Expected requirements in support tools for software process improvement in SMEs

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Abstract: Nowadays being competitive is an important challenge for software development organizations. In order to achieve this, since last years, software process improvement has been an obvious and logical way. Unfortunately, even when many organizations are motivated to implement software process initiatives, not all know how best to do so, especially in Small and Medium Enterprises(SMEs) where due to its especial features, they have to be carefully in how to manage its resources to assure their market survival. Besides, even when there has been developed models which pretend to help SMEs in the implementation of software process improvements, one of the main barrier that stopping SMEs to implement software process improvements are the lack of knowledge and support of software process improvement. This paper presents an analysis of software process improvement at SMEs focusing on identifying on the one hand, SMEs features and success factors in the implementation of SPI initiatives. On the other hand, the expected requirements in a software tool focus on providing support for SMEs in the implementation of software process improvements initiatives (SPI).

I. INTRODUCTION

Small and Medium Enterprises (SMEs) are becoming a cornerstone in the worldwide industry economy since the past two decades. Especially in software development industry, SMEs has emerged, grown and strengthened, so that, they represent a major economic activity throughout many nations in the world [1][2][3].

In order to create a strategic advantage respect to its competitors and to survive in software industry market [4], SMEs are become more and more concern about software process improvement (SPI) since it is well known that software product quality is largely dependent on the process that is used to create it [5].

Unfortunately, even when many authors [5][6][7][8][9] have recognized the importance of the implementation of Software Process Improvement as a mechanism to launch the competitiveness and efficiency in software industry, implementing SPI in organizations has been a path full of obstacles for most organizations [10][11].

This problem is potentiated in SMEs because they have a very limited budget to improve their software processes [2][12][5][13][14] unlike large companies, which could have a budget dedicated to implement SPI initiatives.

As a result, implementing SPI initiatives in SMEs has become a really challenge, mainly because of all the barriers that must be overcome due to SMEs nature and the resistance to change arising from the staff by either ignorance or past frustrated SPI experiences.

The goal of this paper is to make in-depth software process improvement analysis in SMEs focusing on software support tools for the implementation of SPI in SMEs.

In order to focus the context of this research, the first step was to analyze the work culture of SMEs, so that the SMEs features could be established. The second step was to understand the needs of SMEs to implement a success software process improvement initiative, then, the success factors in the implementation of SPI in SME was analyzed and selected.

Besides, a third analysis focus on the developed academic software tools was performing, as a result, a set of features were identified, analyzed and classified
so that the expected requirements that a software improvement tool for SMEs were identified.

This paper is structured as follows: section 2 introduces to software process improvement in SMEs; section 3 shows SMEs features; section 4 describes the success factors in the implementation of SPI initiatives in SMEs; section 5 presents the expected requirements in the support software tool for SPI in SMEs, and finally, section 6 presents the conclusions.

II. SOFTWARE PROCESS IMPROVEMENT IN SMEs

Small and Medium Enterprises (SMEs) in this research work and according to [3] and [15] covers two kind of companies, the small enterprises which are companies with fewer than 50 employees and medium enterprises which are companies that have between 50 and 249 employees.

SMEs represent a major economic activity throughout many nations in the world [1][2][3][14][15].

This is confirmed in [12], where it is mentioned that there is an increasingly growing of SMEs as a key component in the industrial profile of many countries. Besides, SMEs are very important as a key part to the economic growth because they constitute the majority of software development organizations around the world [16].

Due to their importance, since 2002 there has been increasing the interest of software engineering in SMEs [2].

Therefore, on the one way, organizations such as the Software Engineering Institute (SEI) and the International Organization for Standardization (ISO) are focusing their efforts towards this kind of organizations in order to achieve that theirs models and standards such as CMMI, ISO 12207 and ISO 15504 respectively, may be successfully applied in SMEs [16].

On the other way, there has been developed as result of research works models [9][17], methodologies [16], approaches [18][19][20], methods [12], projects [21], frameworks [22] among others which pretend to help SMEs in the implementation of SPI initiatives.

Unfortunately, implementing SPI initiatives in SMEs becomes difficult and most of the times completely chaotic [23], because SMEs are no able to invest in the implementation of expensive SPI programs [10] neither too much time nor too much resources [5][9][23].

The difficulties above mentioned is because the main motivation to implement SPI initiatives in SMEs is not to obtain a certificate, but it is to make a more efficient and effective organization [2][5][8].

III. SMEs features

In last paragraphs there were mentioned that SMEs have special features, so that, they have a really challenge when implementing a SPI initiatives especially in SMEs.

This section shows an analysis made to identify the SMEs features. To achieve it, first of all, there were established a set of four categories, which has allowed having a better classification of the features.

The categories were obtained after making a bottom-up analysis and classification of the SMEs features. Next, the selected categories and their focus are listed:

- Organization: how is a SME?
- Staff: how are the personnel in a SME? / how many activities should they do?
- Software Process (SP): how important are the processes in a SME?
- Software Process Improvement (SPI): how is the implementation of SPI in SMEs?

Table 1 shows the result of analyzing 12 authors indicated by square brackets, in order to identify what they mention about the four categories.

<table>
<thead>
<tr>
<th>TABLE 1. SMEs FEATURES</th>
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<tr>
<td><strong>Features</strong></td>
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<td><strong>ORGANIZATION</strong></td>
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<td>High innovation and adoption</td>
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<td>Agile for change</td>
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<tr>
<td>Daily challenges</td>
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<tr>
<td>Limited customers with high dependency</td>
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<tr>
<td>Focus on practices</td>
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<tr>
<td>Projects with short delivery time</td>
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<tr>
<td><strong>STAFF</strong></td>
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<tr>
<td>Limited staff</td>
</tr>
<tr>
<td>Many activities</td>
</tr>
<tr>
<td>Lack of process culture</td>
</tr>
<tr>
<td><strong>SP</strong></td>
</tr>
<tr>
<td>Minimum training related to processes</td>
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<tr>
<td>Poorly formalization of processes and procedures</td>
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<tr>
<td><strong>SPI</strong></td>
</tr>
<tr>
<td>All staff involved</td>
</tr>
<tr>
<td>Lack of resources</td>
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<tr>
<td>Lack of support</td>
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</table>
As Table 1 shows, the special features of SMEs which are mentioned for more authors, confirms that SPI initiatives could not be implemented in SMEs as in large organizations. Besides, the features such as, limited customers with high dependency, projects with short delivery time, limited staff with many activities, lack of processes culture, and lack of resources, highlight the need to provide support related to the SPI activities in order to convince SMEs investing in this kind of initiatives.

IV. Success factors in the implementation of SPI initiatives in SMEs

This section shows the analysis of the success factors in the implementation of SPI initiatives in SMEs.

Again, the success factors were analyzed and classified in a bottom-up way using the categories organization, staff, software process and SPI. Next, the categories and their focus are listed:

- **Organization**: what does a SME need to establish in order to implement a SPI initiative?
- **Staff**: What does the staff of a SME need to do in order to implement a SPI?
- **Software Process (SP)**: how does a SME know what it needs to implement a SPI initiative?
- **Software Process Improvement (SPI)**: how need to be a SPI to be successfully implemented in a SME?

Table 2 shows the analysis done focused on identifying what the authors say about SPI success factors.

TABLE 2: SMEs SOFTWARE PROCESS IMPROVEMENT IMPLEMENTATION SUCCESS FACTORS

<table>
<thead>
<tr>
<th>Success Factors</th>
<th>Authors</th>
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<tbody>
<tr>
<td><strong>ORGANIZATION</strong></td>
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<tr>
<td>Analyzer organization stability</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Awareness on SPI need</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Build a SPI culture</td>
<td>✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Set rewards programs</td>
<td>✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Resources availability</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Efficient mechanism of communication</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td><strong>STAFF</strong></td>
<td></td>
</tr>
<tr>
<td>Commitment of stakeholders and senior managers</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Stakeholders involvement</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>Training on processes</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
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</table>

As Table 2 shows the success factors mentioned by more authors are: 1) focusing on organization: resource availability and efficient mechanism of communication; 2) focusing on staff: stakeholders and senior management commitments; stakeholder involvement and training on process and on SPI; 3) focusing on SP: adequate assessment frequency; and 4) focusing on SPI: guides the SPI program, SPI is based on real needs, uses an incremental approach, provides support and infrastructure, and chooses an adequate reference model/standard.

V. Expected requirements in a software support tool for SPI in SMEs

The results of the analysis showed in section 3 and section 4 confirm that a key aspect in order to implement a SPI in SMEs is to provide support.

In this paper support refers to software tools that help SMEs providing guide, training, communication mechanism and the infrastructure to manage most of the activities and the work products obtained by implementing a SPI initiative.

In this context, it is important to develop software tools that help SMEs in the implementation of SPI initiatives without forgetting the main restrictions that all SMEs have: short time, few budgets, few resources and few staff with too many activities.

In order to identify the expected requirements in software support tools for SMEs, there were analyzed a set of software tools developed in the academic field as a result of research works.

The analyzed software tools were the result of performing a systematic review focused on software tools that support the implementation of SPI especially in SMEs.

It is important to highlight that this paper considers as SPI tools, those software tools that provide support to organizations throughout the performance of all activities related to the implementation of a SPI.
Table 3 shows the academic software tools analyzed.

### TABLE 3. ANALYSIS OF ACADEMIC SOFTWARE TOOLS

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<tbody>
<tr>
<td>Process assessment</td>
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<tr>
<td>Snapshot of processes</td>
<td>✓</td>
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<tr>
<td>Guide the process selection</td>
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<tr>
<td>Generate SPI plans</td>
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<tr>
<td>Tailor models and standards according to the organization needs</td>
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<tr>
<td>Provide process modeling support</td>
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<tr>
<td>Describe the SPI activities</td>
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<tr>
<td>Support the identification of risk related to SPI</td>
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<tr>
<td>Provide configuration management support</td>
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<tr>
<td>Collect and manage information that are generated by performing SPI</td>
<td>✓</td>
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<tr>
<td>Do not require special knowledge of the organization</td>
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<tr>
<td>Developed for a web environment</td>
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<tr>
<td>Represent a low cost*</td>
<td>✓</td>
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<tr>
<td>Clear rules definition</td>
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* Even when the feature represents a low cost are not applicable to all the analyzed tools, because all of them are research works results, this feature is mentioned in all of them.

As Table 3 shows, there were identified 14 features. Then, they were grouped and as a result 9 requirements were established. Next, expected requirements are briefly described:

1. **Process assessment**: it supports organizations performing a fast internal software process assessment.

2. **Snapshot of process**: it allows organizations to get a snapshot of actual processes.

3. **Guide the process selection**: it provides a guide to select the software process to be improved.

4. **Processes modeling**: it provides support for modeling actual processes and new processes. Besides, it should store them.

5. **Facilitate the improvement implementation**: it provides a strategy and the guide of the activities that should be performed through the implementation of a SPI initiative. Besides, it provides a clear definition of roles and their related activities.

6. **Low cost**: it represents a low inversion to the company.

7. **Self-training**: it provides the essential training on software processes and software processes improvement included as a part of the tool.

8. **Efficient communication**: it provides assistance all time during the improvement implementation that means, it supports the organization throughout all phases of a generic process improvement cycle. It is important to highlight that SMEs will not use a tool unless it proves to be useful.

9. **Useful information**: it provides useful and visible information of the SPI performance; so that key information will be available at the right time and people so that key decisions could be taken.

### VI. Conclusions

This paper showed an analysis of software process improvement at SMEs focusing on SMEs features and the success factors in the implementation of SPI initiatives in SMEs. Besides, a set of software tools has been analyzed to identify the expected requirements related to the software tools that support SMEs in the implementation of SPI initiatives.

As a result, 9 requirements have been identified. Besides, it was possible to identify which of the requirements are more and less covered.

Therefore, on the one hand, requirements such as process assessment, snapshot of processes and useful information are the requirements that have a high coverage in the analyzed tools. On the other hand requirements such as self-training, efficient communication and facilitate the improvement implementation are requirements with a low level of coverage.

In the case of the low cost requirement as in the Table 3 is mentioned, it is a key requirement in SMEs. Besides, in the case of the guide the process selection requirement, most of the software tools guide this selection but focusing on external model and standard instead of focusing on the organization business goals needs.

Finally, it is important to highlight that both, large and small and medium enterprises need software tools...
that support the implementation of SPI initiatives. However, this paper is focused on SMEs because as mentioned above SMEs have special features (short time, few budgets, few resources and few staff with too many activities), so that, it is considered essential to provide software tools that support when starting, during and finishing the implementation of a SPI initiative.

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