Providing a starting point to help SMEs in the implementation of software process improvements

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Agenda

- Introduction
- Framework background
- Framework
- Framework validation
- Conclusions
Introduction

- Software development SMEs are considered a key element in the consolidation of software industry
- In México, software development SMEs represents the 87% of the total of the software development industry

This fact highlights the importance of guaranteeing the quality of their software products

Many authors have recognized the importance of implementing software process improvement (SPI) as a mechanism to launch the competitiveness and efficiency in software industry

SPI has been a path full of obstacles for most organizations

The lack of knowledge on how to address the improvement effort
Introduction

To provide a solution, this paper presents a framework, which aims to set a starting point with regard to

- Model
- Standard
- Agile methodology

To be used as reference in small and medium enterprises (SMEs) based on

- Current needs, features and work culture
Processes entirely depend on the organization work culture and the motivation of people to evolve them.

The human factor is the main source of commitment and responsibility to achieve effective, efficient and quality processes.

Lack of knowledge on how to address the improvement effort.

**EUROSPI 2014:** characterization of software development SMEs' according to their needs for implementing a software process improvement (SPI)

Identifying and defining process improvements patterns, which enable an organization to identify its current scenario and to provide the best way to start a SPI.

Providing a solution to the problem that SMEs should face in selecting a right way to implement a SPI initiative.
The framework should cover an important barrier to implement SPI in SMEs:
1. Use a model or standard tailoring it to SMEs needs;
2. Find a customizable guide that addresses the organization through the best way to implement SPI according to its specific needs and environment;
3. Provide rules adapted to the SMEs size and level of maturity in the implementation of the SPI;
4. Support the development of skills and abilities in the implementation of SPI and;
5. Get tangible results in a short period of time.
The “starting point” should address the SME improvement effort toward the process and model that can be implemented to reduce the detected problem(s).
Framework

Software process improvement patterns  Selection method  Software Tool

Two characterization previously:

• Characterization of software processes improvement needs in SMEs
• Characterizing SME’s needs for implementing a software process improvement: A comparative between the reality and the theory

The pattern elements defined by Coplien and Appleton

Identify context

Provide solutions

Identify forces

Identify patterns

Identify problems
This step aims to establish a set of contexts most commonly detected in SMEs regarding the implementation of software process improvement.

There were selected and analyzed those factors directly related to the human factors.

### Features

**Organization**
- High dependence of customers
- Do not follow a software development cycle
- Do not know the importance of the processes in the software development
- Flat organizational structure

**Human Resources**
- Lack of personnel; their employees number tend to be limited
- There are no roles defined, then employees perform multiple tasks
- The employees have a lack of knowledge of methods regarding SPI
- Lack of communication among the employees

**Processes**
- Do not have defined processes; the software is developing as a craft
- It is very expensive to implement initiatives and producing results quickly
- It is very difficult to adopt a model or standard for implementing a SPI to achieve their goals
- Implement a SPI because of a customer requirement

**Models and Standards**
- Do not use any model and/or standard
- Do not have experience in the adoption of model or standard
- It is very difficult to adopt a SPI Model and/or Standards to achieve the SME’s goals and vision

### Limitations

**High dependency with immature customers; short delivery time**

**There is a lack of role definition and a lack of employees with knowledge of how to implement process improvements**

**Lack of knowledge of the importance between development processes and product quality; lack of processes culture; lack of initiatives to implement software process improvements; and lack of experience in the implementation of SPI**

**Lack or minimal support in the implementation of models and standards**

Three main contexts were identified: (1) do not have defined processes; (2) do not have knowledge in the implementation of software process improvements; and (3) lack of personnel because they have few employees.
### Framework

**Software process improvement patterns**

- **Identify context**
- **Identify problems**
- **Identify forces**
- **Identify patterns**
- **Provide solutions**

**Selection method**

**Software Tool**

This step aims to identify the generic problems that SME can have associated to each identified context. Each generic problem is established as a pattern.

<table>
<thead>
<tr>
<th>FEATURES</th>
<th>LIMITATIONS</th>
<th>GENERIC PROBLEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization</strong></td>
<td>High dependency with immature customers; short delivery time</td>
<td>Do not have historical data; Do not perform a formal risk management; The software development is not documented; Do not detect improvements opportunities</td>
</tr>
<tr>
<td><strong>Human Resources</strong></td>
<td>Lack of role definition and a lack of employees with knowledge of how to implement process improvements</td>
<td>Lack of information and training; Human Resources</td>
</tr>
<tr>
<td><strong>Processes</strong></td>
<td>Lack of knowledge of the importance between development processes and product quality; Lack of processes culture; lack of initiatives to implement software process improvements; and lack of experience in the implementation of SPI</td>
<td>Rework; Delay in the Product delivery; Low quality software products; Projects with estimates out of time and budget; Do not perform a formal risk management</td>
</tr>
<tr>
<td><strong>Models and Standards</strong></td>
<td>Lack of minimal support in the implementation of models and standards</td>
<td>The software development is not documented; Do not have experience in the implementation of software process improvements; Do not detect improvements opportunities;</td>
</tr>
</tbody>
</table>

11 processes patterns were identified:

- **Do not have defined processes**: (1) Rework; (2) Do not have historical data; (3) Delay in the Product delivery; (4) Low quality software products; (5) Do not perform a formal risk management; (6) Projects with estimates out of time and budget; and (7) The software development is not documented.

- **Do not have knowledge in the implementation of software improvements**: (8) Lack of information and training; (9) Do not have experience in the implementation of software process improvements; and (10) Do not detect improvements opportunities.

- **Lack of personnel because they have few employees**: (11) Human resources.
This step aims to identify specific problems derived from the generic problems.

For each generic problem a list of most common problems was developed based on the author experience.

<table>
<thead>
<tr>
<th>Context</th>
<th>Pattern</th>
<th>Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not have defined processes</td>
<td>Rework</td>
<td>Tasks performed incorrectly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New tasks resulting from continuous changes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duplicated tasks as a result of a bad management or shared products</td>
</tr>
<tr>
<td>Do not have knowledge in the implementation of software improvements</td>
<td>Lack of information and training</td>
<td>Unproductivity or low productivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of knowledge of processes performed within the organization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of a strategy to optimize project resources</td>
</tr>
<tr>
<td>Lack of personnel because they have few employees</td>
<td>Human Resources</td>
<td>Low quality personnel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of communication</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of defined roles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of personnel responsibilities and commitments</td>
</tr>
</tbody>
</table>
Framework

This step aims to establish a set of questions, which reflects actions, causes and consequences, and allow identifying SME actual problems.

There were developed a questionnaire, which should reflect the process pattern forces.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Problems</th>
<th># of forces</th>
<th>Forces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rework</td>
<td>Tasks performed incorrectly</td>
<td>1</td>
<td>To determine the corrective actions. Are the problems analyzed?</td>
</tr>
<tr>
<td></td>
<td>New tasks resulting from continuous changes</td>
<td>6</td>
<td>To determine the impact of correctives actions regarding work products, related work products, schedule and cost. Are the change requests analyzed?</td>
</tr>
<tr>
<td>Lack of</td>
<td>Lack of knowledge of processes performed within the</td>
<td>4</td>
<td>Are the mechanisms to provide required knowledge and abilities analyzed and selected?</td>
</tr>
<tr>
<td>information</td>
<td>organization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of</td>
<td>Lack of a strategy to optimize project resources</td>
<td>4</td>
<td>Are the requirements of facilities, equipment and components determined?</td>
</tr>
<tr>
<td>Human</td>
<td>Low quality personnel</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lack of communication</td>
<td>3</td>
<td>Is the state of assigned task and the obtained work products regularly communicated among stakeholders?</td>
</tr>
</tbody>
</table>
Framework

Software process improvement patterns

Selection method

Software Tool

This step aims to set a starting point regarding the model and process that the SME should focus in order to address its improvement effort to reduce a detected problem.

The starting point could be established using SCRUM; Moprosoft; ISO 15504 and CMMI.

<table>
<thead>
<tr>
<th>Problems</th>
<th>Forces</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tasks performed incorrectly</td>
<td>To determine the corrective actions.</td>
<td>CMMI: Project Monitoring and Control</td>
</tr>
<tr>
<td>Tasks performed incorrectly</td>
<td>Are the problems analyzed?</td>
<td>Moprosoft: Specific project management</td>
</tr>
<tr>
<td>Lack of knowledge of processes performed within the organization</td>
<td>Are the mechanisms to provide required knowledge and abilities analyzed and selected?</td>
<td>ISO15504: Project evaluation and control</td>
</tr>
<tr>
<td>Lack of knowledge regarding the best practices contained in the organizational processes</td>
<td>Are the activities of process and product quality assurance recorded in enough detail to know the status of quality results?</td>
<td>SCRUM: Dairy scrum</td>
</tr>
<tr>
<td>Low quality personnel</td>
<td>Are the abilities and knowledge available identified?</td>
<td>CMMI: Configuration management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moprosoft: Resource management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO15504: Configuration management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SCRUM: Sprint review</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CMMI: Product and processes quality assurance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moprosoft: Specific project management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO15504: Quality software assurance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SCRUM: Sprint retrospective</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CMMI: Project planning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moprosoft: Process management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO15504: Project planning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SCRUM:Sprint planning meeting</td>
</tr>
</tbody>
</table>
Example of complete pattern

<table>
<thead>
<tr>
<th>Problems</th>
<th>Forces</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not identified risks</td>
<td>Are the commitment not satisfied or at significant risk of not been satisfied identified?</td>
<td>CMMI: Project monitoring and control</td>
</tr>
<tr>
<td></td>
<td>Is the documentation of the risk state periodically reviewed?</td>
<td>Moprosoft: Specific project management</td>
</tr>
<tr>
<td></td>
<td>If additional information is available. Is the risks documentation updated?</td>
<td>ISO15504: Project evaluation and control</td>
</tr>
<tr>
<td></td>
<td>Is the state of risks communicated to relevant stakeholders?</td>
<td>SCRUM: Dairy scrum</td>
</tr>
<tr>
<td>Unforeseen errors</td>
<td>Are the problems obtained through processes reviews and performance?</td>
<td>CMMI: Project monitoring and control</td>
</tr>
<tr>
<td></td>
<td>To determine corrective actions. Are the problems analyzed?</td>
<td>Moprosoft: Specific project management</td>
</tr>
<tr>
<td></td>
<td>To address identified problems. Are the corrective actions documented?</td>
<td>ISO15504: Project evaluation and control</td>
</tr>
<tr>
<td></td>
<td>Are the corrective actions reviewed and agreed with relevant stakeholders?</td>
<td>SCRUM: Dairy scrum</td>
</tr>
<tr>
<td></td>
<td>Are the changes in external and external commitments treated?</td>
<td></td>
</tr>
<tr>
<td>Bad risk management</td>
<td>Are project risks identified?</td>
<td>CMMI: Project planning</td>
</tr>
<tr>
<td></td>
<td>Are project risk documented?</td>
<td>Moprosoft: Process management</td>
</tr>
<tr>
<td></td>
<td>Is the completeness and correctness of documented risks reviewed and agreed with relevant stakeholders?</td>
<td>ISO15504: Project planning</td>
</tr>
<tr>
<td></td>
<td>Are risks reviewed appropriately?</td>
<td>SCRUM: Planning sprint meeting</td>
</tr>
<tr>
<td></td>
<td>Is the state of risks communicated to relevant stakeholders?</td>
<td>CMMI: Project monitoring and control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moprosoft: Specific project management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ISO15504: Project evaluation and control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SCRUM: Dairy scrum</td>
</tr>
</tbody>
</table>
Select method guides and supports SMEs in the identification of an adequate process pattern according to their actual problems.

**Identify**
- Collect information about SME context (Information such as number of employees and experience in the use of models, standards or methodologies, is collected)
- Collect information about SME actual problems (A questionnaire based on formal software engineering practices related to four processes (project planning, project monitoring and control, configuration management and product and process quality assurance))

**Select**
- Analyze the questionnaire answers and uses the process patterns, so that the actual SME problems are detected and prioritized
- Get assigned a value in the range of 20% to 100% where: 20% means never occurs; 40% means rarely occurs, 60% means sometimes occurs; 80% means usually occurs; and 100% means always occurs
- Identify the prioritized problem: <30%: high, the problem lies in the SME representing a big problem; 30% < 70%: medium, the problem lies moderately in the SME and; ≥ 70%< 100%: low, the problem lies in the SME but it does not seriously affects it

**Guide**
- Show the starting point set to guide SMEs to address their improvement efforts toward the implementation of a software process improvements
- Provide a guide with: (1) the information of the process patterns regarding the problem; (2) the problems priority according to the analysis performed in the selection phase; and (3) the information of the process patterns regarding the list of models, standards and agile methodology as well as the processes and the set of practices that are recommended to implement to reduce or eliminate the detected problems
Identify the main features of the SME toward the implementation of a software process improvement.

- Automatize the phase “identify” → SME actual problems.
- Automatize the phase “select” → analyzing the questionnaires answers, so that, an adequate process pattern, which best ties with the actual SME environment and situation, is selected.

Automatize the phase “guide” of the selected method. The module shows the information regarding the improvement “starting point”.

Paberns

So7ware

Tool
Providing a list of the detected problems and their priority (it uses red, yellow or green colors depending on the impact of the problem in the SME)

Including the models (CMMI or Moprosoft), standard (ISO 15504) or agile methodology (SCRUM) and the processes to be focused on

Providing the processes to be focused on and the set of related best practices that will help the SME to reduce or eliminate the identified problems
Framework Validation

- To evaluate the framework a set of professionals who have been working in software development SMEs were invited

<table>
<thead>
<tr>
<th>Engineer</th>
<th>No. of SME Employees</th>
<th>SPI Experience</th>
<th>Experience using models, standards or methodologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>Never</td>
<td>Often</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>Seldom</td>
<td>Seldom</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>Seldom</td>
<td>Seldom</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>Often</td>
<td>Often</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>Seldom</td>
<td>Seldom</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>Seldom</td>
<td>Seldom</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>Often</td>
<td>Often</td>
</tr>
</tbody>
</table>
Framework Validation

- A survey was developed to collect information to know if the information provided by using the software was useful for them

1. Do you consider that your organization problems have been captured?
2. Do you consider that the provided solution is appropriate according to the actual problems and environment?
3. Do you consider that the provided guidance establish and adequate “starting point” to start a process improvement?
4. Do you consider that the guide provide information that can be tailored to the real needs of your organization?
5. Do you consider that the information provided by the guidance is clear and understandable?
6. Do you consider that the guide can help you to address you improvement effort?

Four answers:
- Total agree
- Partial agree
- Partial disagree
- Total Disagree
Framework Validation

- A survey was developed to collect information to know if the information provided by using the software was useful for them.

The answers are in the range of total agree and partial agree.
Framework Validation

Then we analyse the comments of the engineers, to highlight the best and the worst comment:

-The best comment was that according to his experience the framework makes easy to identify important information which helped him to address the improvement effort;

-The worst comment was related to the questions, because from his point of view the question must be lightened for a better understanding.
Conclusions

Not all organizations obtain the same results when implementing improvements in their processes.

Two main problems are associated:
1. Models and standards to be used as reference and
2. The lack of knowledge of where to start the process improvement

As solution this paper provides a framework:

- It is Focused on the human perspective
- It aims to guide SMEs in the identification of their actual situation, environment and problems
- It sets a starting point, so that, an adequate guide can be provided

In this way:

- It is possible to provide the knowledge to start an implementation of software process improvements based on the identification of SME real problems
- It is possible to use those practices that will help them to reduce those identified problems,
- It is possible to have early results and maximizing the limited resources because the improvement effort can be adequately addressed
Conclusions

- Manage the organizational change in the improvement effort
- Do not lose focus
- Know the culture and focus on identified problems
- Motive all people involved
- Focus the improvement on experience
- Create learning organization
Conclusions

Case study:

✓ Most of the engineers agree with the provided guidance and think the results help them to know where to start regarding their actual situation, environment and problems

✓ It is possible to get information of the model, process and practices that should be implemented to reduce the problems

Future work:

☐ The framework will be updated according to the comments

☐ More engineers will be invited to use the tool, so that, the results can help to improve the framework and integrate it in a SPI platform which aims to provide a complete tool for implementing software process improvements
Thanks for your attention
Providing a starting point to help SMEs in the implementation of software process improvements

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