

Implementation of the CMMI-DEV N3 model in an educational institution: perspective from software quality

ALCÁNTAR-ORTIZ, Patricia*†, MARTÍNEZ-LÓPEZ, Fernando José and VEGA-OLVERA, Gustavo Iván

Received January 18, 2017; Accepted June 20, 2017

Abstract

Quality has become crucial for small size and medium size companies, due to increasing demand for quality by software users. Therefore, it is essential to work under standards that are leading us to optimal results. This is a matter of concern for the Software Development Center (CDS) at the Instituto Tecnológico Superior del Sur de Guanajuato (ITSUR). In 2009, this concern was addressed with the Capability Maturity Model Integration (CMMI) level 2, achieving certification in 2010. Despite the benefits of level 2, the CDS faced daily burdensome and bureaucratic processes; as a result, in 2012 the decision was made to carry out an improvement project with the objective of achieving certification in level 3 version 1.3, in model CMMI, which it was sold as a less heavy version and with a greater adaptability of the company. The implementation involved full time teachers and students, successfully achieving their certification and above all mitigating the deficiencies.

Quality, CMMI, Software, Standards

Citation: ALCÁNTAR-ORTIZ, Patricia, MARTÍNEZ-LÓPEZ, Fernando José and VEGA-OLVERA, Gustavo Iván. Implementation of the CMMI-DEV N3 model in an educational institution: perspective from software quality. ECORFAN Journal-Democratic Republic of Congo 2017, 3-4: 1-5

* Correspondence to Author (email: p.alcantar@itsur.edu.mx)

† Researcher contributing first author.

Introduction

The implementation of quality models is one of the most latent challenges at present within small and medium-sized enterprises (SMEs). This paper reports the implementation of CMMI in the constellation Development (DEV) at its level of maturity 3, and in its version 1.3, in the CDS. CMMI is a model of international quality that emerged in the United States and that for years has begun to interfere in different countries, not being Mexico the exception, one of the challenges with CMMI is the attachment to practices that have not been permeated by the Mexican culture, however in its 1.3 version leaves aside its rigor and allows a better attachment to the way of working of each company, this without leaving aside the use of good practices.

Problem

The quality of the software is a concern that is shared among the members of the CDS. This concern lies in delivering software products on time, meeting the expected costs of meeting customer expectations. In response to this concern, in 2010 the CDS was certified in the CMMI-DEV N2 model, thanks to the implementation of the model, the CDS was able to guarantee the planning and execution of its processes according to the previously established policies, an involvement of all the interested parties, which is monitored, controlled and evaluated. However, despite the kindness shown by the model in its level 2, the CDS faced the following problems:

- Some of the engineering processes are not carried out and those that are implemented are incomplete.
- Estimation of costs and inaccurate times.
- Processes not focused on continuous improvement.

- Long processes, with excessive detail and bureaucratic.
- Work on projects with the same life cycle, despite their differences in size and complexity.

Objectives**General objective**

Implement processes of maturity level 3 of the CMMI-DEV model, in its version 1.3, in the CDS of the ITSUR.

Specific objectives

- Make a diagnosis.
- Define an improvement project.
- Define and adjust the processes, incorporating the best practices of the CMMI-DEV.
- Verify the implementation of the processes.
- Perform implementation cycles.
- Perform a pre-evaluation.
- Conduct the formal evaluation.

Theoretical framework**The role of quality in software development companies**

Currently, you can not visualize a successful company that is not contemplating quality activities in its processes. The quality from the point of view of the software, are all those activities that are carried out to ensure the satisfaction of the client and end users in each of the products, considering among them manuals, minutes, specification documents of requirements and the same software.

It is unacceptable that companies currently deliver products of poor quality and after their delivery they want to remedy the incidents (Sommerville, 2002).

Process improvement

The improvement of processes in the software is a mechanism of continuous improvement of quality, which basically consists of consistently applying those practices that provide good results and eliminating or changing those practices that cause problems or give bad results.

The authors (Pattini, Calvo-Manzano, Cervera, & Fernández, 2004) mention three fundamental aspects in process improvement:

- Choose the improvement model that best suits the institution.
- The model must have four stages: commitment to improvement, diagnostic of the company, planning of the improvement model and implementation of the planning.
- Select a process model that serves as a reference.
- Finally, selection of the method that will be used in the evaluation stage.

The dilemma of software quality

When a company invests a lot of effort in perfecting its processes so that these result in "good" software, some complications occur, in the attempt they realize that they have invested so much that now their software is out of reach of many of their clients and they enter in a dilemma, how much effort should I invest in quality activities? This has been the starting point of some of the current software methodologies where they seek a balance, to be able to generate acceptable quality products that do not require much effort.

Process model: CMMI

CMMI for development or CMMI-DEV is a reference model that covers the activities to develop both products and services. Organizations from numerous sectors, including aerospace, banking, hardware, software, defense and telecommunications, use the CMMI-DEV model (Chrissis, Konrad, & Shrum, 2010). This model helps solve common problems in companies, such as products and services that do not meet customer requirements, delays in delivery and low profitability in projects, high operational costs, low productivity, low levels of innovation and demotivation of staff, all of which results in strategic vulnerability and little competitiveness in the market, one of the fundamental principles in the adaptation of the CMMI model in organizations is the commitment of the high hierarchical levels, these should make possible the entire implementation process (Arboleda, Paz, & Cassallas, 2013).

Methodology

In the present topic, the process that was carried out within the CDS for the implementation of the CMMI-DEV model is described. As a first step was the selection of the consulting company, after having carried out the appropriate negotiations the improvement project was started, which was divided into 5 phases:

First phase: Diagnosis and improvement planning

A comparison was made of the current processes of the CDS and the CMMI model, was carried out by the company Avantare and as a result a diagnosis was obtained, which was crucial for the development of the improvement project plan, the most outstanding findings are shown in Table 1.

Strengths	Weaknesses
Attachment by 55% at level 2	Lack of organizational metrics
Consolidated work team	Attachment by 8% to level 3
There is an estimation tool	The generic practices of the model are not fully met
Handling software tests	

Table 1 Fortalezas y debilidades identificadas.

Source: CDS database

Once the diagnosis was finalized, the improvement plan was carried out, which was based mainly on implementing the actions that would help to strengthen the weaknesses found. In addition to assigning responsibilities to each of those involved.

Second phase: definition and adjustment of processes

This phase and the rest of the phases represent the implementation of the improvement plan. During this phase the following activities were carried out:

- Standardization of work products.
- Definition of organizational objectives.
- Definition of the organizational structure.
- Definition of policies
- Definition of the order of the process areas to be implemented. The order was as follows:
 - Administrative processes
 - Engineering processes
 - Support processes
 - Organizational processes

- Selection of pilot projects. Three projects were selected, two of which were internal and one external.
- Description of the processes and generation of work products.

Third phase: verification of the implementation of the processes

An analysis was made of the current status of the pilot projects and the phase in which they were in order to establish what processes would be implemented in them. Two implementation cycles were carried out:

First cycle: the main activities were to implement the work processes and products, in the pilot projects and identify improvements and / or changes. In Table 2, some of the identified improvements are shown.

Improvement	Impact
Generate a metric that shows the effort in correcting anomalies	High
Standardize the use of Enterprise Architect	Medium
Perform control variables for PPQA review criteria	Medium

Table 2 Concentration of improvements

Source: CDS database

Second cycle: it consisted of executing the same processes and products of the first cycle, including the improvements.

Fourth phase: pre-evaluation

The company Avantare was responsible for directing the evaluation method. He was in charge of evaluating the evidence generated by the CDS in the application of the CMMI model. The objective was the physical evaluation of the evidence of the implementation of the CMMI model and also to ensure that the members of the CDS have correctly implemented the model.

Fifth phase: formal evaluation

In the last phase the Avantare company carried out the formal audit, with a team of 6 people (4 external auditors, 2 internal auditors and a leading auditor) called by the CMMI model as SCAMPI A, the only method that can grant a level of maturity.

Results

The implementation and certification in the model, was achieved in a span of 13 months, with 7 docentes and with approximately 15 students of engineering careers in computer systems and information technology. From the implementation, various processes and work products were obtained, without which it would not have been possible to implement the model.

In table 3. It shows a comparison of levels 2 and 3, in hours per phase of the projects.

	N2	N3
Start	32.33 hours	29.44 hours
Analysis	209.98 hours	140.24 hours
Planning	41.4 hours	43.35 hours
Design	82.74 hours	54.53 hours
Coding	434.40 hours	370.86 hours.
Implementation	140.27 hours	206.86 hours
Closing	20.29 hours	11.09 hours
Total	961.41	856.37

Table 3 Time comparison

Source: CDS database

Before the certification in level 3 of the CMMI model, the CDS had heavy and bureaucratic processes, without leaving aside the lack of engineering processes, now with certification, the processes are more agile and simple, the treatment has improved and the approach with the clients and also it has been managed to improve the delivery time of the products (according to table 3 the time has been reduced by approximately 10%).

Therefore, it can be determined that the quality of the products and processes has improved.

Conclusions

The present work shows that the implementation of the CMMI-DEV model can be implemented in small companies, but also in an environment that combines academic work with the development of software projects. CMMI is a very complete model with large contributions for small companies, however, it is very heavy due to the large number of process areas it handles, it takes many hours of work to fully meet its objectives.

The success lies in finding a balance point and generating quality products that satisfy the customer but have not required much effort. The CMMI-DEV model, no doubt indicates what actions should be performed to generate quality software, finding the point of balance is part of the work of each of the organizations. Those that achieve it will have a huge competitive advantage over others.

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