Initiating Software Process Improvement with a light model for Small Enterprise: Our Experience

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Abstract

For many years, industry and research communities have studied Software Process Improvement in enterprises. However, that research applied mainly to large enterprises. In 1998, the University of Namur (Belgium) began a research project on Software Process Improvement in small settings (fewer than 60 employees), mainly in Wallonia to begin with, where improvements have been evident. Then, experimentations have been conducted in several dozen enterprises in 3 countries by this university, the ÉTS (École de technologie supérieure, University of Québec, (Canada)) and the CETIC (Centre d'Excellence en Technologies de l'Information et de la Communication). After many assessments within Very Small Enterprises (VSE) we found some constant about weaknesses and strength of those enterprises. The first section define what is a small enterprise, the second section present the approach and methodology, the third section presents different assessment results in the last 7 years (1999-2006) and in the fourth section we focused our study on discovering which topics are the weakest among the whole software processes, and what reasons that makes these topics the weakest. The last section is about our conclusion and future work.

Keywords: Software Process Improvement, Maturity Model, Process Evaluation, CMM®, CMMI[SM][1], SPICE, OWPL, Micro-Evaluation, Small Settings.

1 Introduction

In the global market context, large enterprises involved in Information Technology (IT) products and services are aware of the importance of performance, quality and development time. As a result, many invest in time and resources for improving their software product quality and development processes. Some have created their own reference model in that purpose, but most use models such as the CMMI[SM] [14] from the Software Engineering Institute (SEI) or the ISO/IEC 15504 standard from the International Enterprise

[1] CMM and Capability Maturity Model are registered in the U.S. Patent and Trademark Office. CMM Integration, CMMI are service marks of Carnegie Mellon University.

for Standardization (ISO) [18] also commonly known as SPICE.

However, These models are not readily usable by small and very small enterprises (of less than 25 IT employees), as they are much too complicated and too expensive to implement. A solution to this problem was needed. Even though small enterprises exist in every country, our study is limited to Wallonia (Belgium), Québec (Canada), Rhône-Alpes and Provence-Alpes-Côte d'Azur (France). At the University of Namur, a Software Process Improvement (SPI) [5] approach dedicated to small enterprises has been developed during the 1998-2000 period. It has been used and is still being improved in collaboration with the CETIC (Wallonia, Belgium) and the ÉTS (Québec, Canada). This paper relates the results obtained by using this approach in several small settings.

2 Approach and Methodology

The majority of the targeted enterprises have little or no experience with quality concepts, nor with Software Process Improvement (SPI) [5]. Generally, they have limited resources, such as staff, time and budget. Moreover, the typical weaknesses noted in small settings, are that they perform software processes and practices which have uneven maturity levels within the same enterprise. These maturity levels also greatly fluctuate as projects, clients, decision makers and development teams differ. Fortunately, it is often possible to identify and point out those efficient and effective software practices within these enterprises that can easily be generalized throughout teams and projects.

That is to say, the chosen methodology must take into account the particular context of small settings in order to quickly progress within a limited time and budget, to eventually reach a higher maturity level [6].

The methodology described here presents a gradual approach (see Figure 1) which is based on a three-step Software Process Improvement Framework: *OWPL*[2]

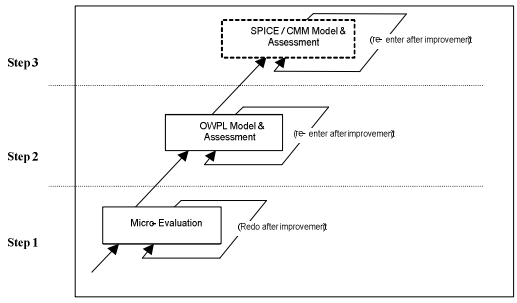

Figure 1: The OWPL Gradual Framework

2.1 The *OWPL* Gradual Framework

The objectives behind using the *OWPL Gradual Framework* [5] is twofold: first, to make the enterprise aware of the software quality aspects and second, to initiate a continuous mechanism of SPI that will produce rapid, but tangible results, and all that, within a minimum range of resources.

2.1.1 Step 1: the Micro-Evaluation

The first step of the framework proposes that an assessment of the small enterprise be carried out. This assessment is made through a simplified questionnaire called the *Micro-Evaluation* [13], which first, assesses the current software practices in the small setting, and second, makes the enterprise aware of software quality aspects. This questionnaire covers six key practice areas and 16 sub-practices, The six key practice areas are:

1. Quality assurance
2. Customer management
3. Supplier management
4. Project management
5. Product management

[2] *OWPL* stands for Observatoire Wallon des Pratiques Logicielles (Walloon Observatory for Software Practices)

6. Training and human resources management.

The 16 sub-practices are: commitment to quality (1), origin of quality (2), requirements formalization (3), change management (4), customer integration (5), subcontractors selection (6a), subcontractors tracking (6b), project phasing (7), development methodology(8), project planning (9), project tracking (10), problems management (11), verification (12), versioning (13), products structure (14) and human resource management (15). These are evaluated according to systematic analysis grids.

The questionnaire is used by an assessor, to interview a representative of the evaluated enterprise. The assessor must have sufficient expertise in software quality and software process improvement. The interviewed individual should also have sufficient knowledge of the enterprise's IT activities.

After the assessment, the results are drawn up in a report. The report should include a brief presentation of the approach used and the assessed organisation, then the collected, analysed and summarized results according to the six axes are presented. After that, a list of the main strengths and weaknesses according to SPI principles is drawn up, and finally the recommended practices intended to help the assessed enterprise to improve its existing practices and processes are listed. The conclusions drawn from the *Micro-Evaluation* responses lead to an action plan to be undertaken. A second *Micro-Evaluation* can be performed a few months after the first one, to evaluate progresses made.

2.1.2 Step 2: the OWPL Model

The second step represents the central component of the framework, where the *OWPL Model* [7] is applied. The model's construction has been influenced by existing standard models like SPICE (ISO 15504) [9] and CMM® [15]. It offers an analogous approach to those standard models, but contrarily to them, the *OWPL Model* has been deeply influenced by experimentations carried out in small enterprises (with the help of the *Micro-Evaluation*), hence building a strong knowledge base on small settings' software development practices, contexts, objectives and maturity levels.

The *OWPL Model* proposes 10 processes, each of them composed of several practices (between 3 and 12). Theses processes are:

1. Requirements management
2. Project planning
3. Project tracking and oversight
4. Development
5. Documentation
6. Testing
7. Configuration management
8. Supplier management
9. Quality management
10. Experience capitalization

The traceability between the above processes and the *Micro-Evaluation's* key practice areas is noticeable and intended.

The *OWPL Model* also proposes 30 *success factors*, which enable to capture objective elements of the particular context of the enterprise and projects currently assessed.

After an *OWPL Model* assessment, a report must be written. It must contain the summary of all the collected information, the data analysis and recommendations for an appropriate improvement plan.

Like the *Micro-Evaluation*, the *OWPL Model* also provides an evaluation that can be carried out several times to measure improvement, and can serve as an entry point for the next and final step of the framework.

2.1.3 Step 3: the SPICE / CMM Models

Only at the third step can the small settings justify the need for a standard labelling, that is, when the enterprise has reached a sufficiently high maturity level. Only then can a SPICE (ISO 15504) [9] or a CMM [15] evaluation may eventually be undertaken. The improvements will then be implemented according to the chosen reference model. Though this approach may seem linear, an enterprise may jump from one step to the other, depending on its size and maturity level.

3 The OWPL Gradual Framework Results and Case Study

These studies have been carried out in small enterprises that provide computer related services or products, and/or electronic components. The enterprise samples for the study include enterprises from Wallonia (Belgium), Québec (Canada), Rhône-Alpes and Provence-Alpes-Côte-d'Azur (France). The rest of the paper is about the micro-evaluation results.

3.1 The *Micro-Evaluation* results

Even though the sample does not claim to be representative of all the world's small enterprises, the particularities that characterize small settings are the same and remain consistent throughout the selected sample. Below is a summary (by country) of the collected results.

3.1.1 The Micro-Evaluation in Wallonia (1998-99)

The *Micro-Evaluation* was first tested by the University of Namur on a sample of 20 small enterprises in Wallonia, in 1998-99 [4]. Figure 2 shows the global maturity profile of the small enterprises involved in the *Micro-Evaluation* [10][11].

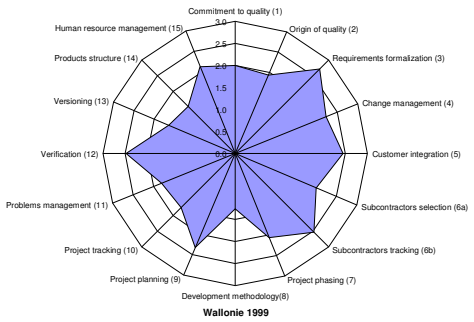

Fig. 2 Results of *Micro-Evaluations* in Wallonie (maturity perception)

The following conclusions were drawn from a first round of the *Micro-Evaluation*:

- For most of the assessed enterprises (2/3), there was a lack of formalism, more particularly poor planning processes, or none at all. For the majority of them, there was no training program, and the enterprises' success was highly dependent on individual skills.
- For the other enterprises (1/3), there was an awareness of the quality aspects of software development: quality improvement processes were already in place, with well-defined and documented procedures.

3.1.2 The Micro-Evaluation in Québec (2004-05)

In the summer and fall of 2004[10] and 2005, 21 *Micro-Evaluations* were performed in Montréal where the average number of employees in the targeted enterprises was about 16, and the average number of years the companies had been producing software was of about 8.

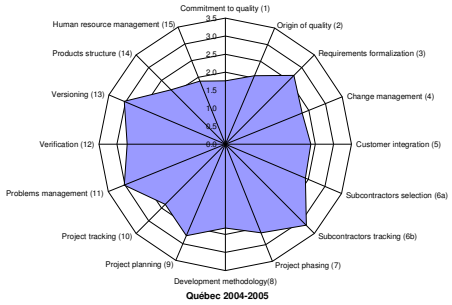

Fig. 3 Results a first round of *Micro-Evaluations* in Québec (maturity perception)

Figure 3 shows that small enterprises were performing, with a score of about 3 on a 4 point scale, subcontractors tracking, problem management, versioning activities. One can also note a certain number of weaknesses: very low scores were obtained on commitment to quality (score=1.8), origin of quality (score=2.2), product structure (score=2.1), human resources management (i.e. training) (score=1.9). It is interesting to note that the scores obtained for Québec do not fluctuate significantly, which corroborates even maturity levels within enterprises.

3.1.3 The Micro-Evaluation in France (2005)

In the summer of 2005, 9 *Micro-Evaluations* were performed under professors' supervision by a graduate student in software engineering at the École de technologie supérieure (co-author of this paper). The average number of employees of that sample was of about 13, and the average number of years they have been in the software development business is about 6 to 7 years. Amongst them, only one was 20 years old.

Figure 4 shows that the targeted enterprises were performing quite well (3 points or more) in the practices related to: project phasing (score = 3.2) and product structure (score = 3.2). The assessed weaknesses (under 2 points) pertain to the activities related to: commitment to quality (score=1.3), origin of quality (score=1.7) change management (score=1.9), development methodologies (score=1.8), problems management (score=0.7), human resources management (i.e. training) (score=1.1). It is to be noted that half of these enterprises had no supplier, biasing the "Subcontractor selection" axis.

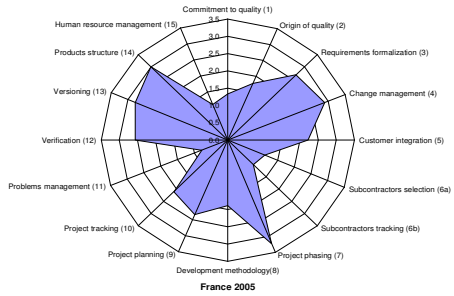

Fig. 4 Results of a first round of *Micro-Evaluations* in France (maturity perception)

3.1.4 New micro-evaluation in Québec (2005-2006)

The micro-evaluation assessment is still in use in Quebec region. In summer 2006 another study has been made based on the Micro-evaluation results for three successive semesters; autumn 2005, winter and summer 2006 which aims at discovering practically the weakest practices and sub-practices applied in the VSE (Score < 2, based on the scales of the Micro-Evaluation) and shed light on them. In autumn 2005 a set of 7 VSE has been assessed, in winter 2006 another round of assessment included 12 VSE; in the following semester (summer 2006) another round of assessment is made for 13 VSE. The results are recorded and analyzed for

Comment [G1]: The sentence below have been removed, since there was no study for another round in some of the visited organizations to measure their degree of improvement

the total of 32 enterprises. After the analysis of the collected data, results are presented graphically as in figure – 5 and figure – 6 below as follows:

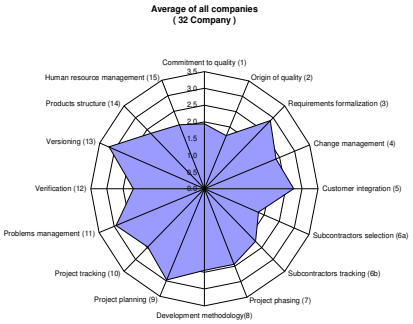

Figure 5 - Detailed Average graph (32 companies)

From Figure 5 we can see that the 2 sub characteristics on quality (Commitment to quality and Origin of quality) are below 2. From Figure 6 we can see that the main axis that is suffering from weaknesses is the quality management axis which scores 1.8 only

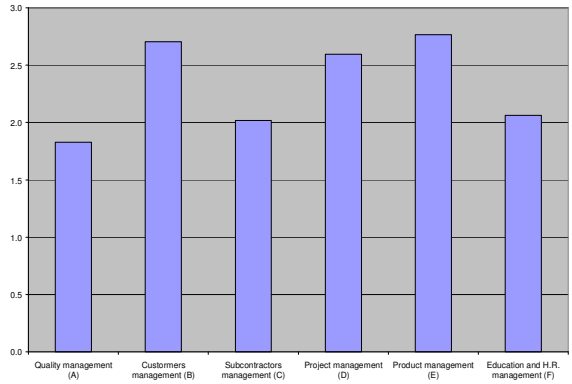

Figure 6 - Average of Scores for the main 6 axis

Based on these results, it is obvious that the quality management axis is the weakest link that needs improvement in VSE, since it is the lowest scored axis.

But what makes the quality management have such low score? Based on our study and analysis of the questionnaires results for the 32 companies, we can refer this weakness to several reasons as follows

1. Most of the quality management activities have been reduced to testing the code only.
2. Code testing is performed mainly by the programmers in an ad hoc manner, i.e. no clear testing plans are used.
3. There are no specialized or trained employees that can apply quality management activities.
4. VSE depend on the personal skills for their employees in performing their tasks.
5. Most of the VSEs are not aware of the quality management activities.

4 Lessons Learned

Section 4.1 describes the highlights from the experience with small enterprises (from Belgium, Québec and France) once the *Micro-Evaluation* was carried out. On the other hand, the experience has raised apparent weaknesses and strengths of the *Micro-Evaluation* itself which are described in sections 4.2 and 4.3, respectively.

4.1 The assessed enterprises

Here are the highlights of some apparent characteristics of the assessed enterprises:

- Globally, small enterprises became aware of SPI topics after the *Micro-Evaluation* assessment has been made.
- Less than a third of the assessed enterprises were aware of software quality aspects.
- In most cases, there was no training program, making the enterprises' success dependent on individual skills, which is typical in small enterprises.

4.2 The *Micro-Evaluation*' weaknesses

These weaknesses will be addressed in order to improve the *Micro-Evaluation*. Improvements will be made based on the following observations:

- Because of the lightness of the *Micro-Evaluation,* the questionnaire has a small number of questions. These questions sometimes cover far too much terrain, making the evaluation scope too vague.
- Some of the *Micro-Evaluation*'s questions are redundant.
- The *Micro-Evaluation* is not adapted for small enterprises that do not have direct clients (if they function on government funding for example, if they produce "of the shelf" or "R&D" types of software).
- A criteria should be added to each question, to specify if a given answer (by an interviewed employee) has been interpreted by the interviewer, or if it has been transcribed literally. This would give some added value on how reliable and objective the scores are.

4.3 The *Micro-Evaluation*' strengths

The main lesson was that the *Micro-Evaluation* is very attractive as a tool for small settings. It offers an optimum ROI (Return-on-Investment) for any small development teams with low maturity levels. Here are more specific positive characteristics:

- The *Micro-Evaluation* is a simple and low cost assessment.
- The *Micro-Evaluation* gives an accurate insight of the assessed enterprises teams.
- The *Micro-Evaluation* can be tuned to match the enterprise's available resources (big or small)
- A simplified vocabulary is used, making the *Micro-Evaluation* understandable to whom are not experts of the software quality improvement aspects.

5 Conclusion and Future Work

Current software practices in most small enterprises are far from being well defined, and the lack of available resources compromises the success of any SPI approach based on models such as CMMI[SM] or SPICE. However, it is possible to undertake a SPI process and to make real progress without investing large amounts: the *OWPL Gradual Framework* has been designed to exactly do that.

The studies show that the *Micro-Evaluation* (step 1 of the framework) is a very attractive assessment tool to start with, mainly because of its simplicity, and also because it helps draw people's attention to the problems related to software quality improvement aspects. For those small enterprises looking for a more exhaustive assessment and software improvement process recommendations, the *OWPL Model* (step 2 of the framework) should be the appropriate answer, as it has been developed taking CMM® and SPICE Models as references on one hand, and the small setting's characteristics and context (which are highlighted thanks to the *Micro-Evaluation*) on the other. Then can a SPICE (ISO 15504) or a CMM evaluation may eventually be undertaken (step 3 of the framework).

The evolution of the *Micro-Evaluation* will be reflected in the next release, as follows:

a) Refining the evaluation's questions and scales to attribute quality levels to each practice, making the mapping easier, between the answers collected and the evaluated practices.
b) Adapting the *Micro-Evaluation* in reference to "Agile" development practices to obtain a better representation of the reality.
c) Adapting the *Micro-Evaluation* in reference to those enterprises who

develop software type products that exclude direct client stakeholders.

d) Modifying axis labels so that direct interpretation drawn from the charts themselves will be more understandable.
e) Refining (or adding) questions to the *Micro-Evaluation*, to better assess the existing software practices.
f) Adding the "objective/subjective" criteria to each of the *Micro-Evaluation*'s questions to add value to the collected answers.
g) Preparing a course on the *Micro-Evaluation* that targets assessors, to improve and normalize the assessment technique and eventually, the collected answers.

It is worth mentioning that the *OWPL Gradual Framework* represents one of the inputs presently considered by the new ISO/IEC SC 7 Working Group 24 [12]. Briefly, the working group is mandated to facilitate access to, and utilization of, ISO (the International Enterprise for Standardization) Software engineering standards in very small enterprises (VSEs), a term which includes small software development departments and small projects within larger enterprises. VSEs are typically enterprises (or projects) that have 25 employees or less.

Further research includes conducting more *Micro-Evaluation*s to gather a more data on small settings, to improve the described approach and improve small enterprises' performances. So far, the results of this experiment are promising. Second rounds of evaluations will be conducted on a number of the already assessed enterprises, in order to evaluate if improvements to their software activities have been identified.

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