report Template.

Appendix E shows the Process Assessment Record Template.

# Chapter 2

# State of the Art

## 2.1 Introduction

Software Quality has not one but many dimensions, ranging from the understandability of a user interface to the portability between different systems. However, a very important dimension of Software Quality is reliability.

> "[...]the probability of failure-free operation of a computer program in a specified environment for a specified time" [MIO87].

When a small, non-critical software application – such as a text editor on a home desktop environment – fails during its operation, it will usually cause no more than an inconvenience, so the cost of failure is relatively small. If however the failure occurs within a critical software application – such as embedded software within an aerospace ground station system or an automotive industry assembly line robot control module – the cost may be measured in millions of euros or even in human lives. The need for reliable software becomes apparent.

One way of making sure that software complies with the specified requirements is by testing it, before making it available for usage.

> "Program testing can be used to show the presence of bugs, but never to show their absence!" [Dij70, end of section 3, On The Reliability of Mechanisms]

But if we take into account the time and effort required to detect and correct bugs, we understand that the more efficient way to achieve software quality is by avoiding the errors altogether.

> "There is now compelling evidence that development methods that focus on bug prevention rather than bug detection can both raise quality and save time and money." [Ame02, preamble]

A software development enterprise, not unlike the majority of organisations, can be seen as a group of skilled people manipulating tools and equipment in order to develop a *product*. It depends on the capabilities and motivation of its workers and on the technologies it possesses. But people rarely work for the same organisation throughout their careers and technologies are rapidly changing, so how can products be developed in a consistent manner?

> "[...] what holds everything together? It is the processes used in your organisation." [CMU06b, section About Capability Maturity Models]

But what is a process, in the organisational area of knowledge? ISO 9001 defines it as "[a]n activity using resources, and managed in order to enable the transformation of inputs into outputs [...]" [ISO00, section 0.2, Process approach].

As recognized by the manufacturing industry for several decades, the processes provide the infrastructure that allows consistent, repeatable and predictable development of products. Software development, similarly, requires a software development process.

## 2.2 Software Development Process

There is much more to software development than just computer programming. Software Engineering good practices usually identify several activities involved in a software development life cycle, including a Requirements Definition phase, a System and Software Design phase, an Implementation phase, a Validation phase and a Deployment phase.

There are currently two widely adopted models for software life cycle processes: the ISO 12207 International Standard and the Capability Maturity Model Integration (CMMI). ISO 12207 "was the first International Standard to provide a comprehensive set of life cycle processes, activities and tasks for software that is part of a larger system, and for stand alone software products and services" [ISO08, Introduction], but has since been adapted in order to be applicable for any type of organisation. CMMI, similarly, was originally developed with focus on software development, its applicability being generalized in the latest iteration [CMU06b, Evolution of CMMI]. It is well established as the *de facto* standard for the development of software, systems, and hardware products [wIMS08].

The ISO 9001 international standard, while not directly related to the software development process, promoting a process approach when establishing the quality management system of an organisation, regardless of its specific business area or industry.

All of these standards state that adoption of the proposed practices will result in organisational benefits such as higher quality products, enhanced costumer satisfaction and cost reduction. However, to be effective, the adoption of either of these standards and subsequent performance of the organisational processes needs to be constantly verified for problems and improvement opportunities, in what is usually called a process assessment.

## 2.3 Process Assessment

A process assessment is the verification of a process capability level, performed internally by an organisation, for process improvement purposes. ISO 15504 defines the paradigm of process assessment, by identifying the main components of its structure, as we can see in Figure 2.1 [ISO03, section 4.1 General].

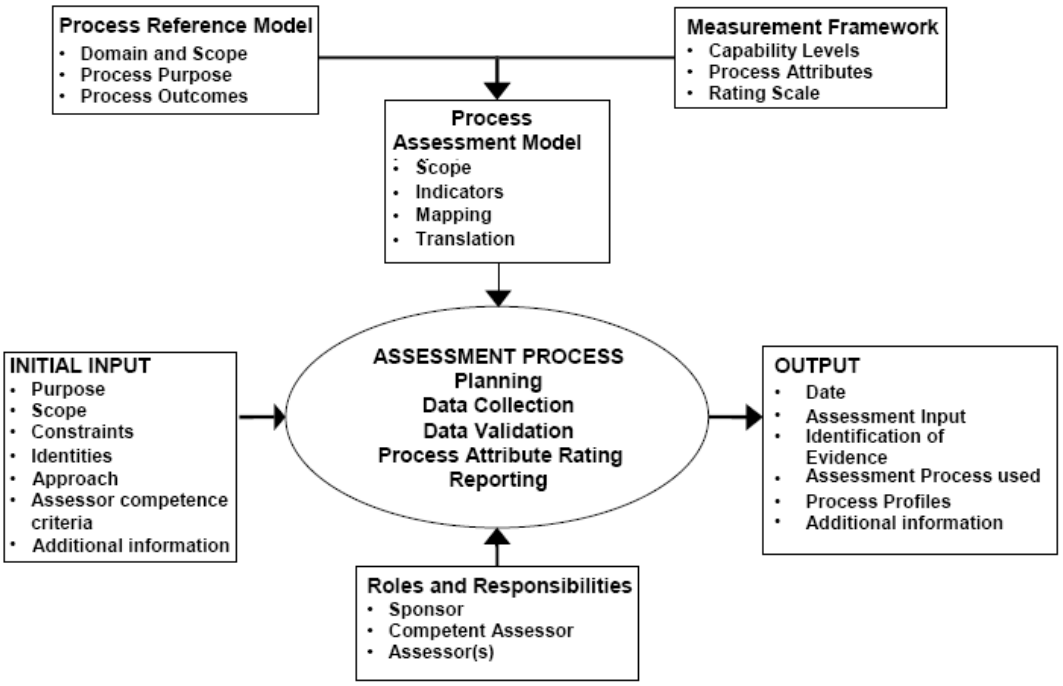



Figure 2.1: Concepts of Process Assessment

### Process Reference Model

A Process Reference Model is essentially the definition of a set of organisational processes, including its descriptions, and the relationship between those processes. A process description must specify the activities to be performed, the expected inputs and outputs, and the associated roles and responsibilities.

ISO 12207 is a Process Reference Model, as well as the Process Areas described within CMMI for Development.

### Measurement Framework

A Measurement Framework defines how the capability of process is to be determined. It is composed by a process capability rating scale, which differentiates among levels of process improvement achievement; a description of the attributes that a process is expected to possess, related to each of the levels in the process capability rating scale; a process attribute rating scale, which allows for the evaluation of each the attribute's achievement; and the rules that define how all the process attribute ratings translate into a single process capability rating.

A Measurement Framework is specified within ISO 15504. In CMMI there are several components which together are the equivalent of a Measurement Framework, namely the Levels, the Generic Goals and the rating rules defined in the Standard CMMI Appraisal Method for Process Improvement (SCAMPI) [CMU06a, section 2.4.2, Characterize Implementation of Model Practices].

### Process Assessment Model

A Process Assessment Model establishes the basis that connects all the process assessment components. It defines the structured format in which the process assessment results are communicated and informs of the possible scope of a process assessment, by specifying which of the processes present in the Process Reference Model are covered in this model. In those cases where the scope of both models is not exactly the same, the mapping from the Process Assessment Model to the Process Reference Model should be provided. It also identifies a set of indicators which shall be verified during a process assessment, in order to objectively evaluate the process attributes described in the Measurement Framework.

ISO 15504 does not establish a Process Assessment Model, specifying instead its expected contents. In CMMI there is not a clear Process Assessment Model. SCAMPI's scope is the same as CMMI and SCAMPI, however, and the Specific and General Practices are identified as the items to be investigated during an assessment, so the concepts underneath the Process Assessment Model are present in CMMI.

### Process Assessment Process

A process assessment is also a process. As such, it requires a documented description that specifies what are the activities to be performed, the expected inputs and outputs, and the associated roles and responsibilities.

While ISO 15504 states the requirements for a Process Assessment Process, SCAMPI is a Process Assessment Process itself.

## 2.4 Relevant Standards

### 2.4.1 Capability Maturity Model Integration – CMMI

Developed by the Software Engineering Institute of Carnegie Mellon University, the Capability Maturity Model Integration (CMMI) arises as the integration, consolidation and evolution of three different process capability models, each addressing different organisational realities. CMMI is a process improvement framework that is currently composed of two major constellations – collections of CMMI components, including a model, its training materials, and appraisal-related documents, around an area of interest –, CMMI for Development and CMMI for Acquisition, with a third being developed, CMMI for Services.

CMMI for Development is the official successor to all previous CMMI and CMM iterations. While the former models focused mainly on software development, CMMI for Development is applicable to the development and maintenance of products and services in a variety of industries.

With CMMI, an organisation can choose one of two process improvement approaches: continuous – where an organisation may select which process areas to improve – and staged – where previously-defined groups of process areas lay a path for organisational improvement.

CMMI for Development, Version 1.2, released August 2006, features 22 Process Areas. Each process area is defined by one or more Specific Goals, which in turn are subdivided into Specific Practices and in some cases Subpractices. All of the process areas, however, share the so-called Generic Goals, which in turn are subdivided into Generic Practices and in some cases Subpractices. Each of the Process Areas belong in one of four categories: Process Management, Project Management, Engineering, Support.

CMMI defines a set of levels to characterize the evolutionary path of an organisation. They are called Capability Levels, if the organisation is using the continuous approach, or Maturity Levels, if the organisation opted for the staged approach.

Capability Levels apply not to the organisation as a whole, but for individual process areas. Ranging from Level 0 to Level 5, these levels are awarded for the satisfaction of all the appropriate goals in the individual process area being rated.

While Level 1 (Performed) characterizes a state where an organisation satisfies Generic Goal 1 – satisfies all the Specific Goals, in other words – in the process

area, Level 0 (Incomplete) describes the non-achievement of such requirement i.e., at least one of the Specific Goals is not satisfied.

Similarly, Levels 2 (Managed), 3 (Defined), 4 (Quantitatively Managed) and 5 (Optimizing) are respectively achieved by satisfying Generic Goals 2 to 5. To achieve each of the Capability Levels 2 to 5, however, it is required to satisfy the requirements of all previous levels – with the obvious exception of Level 0 – e.g., to achieve Capability Level 4 in a process area, an organisation needs to satisfy, simultaneously, the requirements of levels 1 to 4.

Maturity Levels range from Levels 1 to 5 and are awarded to an organisation as a whole. For each Maturity Level – except for Level 1 (Initial) – there is an associated set of Process Areas, to which varying degrees of Generic Goals must be satisfied.

Level 2 (Managed) describes an organisation which has satisfied both Generic Goals 1 and 2 for the associated set of, in this case, seven Process Areas.

Level 3 (Defined) characterizes an organisation which has satisfied Generic Goals 1, 2 and 3 for not only the associated set of eleven Process Areas, but also for the Maturity Level 2 associated set of seven Process Areas.

To achieve Level 4 (Quantitatively Managed), an organisation must then satisfy Generic Goals 1, 2 and 3 for the associated set of two Process Areas and for the mentioned eighteen Process Areas, while defining which of the organisational processes are to be quantitatively managed – this being the focus of the associated set of two Process Areas.

Similarly, an organisation in Level 5 has satisfied Generic Goals 1, 2 and 3 for all twenty-two Process Areas, while defining which of the organisational processes are to be optimized – this being the subject of the last two Process Areas.

In order to verify the Capability Levels of Process Areas or the Maturity Level of an organisation, an appraisal must be conducted. Such an appraisal will then describe how well an organisation has implemented CMMI practices, which may be useful information for both internal process improvement efforts, as for external customers and suppliers. To produce viable results, an appraisal must conform to the Appraisal Requirements for CMMI (ARC).

#### Appraisal Requirements for CMMI – ARC

The Appraisal Requirements for CMMI [CMU06c] specify the requirements that appraisals need to fulfil, in order to correctly verify the adoption of CMMI practices. ARC identifies three appraisal classes – Class A, Class B and Class C – with requirement differences residing mainly in the size of the appraisal team, the amount of objective evidence needed and the resulting outputs.

Class A is the most formal and the only one that results in a recognized rating, thus requiring a larger team and an authorized lead appraiser. It is also required to cover the whole organisational unit. With a few additional requirements, this appraisal class can be compliant with ISO 15504-2 standard.

Class B requirements are a subset of those present in a Class A appraisal, and are aimed as a support to process improvement activities.

Class C have the least requirements of the three classes, and intend to provide a quick, narrow look into a small part of an organisation.

The Standard CMMI Appraisal Method for Process Improvement (SCAMPI) was designed by SEI with the Appraisal Requirements for CMMI in mind.

#### Standard CMMI Appraisal Method for Process Improvement – SCAMPI

The Standard CMMI Appraisal Method for Process Improvement has three variants – SCAMPI A [CMU06a], SCAMPI B and SCAMPI C [CMU05] – , each satisfying the appropriate ARC classes. Regardless of the variant, there are three clearly identified phases in an appraisal – Planning/Preparation, Conduction and Reporting.

During the Planning/Preparation phase, the first step is to analyse the appraisal requirements and the provided input, in order to clearly understand what is requested of the appraiser. An appraisal plan must then be defined, with the review and approval of the involved stakeholders. Afterwards, the appraisal team should be selected and prepared – except in SCAMPI C, where a team is not required. Depending on the SCAMPI variant, participants in the appraisal can be prepared during this phase or later on. Initial objective evidence should be collected in this phase, as well as the verification of the necessary conditions for appraisal conduction.

The main phase of the appraisal is, obviously, its Conduction. It is comprised of the examination of objective evidence – through interviews and document reviews –, the documentation and verification of the examined objective evidence, and the validation of the preliminary appraisal outputs. This phase ends when the final appraisal results are generated.

The Reporting phase brings the appraisal to a close, by delivering the appraisal results to the appropriate stakeholders and appropriately packaging and archiving all the appraisal assets e.g., the appraisal plan and findings.

### 2.4.2 International Standards

#### ISO 15504

ISO 15504 [ISO03][ISO04] is an International Standard that defines a basic platform for process assessment, including a Measurement Framework and the requirements

for performing an assessment. Earlier versions [ISO98] also included a Process Reference Model, but it has since been replaced with requirements for a compatible Process Reference Model, in order to permit a more flexible approach to process assessment. ISO 12207 has been refined to be an ISO 15504-compliant Process Reference Model [ISO08, annex B, Process Reference Model (PRM) for Assessment Purposes].

In a similar fashion to other related standards, ISO 15504 started as a software industry-specific process assessment framework, but has been revised to allow process assessments in any organisation. Also, as defined by this International Standard, process assessments can occur to give visibility for process improvement initiatives in an organisation, or as a part of capability determination activities.

The Measurement Framework is comprised of six consecutive levels, from Level 0 to Level 5, each composed two attributes, except for Level 1, which possesses only one attribute, and Level 0, which has none.

As defined, Level 1 – Performed Process – is simply characterized as a process that achieves its defines outcomes, while Level 0 – Incomplete Process – is precisely the failure to do this.

Level 2 – Managed Process – is comprised of: the Performance management attribute, which relates to the planning, monitoring and management of the process performance and related responsibilities and resources; and the Work product management, dealing with the appropriate identification, control and management of work products of the process, including documentation.

Level 3 – Established Process – is composed by: the Process definition attribute, which refers to the existence and proper maintenance of a standard process definition aimed at supporting process implementation; and the Process deployment attribute, evaluating how well the standard process definition is being used for process deployment in the organisation.

Level 4 – Predictable Process – features: the Process measurement attribute, which addresses the definition of both measurement and performance objectives for the process, as well as the actual measurement results collection, analysis and reporting; and the Process control attribute, which focuses on the usage of quantitative data to manage and control processes within established control limits.

Finally, Level 5 – Optimizing Process – possesses: the Process innovation attribute, which deals with the establishment of process improvement objectives and to its achievement through analysis of common causes of variation in performance and through innovation and best practice; and the Process optimization attribute, which relates to the management of process changes, by evaluating the effective impact of change against the defined process objectives.

The International Standard defines the possible ratings for each of the process attributes in the Measurement Framework:

- N — Not achieved — 0 to 15% achievement.
- P — Partially achieved — > 15% to 50% achievement.
- L — Largely achieved — > 50% to 85% achievement.
- F — Fully achieved — > 85% to 100% achievement.

To achieve a capability level, a process needs to obtain L or F ratings in the attributes belonging to that capability level, and also to obtain F ratings in the attributes of all previous levels, with the obvious exception of Level 0.

Five assessment phases are identified in the requirements for performing an assessment: planning, data collection, data validation, process attribute rating and reporting. Activities expected for each of the phases are also specified. The requirements also define the responsibilities of the sponsor of the assessment, of the responsible assessor and also of any other assessors. Finally, expected inputs and outputs of the assessment are specified.

#### ISO 12207

ISO 12207 is an International Standard that establishes a Process Reference Model – compatible with ISO 15504 [ISO08, annex B, Process Reference Model (PRM) for Assessment Purposes] –, providing organisations with a framework for software life cycle processes.

ISO 12207:2008 features 43 processes, distributed along seven process groups – Agreement Processes, Organisational Project-Enabling Processes, Project Processes, Technical Processes, Software Implementation Processes, Software Support Processes, Software Reuse Processes. Each of the process descriptions contains the purpose, outcomes and activities – each specified by its tasks.

#### ISO 9001

ISO 9001 [ISO00] promotes the implementation and improvement of a Quality Management System as the key to successfully manage the intertwined activities of an organisation, in order to meet costumer requirements and therefore increase costumer satisfaction.

It is based on the Plan-Do-Check-Act methodology, which can be summed up as: establishing the objectives; implementing the processes; monitoring and measuring process performance and results; improving process performance.

This International Standard has several requirements divided into five categories: Quality management system; Management responsibility; Resource management; Product realization; Measurement, analysis and improvement.

An organisation can demonstrate its commitment to quality by being ISO 9001 certified. Similarly to other international standards, this certification should be renewed regularly, usually three years.

TickIT, a software development interpretation of ISO 9001, was produced by the UK Board of Trade. It is designed to help understanding of how to apply ISO 9001 in the software development industry, but is also available for certification by accredited certification bodies.

## 2.5 Critical Software

### 2.5.1 Quality Management System

Critical Software has a Quality Management System (QMS), which was designed to enable projects and other activities to achieve their objectives effectively and efficiently, by use of proven, defined processes and practices. It was also designed to satisfy the requirements of standards such as ISO 9001, TickIT, ISO 15504 (SPICE), ISO 12207, AQAP 2110, AQAP 150, EN/AS 9100, EN/AS 9006, and the ECSS standards.

The scope of the QMS is stated as follows:

> "Development of software technologies for mission and business critical information systems and provision of associated engineering and consulting services. Design and development of customised software solutions to meet specific customer requirements." [CSWa].

The current version of the QMS is structured in six process categories – High Level Processes, Customer, Support, Engineering, Management and Organisational – featuring a total of 45 processes.

Each of the process descriptions contains the purpose, inputs, outputs, roles and responsibilities, relation to other processes, initiation and termination events, success criteria, resources, process activities – each specified by start events, end events, responsible, objectives, inputs, outputs, implementation details and related documents –, process monitoring, and process tailoring.

#### Audit Process

The Audit Process[CSWb], as defined in the QMS, provides a high-level view into the four types of internal audits at Critical Software – Project Audits, Process

Assessments, Appraisals and QMS Audits. Four activities, applicable to all types of internal audits, are established: Planning and Preparation, Execution, Reporting and Follow-Up.

Process assessments are very briefly mentioned, with a slight hint at the possible usage of ISO 15504 to perform process assessments. No implementation details are provided.

#### Process Assessments

Process assessments based on ISO 15504 TR [ISO98] were taking place at Critical Software until 2005, when they were discontinued. Even though these process assessments were always focused on a single process, each one usually just analysed one process instantiation. These process assessments were, as such, more similar to highly focused project audits than to organizational-wide single process verifications, thus having limited value for process improvement efforts at the organizational level.

## 2.6 Conclusions

To develop higher quality software and better fulfil its customers expectations, an organization must pay close attention to how its processes are being performed and specially how they can be improved. However, internal process assessment methods based on the analysed standards are complex, cumbersome, heavy on necessary resources and time.

Therefore, these standards are not the best solution for enterprises that, like Critical Software, want to perform quick and frequent assessments in a cost-effective way, in order to extract relevant, practical and usable information on how to fine-tune their processes.

# Chapter 3

# Process Assessment Modeling

## 3.1 Objective

The high-level objective of this project was to define, validate and implement a simple and effective process assessment model that provides Critical Software with relevant information concerning its processes capacity.

As previously discussed, current standards were not adapted for quick, inexpensive assessments. A previous attempt at using ISO 15504 came short at delivering usable, organisational-wide process improvement results.

The intended process assessment model should be simple, so that a single person – trained in this process assessment model and in Critical Software's Quality Management System – could perform it. No certification should be required for the assessor.

The model was to be used for internal process assessment at Critical Software only, and as such it should be fine tuned to the organisation's reality.

The model was not intended to focus on a single branch of best practices – e.g., CMMI or ISO 15504 – but instead be inspired in several sources. A documented mapping between the process assessment model and CMMI for Development Version 1.2 was to be provided. The same was expected for ISO 9001.

The information yielded by each process assessment should provide an insight into the process performance, detecting the actual and possible problems with its implementation and highlighting the opportunities for improvement. This information would also bring additional input to Critical Software's efforts to achieve CMMI Level 5 certification, a central organisational goal.

## 3.2 Solution

The developed solution is composed by the Process Assessment Procedure, the Process Assessment Record Template and the Process Assessment Report Template. The final version of the Process Assessment Procedure is presented in this chapter. The final version of the two supporting templates – the Process Assessment Record Template and the Process Assessment Report Template – are provided in annex. The final versions of the procedure and of the templates were an evolution of earlier versions, based on the critical analysis performed after the Trial.

### 3.2.1 Process Assessment Procedure

The Process Assessment Procedure is considered a part of the Audit Process and describes Critical Software's model for performing internal process assessments. The approach is based on the overall auditing basic assumptions such as assuring an objective view and having an impartial position.

The procedure is only applicable to Critical Software internal process assessments and should not be used on process assessments in other organisations, at least not without extensive adaptation and customization. It is also not designed to issue a certification to the assessed organisation, but to provide process stakeholders with timely and focused information on the process performance and capability levels.

Each Process Assessment shall verify several instantiations and related support areas, to truthfully assess the process capability level. The process under assessment should be defined in CSW's Quality Management System. The Process Assessment Procedure is based on ISO/IEC 15504 and Appraisal Requirements for CMMI.

A Process Assessment may be carried out by just one assessor, which should be familiar with Critical Software's QMS. The procedure has four tasks: Planning and Preparation, Data Collection, Validation & Results, and Reporting.

It also contains the Measurement Framework used to rate the process under assessment, which is primarily based on the Generic Goals of CMMI for Development. This Measurement Framework also covers the Measurement & Analysis Process Area of CMMI, due to the fact that the corresponding QMS process, Measurement, is transversal to all the processes in QMS. Additionally, in the relatively few cases where it was felt that the CMMI Generic Goals did not provide satisfactory insight, ISO 15504 attributes and ISO 9001 requirements were also included in the Measurement Framework, to increase the scope of the process assessments.

Finally, an easy and simple set of Guidelines for Evaluation was defined, which presents the rules to be followed by the assessor when evaluating the data. Since a pivotal objective for the process assessment model was that the process assessments provided usable and relevant information for purposes of process improvement, there

is a clear specification of the possible Non-conformance types, as well as the Actions that address each Non-conformance.

### 3.2.2 Process Assessment Record Template

This document is a Microsoft Excel Template that provides the assessor with a powerful yet usable tool containing all the items that should be verified during the process assessment. It is designed to have all the information and functionality that an assessor needs during an interview in one place.

For each of the process instantiations or support areas verified during the assessment, the assessor can use the Process Assessment Record to register objective evidence, take notes, rate each of the verification items, while the spreadsheet automatically calculates the intermediate and final results for the eighteen practices and five capability levels.

### 3.2.3 Process Assessment Report Template

This document is the visible output containing final capability level results, detected non-conformances and related actions. It is designed to provide a summary of the process assessment findings and to objectively present what are the next steps for process improvement.

## 3.3 Process Assessment Procedure Overview

**Roles and responsibilities**

**QA Audit Management** is responsible for:

- Assigning the Assessor (see below Requirements to be an Assessor);
- Providing the required assessment input to the Assessor;
- Ensuring the participation and collaboration of the participants involved in the process assessment;
- Ensuring that the Assessor has all the necessary resources to perform the assessment.

**The Assessor** is responsible for:

- Ensuring that the participants in the assessment are briefed on the purpose, scope and approach of the assessment;

- Carrying out the activities associated with the assessment in accordance with this defined procedure;
- Delivering the assessment outputs to the Quality Manager and any other interested parties specified in the assessment input.

**Requirements to be an assessor**

Requirements to be an assessor include:

- Training in this specific procedure;
- Access to all the documentation supporting this procedure;
- Familiarity with CSW's QMS;
- Competence in using the selected tools that support the assessment.

### Procedure inputs

**Process Assessment Report (draft version)** , containing the Assessment purpose and the Process to be investigated.

**Assessment constraints** , including:

- assessment team;
- deadline;
- maximum amount of time to be used for the assessment;
- ownership of the assessment outputs and any restrictions on their use;
- controls on information resulting from a confidentiality agreement.

### Procedure outputs

**Process Assessment Report** , containing the input information and also:

- non-conformances found;
- corrective actions, preventive actions or improvements suggestions to deal with the non-conformances, inherent issues and opportunities for improvement;
- capability level of the process.

**Project Assessment Record** , containing:

- identification of the related Process Assessment Report;
- performed assessment activities;
- traceability between assessment activities and item verification;
- scores of item verifications;
- capability level results.

## 3.4 Procedure Tasks

Figure 3.1 provides an overview into the procedure activities. All activities are mandatory with the Assessor being responsible for all activities.

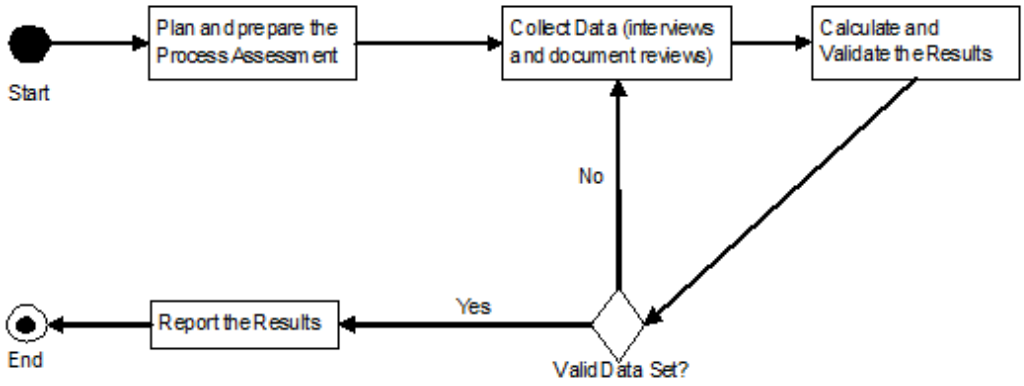



Figure 3.1: Process Assessment Procedure Tasks

### Planning & Preparation

#### Inputs

Assessment purpose;
Process to be investigated;
Assessment constraints:

- assessment team;
- deadline;
- maximum amount of time to be used for the assessment;

- ownership of the assessment outputs and any restrictions on their use;
- controls on information resulting from a confidentiality agreement.

**Outputs**

Assessment plan:

- selected process instantiations and support areas;
- interview schedule.

**Objectives**

Plan the assessment and prepare the needed infrastructure and resources (including the participants) so that the assessment can achieve its purpose.

**Implementation Details**

1. Analyse the input information in the Process Assessment Report draft.
2. Determine which Process Instantiations and Support Areas will be verified and who will be interviewed. Besides people responsible for process instantiations, Higher Level Management and support areas representatives should be considered for interviews.
3. Determine the necessary resources for the assessment.
4. Ensure the availability of necessary resources, e.g.:
    - Meeting room;
    - Projector;
    - Project folder;
    - Access and permissions to Intra, WISE and CVS;
    - Laptop or other means for writing notes;
    - Transportation.
5. Contact the prospective interviewees to request their participation, arrange the interview schedule and inform them of the assessment details:
    - The purpose of the assessment;
    - The scope of the assessment;
    - Their roles and responsibilities in the assessment.

6. Define the schedule of the assessment activities.

7. Document the plan in the Process Assessment Record.

8. Review the plan and ensure that it is feasible and that the activities will be sufficient to meet the assessment purpose and scope.

### Data Collection

#### Inputs

Assessment plan.

#### Outputs

Process Assessment Record with:

- details about the performed interviews, document reviews and document presentations;
- scores for the verified items;
- references to the verified documents;
- notes about the verifications.

#### Objectives

Collect data to support the process assessment results.

#### Implementation Details

- Collect data by reviewing documentation.
- Collect data by conducting interviews.
- Record the collected data in the Process Assessment Record.
- Guarantee that the collected data covers the assessment needs.
- Register the results in the Process Assessment Record.

## Validation & Results

### Inputs

Process Assessment Record with:

- details about the performed interviews, document reviews and document presentations;
- scores for the verified items;
- references to the verified documents;
- notes about the verifications.

### Outputs

Capability level of the process.

### Objectives

Ensure that the collected data is adequate and complete to fully and truthfully portray the process under assessment.

Evaluate the capability level of the process based on the validated data, according to the measurement framework.

### Implementation Details

- Ensure that there is sufficient data to meet the assessment purpose.
- Confirm that the collected data is objective, relevant, accurate and clearly worded.
- Ensure that the data as a whole is consistent.
- Validate the results with the interviewees and the process owner.
- Calculate the capability level of the process.

## Reporting

### Inputs

Process Assessment Record with:

- details about the performed interviews, document reviews and document presentations;

- scores for the verified items;
- references to the verified documents;
- notes about the verifications;
- capability level of the process.

**Outputs**

Process Assessment Report with:

- capability level of the process;
- verified non-conformances;
- actions that address the verified non-conformances.

**Objectives**

Document the results of the assessment and deliver them to the specified interested parties.

**Implementation Details**

- Summarize the relevant findings of the assessment, including the verified non-conformances, in the Process Assessment Report.
- Determine the actions to address the verified non-conformances.
- Review the Process Assessment Report.
- Deliver the Process Assessment Report to Quality Audit Management, interviewees and other specified interested parties.
- Deliver the Process Assessment Record to Quality Audit Management.

# Chapter 4

# Trial and Deployment

## 4.1 Trial

A trial of this process assessment model was conducted, focused on the Requirements Analysis process. The process assessment procedure was followed to verify four instantiations of the process, in four different projects. Interviews were conducted by a team composed of the author and a senior assessor. Results of the trial were presented to the interviewees. Effort spent in each of the assessment activities was registered.

After the regular process assessment activities were conducted, an analysis of the trial took place. Several defects and improvement opportunities were discovered and registered by the assessment team. Finally, a survey was conducted among both the interviewees and the senior assessors involved in the trial.

### 4.1.1 Results

After validation and calculation, the results for the Requirements Analysis process were reported in the appropriate format and presented to the interested partied.

Requirement Analysis is taking place and produces, with varying levels of formality, a requirements specification or equivalent.

The Capability Level results are presented in Figure 4.1, while the found non-conformances and appropriate actions are respectively presented in Table 4.1 and Table 4.2. As it was a trial, no real actions were generated, so some information fields are left blank.

### 4.1.2 Effort

The effort spent for each of the activities of the process assessment trial was registered. Table 4.2 indicates, for each of the four instantiations, the effort spent in

| Capability Level / Practice / Subpractice | 1 | 2 | 3 | 4 | FINAL |
|---|---|---|---|---|---|
| Capability Level 1 - Performed | FI | FI | FI | FI | FI |
| Practice 1.1 - The Process is Performed | FI | FI | FI | FI | FI |
| Capability Level 2 - Managed | PI | PI | PI | PI | PI |
| Practice 2.1 - An Organizational Policy is Established | FI | FI | FI | FI | FI |
| Practice 2.2 - The Process is Planned | PI | FI | FI | PI | PI |
| Practice 2.3 - Resources are Provided | FI | PI | FI | FI | FI |
| Practice 2.4 - Responsibility is Assigned | FI | FI | PI | PI | PI |
| Practice 2.5 - People are Trained | PI | PI | FI | FI | PI |
| Practice 2.6 - Configurations are Managed | FI | FI | PI | FI | FI |
| Practice 2.7 - Relevant Stakeholders are Identified and Involved | FI | FI | FI | FI | FI |
| Practice 2.8 - The Process is Monitored and Controlled | FI | PI | PI | NI | PI |
| Practice 2.9 - Adherence is Objectively Evaluated | FI | FI | FI | NI | PI |
| Practice 2.10 - Status is Reviewed with Higher Level Management | PI | PI | PI | PI | PI |
| Practice 2.11 - Measurement Activities are Defined and Executed | NI | NI | PI | NI | NI |
| Capability Level 3 - Defined | NI | PI | NI | NI | NI |
| Practice 3.1 - A Defined Process is Established | NI | PI | NI | NI | NI |
| Practice 3.2 - Improvement Information is Collected | NI | NI | NI | NI | NI |
| Capability Level 4 - Quantitatively Managed | NI | NI | NI | NI | NI |
| Practice 4.1 - Quantitative Objectives for the Process are Established | NI | NI | NI | NI | NI |
| Practice 4.2 - Subprocess Performance is Stabilized | NI | NI | NI | NI | NI |
| Capability Level 5 - Optimizing | NI | NI | NI | NI | NI |
| Practice 5.1 - Continuous Process Improvement is Established | NI | NI | NI | NI | NI |
| Practice 5.2 - Root Causes of Problems are Corrected | NI | NI | NI | NI | NI |

Figure 4.1: Process Assessment Trial – Capability Level Results

Table 4.1: Process Assessment Trial – Non-conformances

| Id | Description | Type |
|---|---|---|
| 1 | QMS does not require process-oriented (or life cycle phase-oriented) planning i.e., the requirements analysis process was not planned in the verified projects. | 4 |
| 2 | No measures or measurement collection/analysis/storage procedures are defined at an organisational level. | 3 |
| 3 | “Project 4” Requirements Analysis process is informally controlled. | 1 |
| 4 | “Project 4” Requirements Analysis process is not being subject of on-process evaluation. | 1 |
| 5 | “Project 1”, “Project 2” and “Project 4” Requirements Analysis implementation was not based on the QMS definition and was not tailored according to the guidelines as the project managers were not aware of the requirements process description. | 1 |
| 6 | The QMS requirements process definition was not reviewed during the last year. | 3 |

Table 4.2: Process Assessment Trial – Actions

| Work Order Id | Type | Description (Non-conformance Id) | Target Date |
|---|---|---|---|
| | IS | Review QMS in order to include process-oriented planning and detect other problems. (NC1) | |
| | CA | Review Requirements Analysis process in order to guarantee the planning activity (NC1), (NC6) | |
| | IS | Define measurement strategy for QMS processes (which ones require measures and what measures to consider) and associated collection, analysis, and storage procedures. (NC2) | |
| | CA | Monitor and control the Requirements Analysis phase in a more formal way. (NC3) | |
| | CA | Perform on-process evaluation. (NC4) | |

each of the main task of the assessment: planning, document reviews, interviews, data consolidation – both alone and between assessors –, reporting and reviewing.

| | Instantiation | | | | Total | | Average | |
|---|---|---|---|---|---|---|---|---|
| Activity | 1 | 2 | 3 | 4 | minutes | hours | minutes | hours |
| Planning | 30 | 30 | 30 | 30 | 120 | 2.00 | 30 | 0.50 |
| Document Reviews | 55 | 180 | 35 | 40 | 310 | 5.17 | 78 | 1.29 |
| Interviews | 90 | 90 | 90 | 75 | 345 | 5.75 | 86 | 1.44 |
| Data Consolidation | 60 | 60 | 90 | 90 | 300 | 5.00 | 75 | 1.25 |
| Data Consolidation (between assessors) | 30 | 30 | 90 | 30 | 180 | 3.00 | 45 | 0.75 |
| Reporting | 20 | 20 | 20 | 20 | 80 | 1.33 | 20 | 0.33 |
| Reviewing | 40 | 40 | 40 | 40 | 160 | 2.67 | 40 | 0.67 |
| **Total (minutes)** | 325 | 450 | 395 | 325 | 1495 | | | |
| **Total (hours)** | 5.42 | 7.50 | 6.58 | 5.42 | | 24.92 | | |
| | | | | | | | 374 | |
| | | | | | | | | 6.23 |

Figure 4.2: Process Assessment Trial – Effort

Total effort for the assessment was 25 hours, with the average effort for each verified instantiation little more than 6 hours.

### 4.1.3 Trial Analysis

Both the procedure and the supporting templates had minor problems that needed correction, or details that could be improved. These change requests were all integrated into the current iteration of the procedure and templates, unless where

otherwise noted.

#### 4.1.3.1 Process Assessment Procedure

**Glossary** Some of the concepts were not immediately understandable by the assessor team. To help with the procedure's understanding, a relevant glossary should be compiled and embedded within the procedure description.

**Data Collection Coverage** The collection of process instantiation evidences was not enough to cover all model requirements and to acquire complete, accurate data. Even though four project instantiations were analysed during the trial, it was concluded that different points of view on how the process was performed were necessary to get the complete picture. High level management and support areas representatives – e.g, Human Resources, Quality, IT and Business Development – would provide further insight into the process and allow for a more accurate process assessment. This requirement should be reflected in the procedure description, by clearly stating that process assessment plans must include interviews with a diversified group of relevant process stakeholders.

**Non-conformances** The detected problems in the process should be labelled as one of four types of non-conformances:

1. An inadequate instantiation of the process — the process is not implemented as defined by the QMS in one or several instances, even though the process definition is adequate to CSW reality e.g., project A is not performing the requirements specification validation with the client.

2. An incorrect definition on the QMS — the process is not implemented as defined by the QMS in several or all instances because the process definition is not adequate to CSW reality e.g., activity A1 of process X is not being implemented through all verified instantiations because interviewees say it's not needed.

3. An inadequate support of the process — the process is not implemented as defined by the QMS in all instances because an organisational-level asset or resource is inadequate e.g., requirements process is not being measured because no metrics definitions exist at organisational level.

4. A non-compliant definition on the QMS — the process definition is not compliant with a standard under verification e.g., the process does not cover ISO9001 requirements 8.2 and CMMI PA MA SP 2.2.

**Actions** Each of the non-conformance types defined above should have an appropriate corresponding action to address the problem:

1. Corrective Action — submitted to the responsible for the verified instantiation.
2. Improvement Suggestion / Preventive Action — submitted to the Quality Department.
3. Improvement Suggestion / Preventive Action — submitted to the Board.
4. Corrective Action — submitted to the Quality Department.

#### 4.1.3.2 Process Assessment Record

Practice Capability Level calculation was considered too lenient. The formula to calculate practice results should be changed to:

- Fully Implemented – $x \leq 0,5$
- Partially Implemented – $0,5 < x \leq 1,75$
- Not Implemented – $x > 1,75$

Similarly, the final results calculation should be also be stricter, according to the rule: "If a Not Implemented rating is awarded to a practice implementation, the maximum final value for that practice is Partially Implemented". This rule should be automatically be observed on the Process Assessment Record.

Sub-practice descriptions were considered extensive and too complex, so they should be simplified. Also, where applicable, multiple sub-practices should be combined into a single item.

It was deemed inconvenient that every sub-practice evaluation value started by default at 0. These cells should be blank at the beginning.

To help the assessor, tips of where and what to search for – when looking for objective evidence – should be present in each sub-practice. A comment with such information should be added in every appropriate cell.

In case it is necessary to repeat a document verification, it should be easy to identify and locate the appropriate document. For this reason, document location (such as CVS Path) and CVS revision number should be registered for each verified document. A copy of relevant documents presented during interviews may be kept within the process assessment evidences folder (in CVS) and their identification registered in the record.

The Document Review status is not necessary, as it is not practical or realistic to plan which documents will be reviewed in a specific instantiation verification.

A specific area for taking clarification notes should be present in each instantiation verification area.

The #DIV/0 errors should be ignored automatically by the evaluation formula, for every case of non-applicable or non-evaluated sub-practices.

Background colours should be consistent in each uneditable row, for easier understanding of the template.

Uneditable cells should be lock and protected to prevent misuse of the template. However, this would also prevent the manipulation of the group and outline visibility functions, which is the basis for understanding the enormous quantity of collected data in a process assessment. This improvement was therefore not integrated into the final templates.

It is important to clearly understand who are the interviewees and who are the assessors in each interview, so the participants cell should be separated to allow these two different roles.

Instructions on how to use this template should be embedded and not provided separately.

#### 4.1.3.3 Process Assessment Report

To effectively verify if the actions that address problems detected during a process assessment were being undertaken, it was considered important to provide the identification of the responsible for each of the corrective actions, so this information should be included in the record.

Instructions on how to use this template should be embedded and not provided separately.

### 4.1.4 Survey

An online anonymous survey was conducted among the four interviewees and the two senior assessors to help gather quantitative feedback about the process assessment trial. The questions focused on the general process assessment method and on the results that were presented at the end of the trial. The interviewees were also asked to provide improvement suggestions for the method, but none were submitted. Table 4.3 presents the full results of the survey.

## 4.2 Deployment

After the trial was conducted and the improvements and corrections were applied to the procedure and the templates, the process assessment procedure was deployed for regular production usage. In June, two process assessments were initiated, having

Table 4.3: Process Assessment Trial – Survey Results

| Questions | A | B | C | D | E | F | Average |
|---|---|---|---|---|---|---|---|
| Was the Process Assessment model / approach adequate? (1 = lower / 10 = higher) | 8 | 8 | 8 | 8 | 7 | 7 | 7.667 |
| Were the interviews well conducted? (1 = lower / 10 = higher) | 7 | 8 | 8 | 6 | 6 | 7 | 7 |
| Were the Process Assessment outcomes / results of added value? (1 = lower / 10 = higher) | 9 | 8 | 10 | 10 | 4 | 8 | 8.167 |
| Has your visibility over process performance increased? By how much? (0 - none / 1 - lower / 10 - higher) | 7 | 5 | 10 | 7 | 8 | 8 | 7.5 |

Requirements Analysis and Process Improvement as the processes under assessment. The selection of Requirements Analysis once again was intentional, to allow comparison with the process assessment trial. While the Process Improvement process assessment is almost complete, the Requirements Analysis process assessment was nearing completion, and reached final results.

### 4.2.1 Requirements Analysis

The Requirements Analysis process assessment covered extensively more perspectives than the process assessment trial, as it verified six projects, a Project Management Office representative, the Engineering Manager and the SPAM for ECS – one of two engineering areas at Critical Software –, and the Engineering Director.

The Capability Level results are presented in Figure 4.3.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | FINAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Capability Level / Practice / Sub-practice** | **Results** | **Results** | **Results** | **Results** | **Results** | **Results** | **Results** | **Results** | **Results** | **Results** | **Results** |
| Capability Level 1 - Performed | NR | FI | FI | NR | NR | NR | FI | FI | NR | FI | FI |
| Practice 1.1 - The Process is Performed | NR | FI | FI | NR | NR | NR | FI | FI | NR | FI | FI |
| Capability Level 2 - Managed | PI | PI | PI | PI | PI | PI | FI | PI | PI | PI | PI |
| Practice 2.1 - An Organizational Policy is Established | NR | NR | NR | PI | PI | FI | NR | NR | NR | NR | PI |
| Practice 2.2 - The Process is Planned | PI | PI | PI | NR | NR | NR | FI | FI | PI | PI | PI |
| Practice 2.3 - Resources are Provided | NR | FI | PI | NR | NR | NR | PI | PI | PI | FI | PI |
| Practice 2.4 - Responsibility is Assigned | PI | FI | PI | PI | PI | NR | FI | FI | FI | FI | PI |
| Practice 2.5 - People are Trained | NI | PI | FI | PI | PI | NR | FI | FI | FI | PI | PI |
| Practice 2.6 - Configurations are Managed | NR | PI | PI | NR | NR | NR | FI | FI | NR | FI | FI |
| Practice 2.7 - Relevant Stakeholders are Identified and Involved | PI | FI | FI | NR | NR | NR | FI | FI | PI | PI | PI |
| Practice 2.8 - The Process is Monitored and Controlled | PI | PI | PI | NR | NR | NR | PI | FI | PI | PI | PI |
| Practice 2.9 - Adherence is Objectively Evaluated | NR | NI | FI | NR | NR | NR | FI | NI | NI | NR | PI |
| Practice 2.10 - Status is Reviewed with Higher Level Management | NI | NR | NR | PI | NI | NR | NR | NR | NR | NR | NI |
| Practice 2.11 - Measurement Activities are Defined and Executed | NI | NI | NI | NR | NR | PI | PI | PI | PI | NI | PI |
| Capability Level 3 - Defined | NR | NI | PI | NI | NR | NR | NI | NI | NR | NI | NI |
| Practice 3.1 - A Defined Process is Established | NR | NI | PI | NI | NR | NR | NR | PI | NR | NI | NI |
| Practice 3.2 - Improvement Information is Collected | NR | NR | NR | NR | NR | NR | NI | NI | NR | PI | NI |
| Capability Level 4 - Quantitatively Managed | NR | NI | NI | NR | NR | NR | NR | NR | NR | NR | NI |
| Practice 4.1 - Quantitative Objectives for the Process are Established | NR | NI | NI | NR | NR | NR | NR | NR | NR | NR | NI |
| Practice 4.2 - Subprocess Performance is Stabilized | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Capability Level 5 - Optimizing | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Practice 5.1 - Continuous Process Improvement is Established | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |
| Practice 5.2 - Root Causes of Problems are Corrected | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR | NR |

Figure 4.3: Process Assessment – Requirements Analysis – Capability Level Results

The discovered non-conformances and the actions did not have yet some of the required information, since the process assessment was not yet concluded. Different results than those obtained in the process assessment trial, partially because of the strictness of the evaluation rules.

### 4.2.2 Process Improvement

The Process Improvement process assessment was of a relatively smaller scope, as it only involved three process stakeholders, namely the Quality Manager, the Quality Department member responsible for Process Improvement management and the SPAM for ECS. This is understandable, since this is an organisational process that has a small number of people directly involved.

The Capability Level results are presented in Figure 4.3. No non-conformances or actions are documented, since the process assessment was not yet concluded.

| | 1 | 2 | 3 | FINAL |
|---|---|---|---|---|
| **Capability Level / Practice / Sub-practice** | **Results** | **Results** | **Results** | **Results** |
| Capability Level 1 - Performed | FI | FI | NR | FI |
| Practice 1.1 - The Process is Performed | FI | FI | NR | FI |
| Capability Level 2 - Managed | PI | PI | PI | PI |
| Practice 2.1 - An Organizational Policy is Established | FI | NR | NR | FI |
| Practice 2.2 - The Process is Planned | FI | FI | NR | FI |
| Practice 2.3 - Resources are Provided | PI | PI | PI | PI |
| Practice 2.4 - Responsibility is Assigned | PI | PI | PI | PI |
| Practice 2.5 - People are Trained | PI | PI | PI | PI |
| Practice 2.6 - Configurations are Managed | PI | PI | NR | PI |
| Practice 2.7 - Relevant Stakeholders are Identified and Involved | FI | FI | NR | FI |
| Practice 2.8 - The Process is Monitored and Controlled | FI | PI | NR | PI |
| Practice 2.9 - Adherence is Objectively Evaluated | PI | PI | NR | PI |
| Practice 2.10 - Status is Reviewed with Higher Level Management | NR | PI | PI | PI |
| Practice 2.11 - Measurement Activities are Defined and Executed | PI | PI | NR | PI |
| Capability Level 3 - Defined | PI | PI | NR | PI |
| Practice 3.1 - A Defined Process is Established | PI | PI | NR | PI |
| Practice 3.2 - Improvement Information is Collected | FI | FI | NR | FI |
| Capability Level 4 - Quantitatively Managed | NI | NR | NR | NI |
| Practice 4.1 - Quantitative Objectives for the Process are Established | NI | NR | NR | NI |
| Practice 4.2 - Subprocess Performance is Stabilized | NI | NR | NR | NI |
| Capability Level 5 - Optimizing | NI | NR | NR | NI |
| Practice 5.1 - Continuous Process Improvement is Established | NI | NR | NR | NI |
| Practice 5.2 - Root Causes of Problems are Corrected | NI | NR | NR | NI |

Figure 4.4: Process Assessment – Process Improvement – Capability Level Results

# Chapter 5

# Conclusions and Future Work

## 5.1 Accomplishment of the Objectives

As was exposed, during this project there was opportunity to research various standards related to software life cycle processes and to process assessments. Comparing the intricacies of different perspectives on this subject infused the author with a broad overview of the best practices in the area.

After designing a draft version of the solution, the performed process assessment trial provided valuable feedback to refine the model and bring it closer to Critical Software's expectations.

In summary, the resulting process assessment model is a lightweight combination of the relevant process assessment aspects of CMMI and International Standards ISO 15504 and ISO 9001, while the process assessments already performed using this methodology are providing useful insight for Critical Software.

The objectives for this project were all accomplished, as the whole process assessment model "package" of deliverables was completed and addressed the organisation's needs: the Process Assessment Procedure, including the Measurement Framework and the Guidance for Evaluation, the Process Assessment Record Template, and the Process Assessment Report Template.

Process assessments based on this model will be regularly performed at Critical Software as a strong driver of process improvement activities, namely towards the achievement of CMMI Maturity Level 5 certification.

## 5.2 Future Developments

One of the possible expansions of the procedure would be an update to contemplate the improvements in ISO 9001:2008. As the standard is still on the final stages of development, it could not be integrated in the defined process assessment model

during this project. Future integration should not be an excessive effort, since the Measurement Framework Traceability Matrix includes ISO 9001:2000 requirements mapping.

It may be useful to develop documentation and materials that facilitate the training of assessors in this procedure. A presentation providing an overview of the Process Assessment Procedure and exemplifying the usage of the related templates would be a better starting point for people with no background on process assessment.

Finally, this model might need adjustments in Levels 4 and 5 of the Measurement Framework. This will become clearer as Critical Software adopts practices related to CMMI Maturity Levels 4 and 5.

# References


[Ame02] Peter Amey. Correctness by construction: Better can also be cheaper. *CrossTalk – The Journal of Defense Software Engineering*, pages 24–28, March 2002. http://www.praxis-his.com/pdfs/c_by_c_better_cheaper.pdf.

[CMU05] CMU/SEI-2005-HB-005. *Handbook for Conducting Standard CMMI Appraisal Method for Process Improvement (SCAMPI) B and C Appraisals, Version 1.1.* Software Engineering Institute, 2005.

[CMU06a] CMU/SEI-2006-HB-002. *Standard CMMI Appraisal Method for Process Improvement (SCAMPI) A, Version 1.2: Method Definition Document.* Software Engineering Institute, 2006.

[CMU06b] CMU/SEI-2006-TR-008. *CMMI for Development, Version 1.2.* Software Engineering Institute, 2006.

[CMU06c] CMU/SEI-2006-TR-011. *Appraisal Requirements for CMMI, Version 1.2.* Software Engineering Institute, 2006.

[CS08] S.A. Critical Software, 2008. http://www.criticalsoftware.com/ – last visited on 7th July 2008.

[CSWa] CSW – Critical Software, S.A. *Quality Manual.*

[CSWb] CSW – Critical Software, S.A. *SUP.4 – Audit Process.*

[Dij70] Edsger W. Dijkstra. Notes on structured programming, April 1970. http://www.cs.utexas.edu/users/EWD/ewd02xx/EWD249.PDF.

[ISO98] ISO/IEC TR 15504. *Information technology – Software process assessment.* ISO, Geneva, Switzerland, 1998.

[ISO00] ISO 9001:2000. *Quality management systems – Requirements.* ISO, Geneva, Switzerland, 2000.

[ISO03] ISO/IEC 15504-2:2003. *Software engineering – Process assessment – Part 2: Performing an assessment.* ISO, Geneva, Switzerland, 2003.

[ISO04] ISO/IEC 15504-3:2004. *Software engineering – Process assessment – Part 3: Guidance on performing an assessment.* ISO, Geneva, Switzerland, 2004.

[ISO08] ISO 12207:2008. *Systems and software engineering – Software life cycle processes*. ISO, Geneva, Switzerland, 2008.

[MIO87] J.D. Musa, A. Iannino, and K. Okumoto. *Engineering and Managing Software with Reliability Measures*. McGraw-Hill, 1987.

[wIMS08] wibas IT Maturity Services. Cmmi: Improvement of product development, 2008. http://www.wibas.com/models/cmmi/cmmi/index_en.html – last visited on 2nd July 2008.

# Appendix A

# Measurement Framework

The Measurement Framework in this procedure is primarily based on both the CMMI Generic Goals and the CMMI Measurement & Analysis Process Area, with complementary input from some ISO9001:2000 Requirements and ISO15504-2 Process Attributes.

It is defined as an ordinal scale of six levels, in line with CMMI and ISO15504-2 approaches. Except for level 0, each level contains practices which are required in order to achieve the level.

## Level 0 – Not performed

The process does not deliver the expected output, either because it is not being performed or its execution is incomplete.

## Level 1 – Performed

The process is done informally or its execution is only partially managed.

### Practice 1.1 – The Process is Performed

The process delivers the expected work products and achieves the expected outcomes.

## Level 2 – Managed

The process is planned, monitored and controlled according to its objectives, has the required infrastructure and resources, and its work products are appropriately established, controlled and maintained.

### Practice 2.1 – An Organizational Policy is Established

Senior management has organizational expectations for the process and is committed to its success. This is communicated effectively throughout the organization.

### Practice 2.2 – The Process is Planned

A plan for performing the process according to its objectives is defined in an appropriate format, reviewed, agreed on and maintained as necessary. The plan typically includes the following:

- Process description;
- Standards, requirements for the work products and services of the process;
- Specific objectives for the performance of the process (e.g., quality, time scale, cycle time and resource usage);
- Dependencies among the activities, work products and services of the process;
- Resources (including funding, people and tools) needed to perform the process;
- Assignment of responsibility and authority;
- Training needed for performing and supporting the process;
- Work products to be controlled and the level of control to be applied;
- Measurement requirements to provide insight into the performance of the process, its work products and its services;
- Involvement of identified stakeholders;
- Activities for monitoring and controlling the process;
- Objective evaluation activities of the process;
- Management review activities for the process and the work products.

#### Sub-practices

1. The plan is defined and documented.
2. The plan is reviewed with relevant stakeholders to get their agreement.
3. The plan is revised as necessary.

### Practice 2.3 – Resources are Provided

The adequate resources for performing the process are provided when needed. Resources include skilled people, funding, tools, physical facilities and work environment.

### Practice 2.4 – Responsibility is Assigned

Responsibility and authority for performing the process is unequivocally assigned to specific people. This responsibility and authority is communicated within the organization.

**Sub-practices**

1. Overall responsibility and authority for performing the process is assigned.
2. Responsibility and authority for performing the specific tasks of the process is assigned.
3. The people assigned to the responsibilities and authorities understand and accept them.

### Practice 2.5 – People are Trained

The people performing or supporting the process have the required education, skills and experience.

### Practice 2.6 – Configurations are Managed

Work products of the process are under appropriate levels of control and their integrity is assured through configuration management. The work products are appropriately identified, documented and controlled.

### Practice 2.7 – Relevant Stakeholders are Identified and Involved

All the relevant stakeholders of the process are identified and involved in the relevant process activities, such as the following:

- Planning;
- Decisions;
- Commitments;
- Communications;
- Coordination;
- Reviews,
- Assessments;
- Requirements definitions;
- Resolution of problems/issues.

**Sub-practices**

1. Stakeholders relevant to this process and the levels of their involvement are identified, and this knowledge is communicated to the planners.
2. Relevant stakeholders are involved as planned.

### Practice 2.8 – The Process is Monitored and Controlled

The process is monitored and controlled against the plan on a daily basis, and appropriate corrective actions are taken accordingly. Attributes of the process and work products are measured.

**Sub-practices**

1. Actual performance is measured against the plan.
2. Accomplishments and results of the process are reviewed against the plan.
3. Activities, status and results of the process are reviewed with the immediate level of management responsible for the process to identify issues.
4. The effects of significant deviations from the plan are identified and evaluated.
5. Problems in the plan and in the execution of the process are identified.
6. Corrective action is taken when requirements and objectives are not being satisfied, when issues are identified, or when progress differs significantly from the plan. Corrective action may include the following:
7. Taking remedial action to repair defective work products or services;
8. Changing the plan;
9. Adjusting resources, including people, tools and other resources;
10. Negotiating changes to the established commitments;
11. Securing change to the requirements and objectives that have to be satisfied;
12. Terminating the effort.
13. Corrective action is tracked to closure.

### Practice 2.9 – Adherence is Objectively Evaluated

Adherence of the process against its process description, standards and procedures is objectively evaluated and non-compliances are addressed.

### Practice 2.10 – Status is Reviewed with Higher Level Management

The activities, status and results of the process are periodically reviewed with higher level management, including senior management. Higher level management is provided visibility into the process. Issues with the process are detected and corrected.

### Practice 2.11 – Measurement Activities are Defined and Executed

Measurement objectives have been defined for the process, measures to address the objectives have been defined and related collection, storage and analysis procedures have been specified. Measures have been collected, analysed and stored as defined. Results of measurement have been communicated to the relevant stakeholders.

**Sub-practices**

1. Measurement objectives are established.
2. Measure definitions are specified.
3. Measurement collection, storage and analysis procedures are specified.
4. Measurement data is collected and analysed in accordance to the specification.
5. Measurement data and results are stored in accordance to the specification.
6. Results are communicated to all relevant process stakeholders.

## Level 3 – Defined

The process is implemented throughout several instantiations (projects) using, when applicable, adequate tailoring of a standard process, according to specified tailoring guidelines.

### Practice 3.1 – A Defined Process is Established

The process activities, work products and services are planned, executed and managed as defined by the QMS or throughout the considered instantiations using tailoring of the QMS process description when applicable.

**Sub-practices**

1. The process that best meets the needs of the project or organizational function is selected from the QMS.
2. The defined process is established as defined by the QMS or by tailoring the selected process according to the specified tailoring guidelines.
3. The organization's process objectives are appropriately addressed in the defined process.
4. The defined process and the records of the tailoring are documented.
5. The description of the defined process is revised as necessary.

### Practice 3.2 – Improvement Information is Collected

Work products, measures, measurement results and improvement information derived from planning and performing the process are collected to provide input to process improvement activities.

**Sub-practices**

1. Process and product measures are stored in the organization's measurement repository.
2. Documentation and Lessons Learned are submitted for inclusion in the organization's process asset library.
3. Improvements to the organizational process assets are proposed and managed.

## Level 4 – Quantitatively Managed

The process has quantitative objectives for quality and process performance, and is managed and controlled using quantitative techniques.

### Practice 4.1 – Quantitative Objectives for the Process are Established

Quantitative objectives for quality and process performance are established and maintained throughout the process life, address intermediate as well as output objectives, and are based on customer needs and business objectives.

### Practice 4.2 – Sub-process Performance is Stabilized

The performance of critical sub-processes is stabilized, using appropriate quantitative techniques, to support predicting the ability of the process to achieve the established quantitative quality and process-performance objectives.

**Sub-practices**

1. The performances of one or more sub-processes that are critical contributors to the overall performance of the process are statistically managed.
2. The ability of the process to achieve its established quantitative objectives is predicted taking into account the performance of the statistically managed sub-processes.
3. Selected process-performance measurements are incorporated into the organization's process-performance baselines.

## Level 5 – Optimizing

The process is continuously improved based on an understanding of the common causes of variation inherent in the process, through both incremental and innovative improvements.

### Practice 5.1 – Continuous Process Improvement is Established

Process and technology improvements are selected and systematically deployed to meet established quality and process-performance objectives.

**Sub-practices**

1. Quantitative process improvement objectives that support the organization's business objectives are establish and maintained.
2. Process improvements that would result in measurable improvements to process performance are identified.
3. Process improvements are selected based on the quantified expected benefits, the estimated costs and impacts, and the measured change to process performance.
4. Deployment of selected process improvements is planned and managed.

### Practice 5.2 – Root Causes of Problems are Corrected

Defects and other problems in the process are analysed, and its root causes are identified and corrected.

# Appendix B

# Guidelines for Evaluation

## Item evaluation

Each sub-practice under evaluation can be rated with 0, 1 or 2:

**0** – The sub-practice is not being performed or fails at its objectives.

**1** – The sub-practice is being performed but has problems in its implementation.

**2** – The sub-practice is being performed without major problems.

However, if no data is available to verify a sub-practice, the item cannot be rated, so the appropriate cell should be left blank.

## Capability Level evaluation

Each capability level is calculated as the average of its practices, which, in turn, are calculated as the average of its sub-practices. For both capability levels and practices, the formula is:

- Fully Implemented: $average > 1,75$;
- Partially Implemented: $0,5 < average \leq 1,75$;
- Not Implemented: $average \leq 0,5$.

However, the following rules apply:

- If any practice is classified as Not Implemented (in a verified instantiation) the maximum result for the related capability level (for that verified instantiation) is Partially Implemented – example on Figure B.1, where NI result for Practice 2.11 limits the Capability Level 2 result to a maximum of PI.
- The same is true for final capability level results i.e., if a capability level or practice is rated as Not Implemented in any of the applicable verifications, the maximum final result is Partially Implemented – example on Figure B.2, results for Instantiation 4 limits the Final result to a maximum of PI.

| Capability Level 2 - Managed | PI |
|---|---|
| Practice 2.1 - An Organizational Policy is Established | FI |
| Practice 2.2 - The Process is Planned | PI |
| Practice 2.3 - Resources are Provided | FI |
| Practice 2.4 - Responsibility is Assigned | FI |
| Practice 2.5 - People are Trained | PI |
| Practice 2.6 - Configurations are Managed | FI |
| Practice 2.7 - Relevant Stakeholders are Identified and Involved | FI |
| Practice 2.8 - The Process is Monitored and Controlled | FI |
| Practice 2.9 - Adherence is Objectively Evaluated | FI |
| Practice 2.10 - Status is Reviewed with Higher Level Management | PI |
| Practice 2.11 - Measurement Activities are Defined and Executed | NI |

Figure B.1: Capability Level Evaluation – Rules Example 1

| Capability Level / Practice / Subpractice | Inst 1 | Inst 2 | Inst 3 | Inst 4 | FINAL |
|---|---|---|---|---|---|
| Practice 2.9 - Adherence is Objectively Evaluated | FI | FI | FI | NI | PI |

| Capability Level / Practice / Subpractice | Inst 1 | Inst 2 | Inst 3 | Inst 4 | FINAL |
|---|---|---|---|---|---|
| Capability Level 2 - Managed | FI | FI | FI | NI | PI |

Figure B.2: Capability Level Evaluation – Rules Example 2

## Non-Conformances

There are four types of non-conformances:

1. An inadequate instantiation of the process i.e., the process is not implemented as defined by the QMS in one or several instantiations even though the process definition is adequate to CSW's reality. (e.g. project A is not performing the requirements specification validation/approval with the client).
2. An incorrect definition on the QMS i.e., the process is not implemented as defined by the QMS in several or all the verified instantiations because the process definition is not adequate to CSW's reality. (e.g. activity A1 of process X is not being implemented through all verified instantiations because interviewees say it's not needed).
3. An inadequate support of the process i.e., the process is not implemented as defined by the QMS in all instances because an organizational-level asset or resource is inadequate. (e.g. requirements process is not being measured because no metrics definition exists at organizational level).
4. The process definition is not compliant with the standard under verification (e.g. the process does not cover ISO9001 requirements 8.2 and CMMI Measurement & Analysis Specific Practice 2.2).

## Actions

Each type of non-conformance should be dealt in a different way:

1. Associated Corrective Action, submitted to the responsible for the verified instantiation.
2. Associated Improvement Suggestion / Preventive Action, submitted to the Quality Department.
3. Associated Improvement Suggestion / Preventive Action submitted to the Board.
4. Associated Corrective Action, submitted to the Quality Department.

# Appendix C

# Process Assessment Measurement Framework Traceability Matrix

Table C.1 shows the traceability between the CSW Practices – specified in the Measurement Framework – and components from three standards, namely CMMI for Development Version 1.2 (CMMI), ISO 15504-2:2003 (ISO 15504) and ISO 9001:2000 (ISO 2001).

In the CMMI column the numbers may identify different Goals or Practices, depending on the preceding key – GP identifies a Generic Practice(s), while MA SG means Specific Goal(s) of the Measurement & Analysis Process Area. In the ISO 15504 column each of the numbers identifies a Process Attribute. Finally, in the ISO 9001 column each of the numbers identifies a Requirement.

Table C.1: Process Assessment Measurement Framework Traceability Matrix

| **CSW** | | **Fully Covered** | **Largely or Partially Covered** | |
|---|---|---|---|---|
| CSW Level | CSW Practice | CMMI | ISO 15504 | ISO 9001 |
| 1 | 1.1 | GP 1.1 | 1.1 | |
| 2 | 2.1 | GP 2.1 | 2.1 | 5.1 |
| | 2.2 | GP 2.2 | 2.1, 2.2 | 7.1 |
| | 2.3 | GP 2.3 | 2.1 | 6.1, 6.4 |
| | 2.4 | GP 2.4 | 2.1 | 5.5.1 |
| | 2.5 | GP 2.5 | | 6.2.1 |
| | 2.6 | GP 2.6 | 2.2 | 4.2.3 |
| | 2.7 | GP 2.7 | 2.1 | 5.1 |
| | 2.8 | GP 2.8 | 2.1, 2.2 | 8.2.3 |
| | 2.9 | GP 2.9 | 2.1 | |
| | 2.10 | GP 2.10 | | 5.6.1, 5.6.2, 5.6.3 |
| | 2.11 | MA SG 1, 2 | 4.1 | 8.1, 8.2.2, 8.2.3, 8.5.1, 8.5.2 |
| 3 | 3.1 | GP 3.1 | 3.2 | 7.1 |
| | 3.2 | GP 3.2 | 3.2 | 8.4 |
| 4 | 4.1 | GP 4.1 | 4.1 | |
| | 4.2 | GP 4.2 | 4.1, 4.2 | |
| 5 | 5.1 | GP 5.1 | 5.1, 5.2 | |
| | 5.2 | GP 5.2 | 5.1, 5.2 | |

As the table clearly shows, the Measurement Framework was heavily based on the CMMI Generic Practices, while covering additional aspects not identified within the CMMI collection of best practices.

# Appendix D

# Process Assessment Report

Critical software

# PROCESS ASSESSMENT REPORT

| 1. Document Control | | | |
|---|---|---|---|
| **Date:** | <DD-MM-YYYY> | **Pages:** | 2 |
| **Status:** | Draft / Approved | **Access:** | Confidential Critical |
| **Reference:** | CSW-QDEPAR-2008-RPT-NNNN | **Version:** | VV |

| 2. Details | |
|---|---|
| **Purpose:** | <purpose> |
| **Process name:** | <process name> |

| 3. Capability Level |
|---|
| <insert capability level result here> |

| 4. Non-conformances | | |
|---|---|---|
| **Id** | **Description** | **Type**[1] |
| <1> | <description> | <t> |
| <2> | <description> | <t> |
| <3> | <description> | <t> |

| 5. Actions | | | | |
|---|---|---|---|---|
| **Work Order Id** | **Type**[2] | **Description (NC Id)** | **Responsible** | **Target Date** |
| <id> | <t> | <description (NC Id)> | <responsible> | <DD-MM-YYYY> |
| <id> | <t> | <description (NC Id)> | <responsible> | <DD-MM-YYYY> |
| <id> | <t> | <description (NC Id)> | <responsible> | <DD-MM-YYYY> |

[1] 1 – Inadequate Instantiation of Process; 2 – Incorrect Definition on QMS; 3 – Inadequate Support of Process; 4 – Non-compliance with Standard
[2] CA – Corrective Action; PA – Preventive Action; IS – Improvement Suggestion.



Figure D.1: Process Assessment Report Template (Page 1)

**Process Assessment Report (continued)**

**Process Assessment Report Template Instructions (DELETE BEFORE DOCUMENT IS SUBMITTED FOR APROVAL)**

**1. Document Control**

Details of the document properties, standard feature in CSW documents:

- Date is the most recent document modification date (use Document Properties to define this field).
- Pages are automatically generated.
- Status should be "Draft" until approved by QA Audit Management.
- Access is by default "Confidential Critical"; should be modified if further access control is needed.
- Reference is in the standard format, generated by INTRADOC (use Document Properties to define this field).
- Version is a sequential number (01, 02, 03, etc.) that corresponds to the approved CVS revision of the current document (use Document Properties to define this field).

**2. Details**

Input data provided by QA Audit Management to the Assessor:

- Purpose is a description of the reason why the process assessment is being performed.
- Process name is the process name as defined in the QMS.

**3. Capability Level**

Result of the Assessment (can be in text or graphic format).

**4. Non-conformances**

List of non-conformances detected:

- Id is a unique sequential number.
- Description contains the details of the verified non-conformance.
- Type is 1, 2, 3 or 4, as defined in the Process Assessment Procedure (CSW-QMS-2008-PRO-04271.

**5. Actions**

Corrective actions that address verified non-conformances detected during the process assessment:

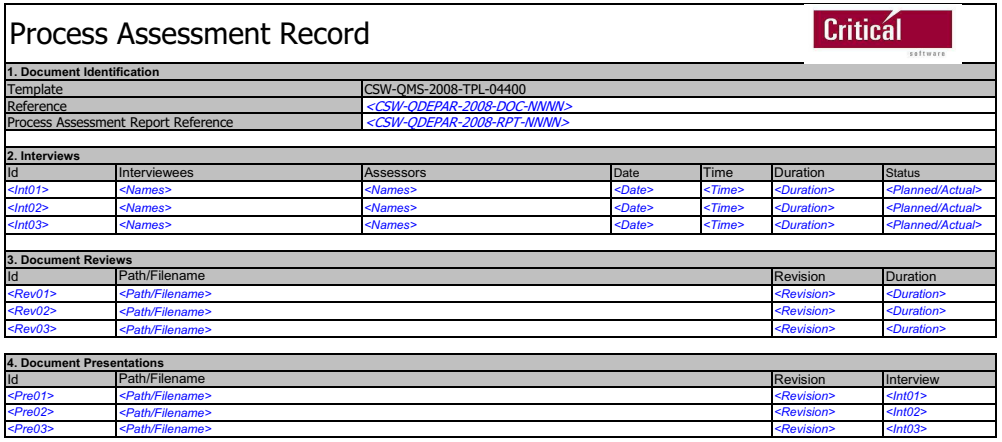
- Work Order Id refers to the number generated by the Work Orders internal tool.
- Type is one of three types of actions, as defined in the Process Assessment Procedure (CSW-QMS-2008-PRO-04271): CA – Corrective Action; PA – Preventive Action; IS – Improvement Suggestion.
- Description (NC Id) specifies the action needed to be taken, and references the id of the respective Non-conformances.
- Responsible identifies the person or entity responsible for the action implementation, monitoring and effective closure.
- Target Date is the expected date by which the action should be accomplished.



Figure D.2: Process Assessment Report Template (Page 2)

# Appendix E

# Process Assessment Record



Process Assessment Record

| 1. Document Identification | |
|---|---|
| Template | CSW-QMS-2008-TPL-04400 |
| Reference | *<CSW-QDEPAR-2008-DOC-NNNN>* |
| Process Assessment Report Reference | *<CSW-QDEPAR-2008-RPT-NNNN>* |

| 2. Interviews | | | | | | |
|---|---|---|---|---|---|---|
| Id | Interviewees | Assessors | Date | Time | Duration | Status |
| *<Int01>* | *<Names>* | *<Names>* | *<Date>* | *<Time>* | *<Duration>* | *<Planned/Actual>* |
| *<Int02>* | *<Names>* | *<Names>* | *<Date>* | *<Time>* | *<Duration>* | *<Planned/Actual>* |
| *<Int03>* | *<Names>* | *<Names>* | *<Date>* | *<Time>* | *<Duration>* | *<Planned/Actual>* |

| 3. Document Reviews | | | |
|---|---|---|---|
| Id | Path/Filename | Revision | Duration |
| *<Rev01>* | *<Path/Filename>* | *<Revision>* | *<Duration>* |
| *<Rev02>* | *<Path/Filename>* | *<Revision>* | *<Duration>* |
| *<Rev03>* | *<Path/Filename>* | *<Revision>* | *<Duration>* |

| 4. Document Presentations | | | |
|---|---|---|---|
| Id | Path/Filename | Revision | Interview |
| *<Pre01>* | *<Path/Filename>* | *<Revision>* | *<Int01>* |
| *<Pre02>* | *<Path/Filename>* | *<Revision>* | *<Int02>* |
| *<Pre03>* | *<Path/Filename>* | *<Revision>* | *<Int03>* |

Figure E.1: Process Assessment Record Template (Details Sheet)

| GROUPING INSTRUCTIONS IN COMMENT | | < Process Instantiation / Support Area > | | | |
|---|---|---|---|---|---|
| **Capability Level / Practice / Sub-practice** | **HLM?** | **Reference** | **Notes** | **Score** | **Results** |
| Capability Level 1 - Performed | | | | | NR |
| Practice 1.1 - The Process is Performed | | | | | NR |
| Expected work products and outcomes | | | | | |
| Capability Level 2 - Managed | | | | | NR |
| Practice 2.1 - An Organizational Policy is Established | | | | | NR |
| Senior management has organizational expectations for the process | | | | | |
| Senior management is committed to its success | | | | | |
| Senior management expectations and commitment is communicated effectively throughout the organization | | | | | |
| Practice 2.2 - The Process is Planned | | | | | NR |
| The plan is defined with: | | | | | |
| Reference to the process definition | | | | | |
| Standards and requirements for the work products and services | | | | | |
| Objectives for the performance of the process | | | | | |
| Dependencies among the activities, work products and services | | | | | |
| Resources needed | | | | | |
| Funding | | | | | |
| People | | | | | |
| Tools | | | | | |
| Physical facilities | | | | | |
| Work environment | | | | | |
| Other resources | | | | | |
| Assignment of responsibility and authority to specific people | | | | | |
| Training needed | | | | | |
| List of work products | | | | | |
| Work products to be controlled | | | | | |
| Level of control for each work product | | | | | |
| Measurement requirements | | | | | |
| Involvement of stakeholders | | | | | |
| Activities for monitoring and controlling the process | | | | | |
| Evaluation activities | | | | | |
| Management review activities | | | | | |
| The plan is documented in an appropriate format | | | | | |
| The plan is reviewed with the relevant stakeholders | | | | | |
| The plan is agreed upon by the relevant stakeholders | | | | | |
| The plan is revised as necessary | | | | | |
| Practice 2.3 - Resources are Provided | | | | | NR |
| People are provided | | | | | |
| Funding is provided | | | | | |
| Tools are provided | | | | | |
| Physical facilities are provided | | | | | |
| Work environment conditions are provided | | | | | |
| Other needed resources are provided | | | | | |
| Practice 2.4 - Responsibility is Assigned | | | | | NR |
| Responsibility and authority for the whole process is assigned | | | | | |
| Responsibility and authority for the specific tasks of the process is assigned | | | | | |
| The people assigned to the responsibilities and authorities understand and accept them | | | | | |
| Responsibility and authority assignment is communicated within the organization | | | | | |
| Practice 2.5 - People are Trained | | | | | NR |
| The people have the required education | | | | | |
| The people have the required skills and training | | | | | |
| The people have the required experience | | | | | |
| Practice 2.6 - Configurations are Managed | | | | | NR |
| Work products are under appropriate levels of control | | | | | |
| Work products are under configuration management | | | | | |
| Work products are appropriately identified | | | | | |
| Work products are appropriately documented | | | | | |
| Practice 2.7 - Relevant Stakeholders are Identified and Involved | | | | | NR |
| Relevant stakeholders are involved as planned | | | | | |
| Practice 2.8 - The Process is Monitored and Controlled | | | | | NR |
| Performance is measured against the plan | | | | | |
| Accomplishments and results are reviewed against the plan | | | | | |
| Activities, status and results are reviewed with the immediate level of management, to identify issues | | | | | |
| The effects of significant deviations from the plan are identified and evaluated | | | | | |
| Problems in the plan and in the execution of the process are identified | | | | | |
| Corrective action is taken when problems occur | | | | | |
| Corrective action is tracked to closure | | | | | |
| Practice 2.9 - Adherence is Objectively Evaluated | | | | | NR |
| On-process evaluation occurs | | | | | |
| Noncompliances are addressed | | | | | |
| Practice 2.10 - Status is Reviewed with Higher Level Management | | | | | NR |
| The process is periodically reviewed with higher level management | | | | | |
| Issues are detected and corrected | | | | | |
| Practice 2.11 - Measurement Activities are Defined and Executed | | | | | NR |
| Measurement objectives are established | | | | | |
| Measure definitions are specified | | | | | |
| Collection procedures are specified | | | | | |
| Storage procedures are specified | | | | | |
| Analysis procedures are specified | | | | | |
| Data is collected in accordance to the specification | | | | | |
| Data is analysed in accordance to the specification | | | | | |
| Data and results are stored in accordance to the specification | | | | | |
| Results are communicated to all relevant process stakeholders | | | | | |
| Capability Level 3 - Defined | | | | | NR |
| Practice 3.1 - A Defined Process is Established | | | | | NR |
| The process that best meets the needs of the project or organizational function is selected from the QMS | | | | | |
| The defined process is established as defined by the QMS or by tailoring the selected process according to the specified tailoring guidelines | | | | | |
| The organization's process objectives are appropriately addressed in the defined process | | | | | |
| The defined process and the records of the tailoring are documented | | | | | |
| The description of the defined process is revised as necessary | | | | | |
| Practice 3.2 - Improvement Information is Collected | | | | | NR |
| Process and product measures are stored in the organization's measurement repository | | | | | |
| Documentation and Lessons Learned are submitted for inclusion in the organization's process asset library | | | | | |
| Improvements to the organizational process assets are proposed | | | | | |
| Capability Level 4 - Quantitatively Managed | | | | | NR |
| Practice 4.1 - Quantitative Objectives for the Process are Established | | | | | NR |
| Quantitative objectives for quality and process performance are established and maintained throughout the process life | | | | | |
| Quantitative objectives for quality and process performance address intermediate as well as output objectives | | | | | |
| Quantitative objectives for quality and process performance are based on customer needs and business objectives | | | | | |
| Practice 4.2 - Subprocess Performance is Stabilized | | | | | NR |
| The performance of subprocesses that are critical contributors to the overall performance of the process is statistically managed | | | | | |
| Ability of the process to achieve its established quantitative objectives is predicted based on the performance of the statistically managed subprocesses | | | | | |
| Selected process-performance measurements are incorporated into the organization's process-performance baselines | | | | | |
| Capability Level 5 - Optimizing | | | | | NR |
| Practice 5.1 - Continuous Process Improvement is Established | | | | | NR |
| Quantitative process improvement objectives that support the organization's business objectives are establish and maintained | | | | | |
| Process improvements that would result in measurable improvements to process performance are identified | | | | | |
| Process improvements are selected based on quantified expected benefits, estimated costs and impacts and measured change to process performance | | | | | |
| Deployment of selected process improvements is planned and managed | | | | | |
| Practice 5.2 - Root Causes of Problems are Corrected | | | | | NR |
| Defects and other problems in the process are analyzed | | | | | |
| The root causes of defects and problems are identified | | | | | |
| The root causes of defects and problems are corrected | | | | | |

Figure E.2: Process Assessment Record Template (Results Sheet - Left Half)

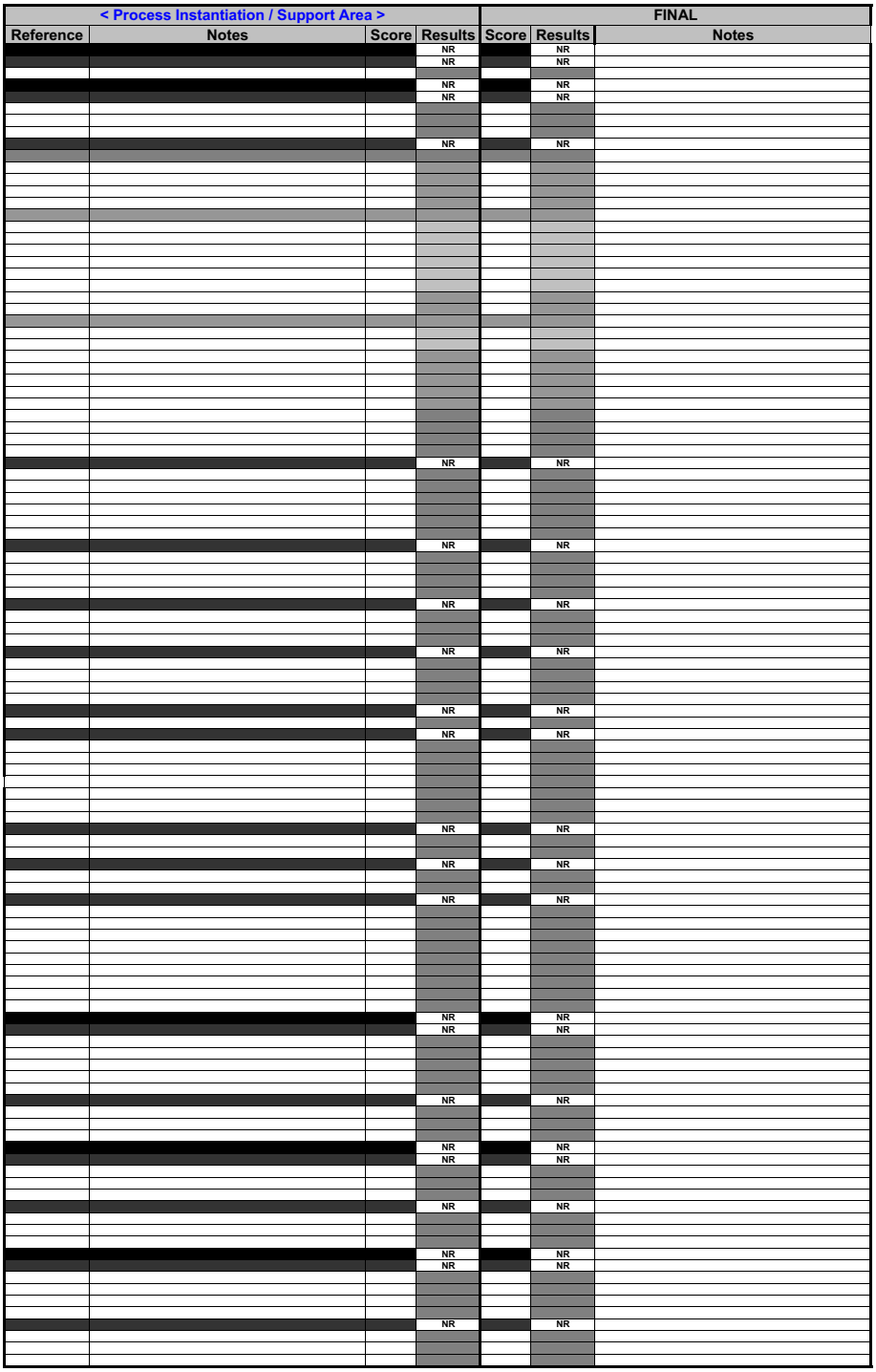



Figure E.3: Process Assessment Record Template (Results Sheet - Right Half)