INTEGRATION METHOD AMONG BSC, CMMI AND SIX SIGMA USING GQM TO SUPPORT MEASUREMENT DEFINITION (MIBCIS)

Leonardo Romeu, Jorge Audy and Andressa Covatti
School of Computer Science, Pontifical Catholic University of Rio Grande do Sul
Porto Alegre, Rio Grande do Sul, Brazil

Keywords: Software Process Improvement, CMMI, GQM, Six Sigma.

Abstract: The software quality area has presented various studies and surveys in different fronts, either about products or processes. There are many initiatives in the area of software process improvement, which might be more than often conflicting in an organization. If we observe some of the existing models and methodologies in the market, the CMMI Model and the Six Sigma Methodology stand head and shoulders above the rest for being complemented. While CMMI focuses on organization and on process management and Six Sigma has its focus on the client and on the financial results, both highlight the importance of the data produced for decision making. This study presents a method for the integrated implementation of the CMMI Model and the Six Sigma Methodology for programs of process improvement, having as a backup measurement and assessment techniques such as the Balanced Scorecard (BSC) and the Goal-Question-Metric (GQM).

1 INTRODUCTION

Quality is a concern even bigger in all types of organizations, in the software organizations this concern is intensified, once that the level of information systems in all sections grows. During the last years, there has been a great interest by the software engineering community in general, for process improvement as an agent that provides product improvement, taking into account that, by understanding and improving the development processes it is possible to improve the product quality and cut down on expenses. (Sommerville, 2003)

The major concern with the software process is straight related with the necessity to understand, evaluate, learn, improve, plan, verify and mainly control software engineers's job. To achieve this goal it is needed to, document the facts, define, measure, analise, evaluate, control and change the development processes.

These controls could help the organization to reduce terms, supply trustable budgets, speed their processes of development and will have primacy of the market (Rocha, Maldonado and Weber, 2001).

Balanced Scorecard (BSC) is a businees performance evaluation known by the industry as a measure of health of the organizations. The BSC can also be described as a bunch of actions derived from the organizational strategy that are selected to represent a tool that will be used by the leadears to communicate either external or internal in the organization (Goethert and Fisher, 2003).

The Capability Maturity Model Integration (CMMI) is a model very well spread and used in the world to implement processes improvement in software companies. (Chrissis, Konrad and Shrum, 2003).

The methodology Six Sigma is at its turn know to be used in the industry to improve the development processes of products. It is based on statistics to measure and prove the improvement of the products and processes.

These initiatives BSC, CMMI and Six Sigma, might be called as complements, in the moment that we use the CMMI to implement development processes and Six Sigma as the official methodology to implement continuous process improvement. Connected to this, the utilization of BSC to support the improvement program, to be adjusted to

Romeu L., Audy J. and Covatti A. (2009).
INTEGRATION METHOD AMONG BSC, CMMI AND SIX SIGMA USING GQM TO SUPPORT MEASUREMENT DEFINITION (MIBCIS).
In *Proceedings of the 11th International Conference on Enterprise Information Systems - Databases and Information Systems Integration*, pages 171-176
DOI: 10.5220/0002003901710176

organization's strategic objectives and the GQM approach to define efficient measures.

This paper aims to introduce a method that proposes connections between models and methodologies above mentioned and to describe a case study performed to validate the method proposed.

This paper has the following structure: section 2 presents the theoretical base; section 3 describes related studies; section 4 describes the proposed method; section 5 discuss the case study; section 6 presents the conclusions, future studies and the research limitations.

2 THEORETICAL BASE

2.1 CMMI

CMMI is an evolution to the model Capability Maturity Model (CMM) (Kulpa, 2003). It was created to help the organizations in maturity or capabilities evaluations of process areas, set improvement priorities and to implement these improvements. To attend these objectives in the several areas either the systems engineering as well as software engineering, CMMI version 1.1 is composed by the following models:

- SE-CMM (Systems Engineering CMM);
- SA-CMM (Software Acquisition CMM);
- IPD-CMM (Integrated Product Development Team Model);
- SECAM (System Engineering Capability Assessment Model);
- SECM (Systems Engineering Capability Model);

CMMI is formed by the integration of the models above and it covers products, development and maintenance areas. Nowadays four areas are covered by CMMI v1.1: Systems Engineering, Software Engineering, Integrated Product and Process Development and Suppliers (Chrissis, Konrad, Shrum, 2003).

2.2 Six Sigma

The Six Sigma methodology can be considered as a quality management philosophy. It is a methodology used to manage business and processes improvement and has its focus on the customer. It uses data to lead and implement solutions that are found from causal analysis of a certain problem.

The method uses statistics to measure and analyse organization's processes. Statistically talking, reach the Six Sigma means that, the process or product is being done or manufactured practically with no defects. The Six Sigma represents 3.4 defects found per millions of opportunities, which represents a potentiality of about 99.9996% of efficiency. It is known that nowadays the majority of implemented processes operate between 3 and 4 sigma, that means, close to 93.3% to 99.4% of efficiency. (Hayes, 2005).

Six Sigma, apart from the quality models, is a methodology oriented to business that uses a process improvement approach with several aspects like cost reduction and profit increase. Its main principle is increasing customer's satisfaction based on the defects reduction. Six Sigma methodology, when used by the organizations, enables that the team responsible for implementing improvement, to identify the process and the actions correspondent that will be affected. This flexibility is the part that allows Six Sigma and its joint of tools to be easily integrated to process improvement models already existent.

2.3 Balanced Scorecard

The organizations face several obstacles when they develop a measuring system that is able to measure the right things at the right time. What is needed is a system that balances the historical accuracy of financial numbers with the future performance objectives as well as it helps the organization to implement new strategies.

BSC is a tool that meets both purposes, the approach developed by Robert Kaplan and David Norton as a result of a research on the 90's intended to prove that only financial indicators were not efficient to the global organizations. Throughout researches made in many companies, they created the so called Balanced Scorecard, which apart from the financial indicators also concerns with customer's problems, internal processes and learning and growth. (Niven, 2002).

2.4 GQM

The Goal Question Metric approach is based on the presuming that, for an organization to implement a measurement process in an effective way, first they must specify their objectives and projects. From this point, data for each objective must be planned so that they can be set in an operational manner. Finally, provides a structure to interpret the collected

data that would meet the measurement objectives previously defined. (Basili, 1994)

GQM helps to define and gather objectives to process models, products and quality perspectives based on specific needs of projects and organizations through measurement program.

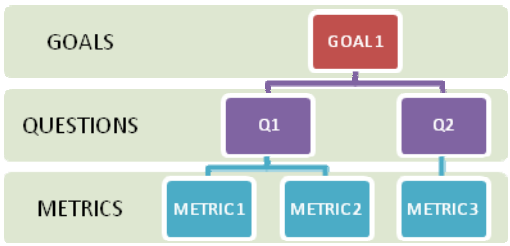

Figure 1: GQM structure.

3 RELATED STUDIES

Recent studies prove the concerns to integrate improvement efforts, in order to obtain organizational growth in all areas using different models, methods and approaches. (Rocha, Maldonado and Weber, 2001).

According to Vasques, Balanced Scorecard, CMMI and Six Sigma are strongly related because, the first deals with de organization's strategies, directions that it is going to take and its priorities; the second one provides to the organizations a guide of management by processes and the third provides a process improvement methodology already rested and proved worldwide. (Vasques, 2005).

Pickeril says that there is an interesting relationship between the improvement approach used by CMMI, the IDEAL model, developed by SEI, and Six Sigma methodology. IDEAL improvement life-cycle contemplates five steps to process improvement: Initiating, Diagnosing, Establishing, Acting and Leveraging and it might be used to implement process improvement along with Six Sigma. (Pickerill, 2005).

As per Siviy, Six Sigma can be used as a support tool to implement CMMI in software organizations. Teams that are used to the Six Sigma methodology feel more comfortable and contribute on the implementation of a quality model like CMMI, and besides that, these teams will not be resistant on the implementation of measures and controls in the proposed processes. (Siviy, 2004).

4 PROPOSED METHOD

After the studies of several models, methodologies, and methods it becomes clear that the efforts to processes implementation and continuous improvement programs at the software organizations quality area need to be adjusted to the strategic plans of the organization. This basis it will be possible to help on the achievement of goals and objectives proposed to them. The method is divided basically in three levels: Organizational, Projects and Systems and Continuous improvement.

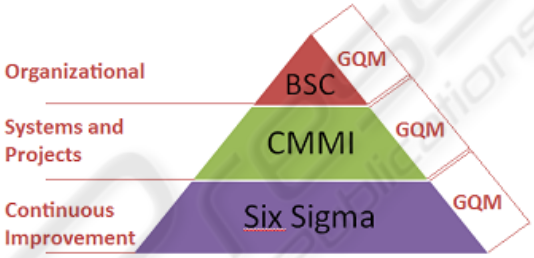

Figure 2: Method basic configuration.

As we can note in the figure 2 that the GQM approach is part of all levels of the model supporting measures definition and interpretation.

To represent the method MIBCIS it was chosen UML through activities diagrams. Some adjustments and use of stereotypes are necessary to better specify the method.

The activities proposed in the method MIBCIS does not happen in sequence, some are periodical and some are by events. The strategic plans, for instance, are done/revised periodically. On the other hand, continuous improvement happens by events, the improvements or new processes implementation is an activity usually triggered from improvement opportunities or requests of change. Besides the activities described on the model through UML activity diagrams, a series of document templates have been developed as work products for each activity.

4.1 Organizational Level

On the organizational level the organization's strategic objectives are evaluated. The business processes passes by an analysis, and based on that, BSC approach is used to define performance indicators that will support decisions that are supposed to be taken based on that data.

The organization's strategic objectives and planning are used to construct the strategic maps

which are part of the existing work products of this stage. At this point it is also created the so-called document Strategic Objectives, where they are organized within BSC perspectives.

Each strategic objective must be worked and detailed afterwards to generate the performance indicators definition. The objectives detailing is done in a document called strategic maps.

Based on the information of these documents, finally it is defined the performance indicators. The performance indicators provide management information to support decision making process. To help these performance indicators to be composed there is a necessity to define and specify good measures. MIBCIS proposes the GQM approach to be used to set the measures.

4.2 Projects and Systems Level

In this level, the method MIBCIS suggests to use the reference model CMMI to define software development processes and management processes. The reference model guides the organization in the direction of saying what should be done to achieve quality projects but not how to do it. How to do will be set by the organization itself that will generate a framework of processes from the good practices suggested by CMMI.

To help in the construction of new processes the method also proposes the usage of a methodology called Design for Six Sigma (DFSS) that implements a development life-cycle, specifically to attend the necessities of creation of new processes, products and services.

This combination of Six Sigma to implement new processes using CMMI as a reference model turned to be able through the mapping of DFSS to IDEAL.

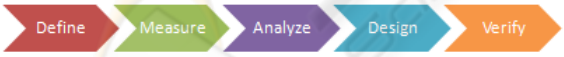

Figure 3: DMADV.

By using DMADV life-cycle, which can be seen on Figure 3 above, along with the IDEAL model the new processes will be set. The process commences through the Define phase, as its name says it deals with customer's needs definition, be it internal or external. In the Measure phase these needs are specified on a measurable way. It can be achieved by studying competitors and/or partners results, and to do so, benchmark technique can be used. At the Analyse phase, possible solutions must be considered to support customer's requirements. On this phase, besides solutions' analysis, one of them will be chosen to be developed. In the Design phase the previously chosen solution is then fully developed and implanted. At last, in the Verify phase it is necessary to identify if the new process requirements are in compliance with the benchmarks, until the execution allows the organization to have an own base of comparison.

After the defining the new process, the organization must use its GQM program to define measures to manage it quantitatively.

Eventually, when the new process is ready, it will be part of the organization's process framework.

4.3 Continuous Improvement Level

The Continuous improvement level is responsible to identify improvement opportunities and to develop solutions to enhance the processes, products and services quality.

The improvement opportunities identification is done through performance indicators data analysis. All the generated organization's measurement data will be submitted to analysis by the process improvement group that will be formed by a multidiscipline team that are able to evaluate the data over several perspectives.

After this analysis the results will be re-checked and if they are satisfactory, the data analysis is concluded. If the analysis results are not acceptable the problem causes need to be identified and the group might take two different decisions: either it is necessary to create a process improvement project or it is necessary to create a new process to give solution of the existing problems. If the analysis results points to the creation of a new process, so the methodology Design for Six Sigma will be used as per previously described. If the analysis results suggests that there is no need of a new process, but changing one of the existing processes, so the methodology DMAIC will be used.

The method DMAIC of the Six Sigma methodology can be mapped to the process improvement activities proposed by the IDEAL model and it is formed by five phases as shown below:

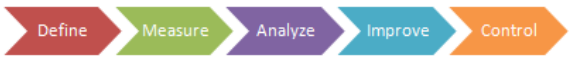

Figure 4: DMAIC.

5 CASE STUDY

The case study was applied on a large scale software development unit. The organization owns offices in more than 34 countries worldwide. According to the information supplied by the organization, it has more than 55 thousand employees all over the world. The unit where the study was carried out is located in Porto Alegre, Rio Grande do Sul State, Brazil. There are more than 400 people working on projects that meet the companies' IT area in any region of the world. The biggest interaction is with the headquarters, located in Austin, Texas, USA, which is responsible for the demand of projects. This Brazil's unit is certified on SW-CMM level 2 January/2003.

5.1 Organizational Level

Concerning this level of the model, the same brings meaningful contributions setting the flows for usage of the Balanced Scorecard. This level of the model does the alignment of the program of quality with the organization's strategic objectives in a clear and efficient way.

Through the case study it was noted that this level of the method presents signs of possibility of generalization, once that, the studied organization does not uses the technique BSC. This basis the performance indicators were mapped from the Hoshin Plan, used by the organization to the BSC proposed in the method. This mapping was done through Strategic Objectives and Strategic Maps documents. The sources of the data were the Hoshin Plans of the IT, PMO and GPQT (Global Process, Quality and Tools) areas of the studied organization.

5.2 Projects and Systems Level

The method adopts cycles well spread to the creation of processes; this basis the application of this level was easy and direct. But it was noted that the method is not efficient when it comes to defining execution roles to the creation of process' life-cycles. This facility however, does not mean that the method can help in a practical way the organizations which are commencing the definition of its own processes' framework once the studied organization has already been working this way.

5.3 Continuous Improvement Level

Though the analysis flow of measures and indicators the proposed method contributes straight with this area. The organization which was object of studies had all the information needed to this level, although they were not well organized in a way that everybody could have access. The improvement projects, that use a specific program called BPI, could be perfectly mapped to the proposed methods, because they meet all Six Sigma requirements.

6 CONCLUSIONS

We can note that the integration between continuous improvement initiatives used in one organization can help the implementation of a quality program. The different efforts that arise with the objective to improve products, processes e services quality need to be connected. These actions need to have as a main focus on the business process improvement of each organization.

Along with BSC, software measures were the quantitative part of the indicators, it means, what we want to measure. Those measures will naturally be aligned to the strategic objectives of the organization once they will be created from performance indicators' definitions. This procedure eliminates efforts to collect and work information that are not import for the organization.

After it is given a definition to what type of information it is considered important to the organization it is necessary to define which process will give origin to the data that will feed the indicators.

Once this process is defined, the indicators will give to the organization the possibility to realize and choose improvement fields based on trustable information. Using the methodology Six Sigma, it is possible to make an analysis of the processes, work the causes that affect them and control the process.

REFERENCES

Basili, V. R. The Goal Question Metric Approach. Available at: ftp://ftp.cs.umd.edu/pub/sel/papers/gqm.pdf

Chrissis, Mary Beth; Konrad, Mike; Shrum, Sandy. CMMI Guidelines for Process Integration and Product Improvement. Addison-Wesley, 2003, 664pp.

Goethert, Wolfhart; Fisher Matt. Deriving Enterprise-Based Measures Using the Balance Scorecard and Goal-Driven Measurement Techniques. Institute Carnegie Mellon University. October 2003.

Kulpa, Mararet K. Interpreting the CMMI: a process improvement approach. Estados Unidos: Auerbach, 2003, 1º Edição, 414 pp.

Niven, P.R. Balance Scorecard step-by-step. John Wile & Sons. 2002.

Pickerill Jay. Implementing the CMMI in a Six Sigma World. Institute Carnegie Mellon University. Available at: http://www.sei.cmu.edu/cmmi/adoption/pdf/pickerill.pdf.

Pressman, Roger S. Engenharia de Software. São Paulo, McGraw-Hill,, 2001, 5ª Edição.

Rocha, Ana R.; Maldonado, José; Weber, Kival. Qualidade de Software - Teoria e Prática. São Paulo, Prentice Hall, 2001, 303pp.

Siviy, Jeannine M; Forrester, Eileen C., Using Six Sigma to Accelerate the Adoption of CMMI for Optimal Results. Institute Carnegie Mellon University. Available at: http://www.sei.cmu.edu/cmmi/adoption/comparisons.html. 2004

Sommerville, Ian. Engenharia de Software. São Paulo, Addison Wesley, 2003, 592 pp.

Vasques, Renato. What does "High Maturity" Really Mean? An Integrated View from Best practices: BSC, CMMI and Six Sigma, SEPGLA, México, 2005.