

# Expected requirements in support tools for software process improvement in SMEs

Muñoz Mirna, Mejía Jezreel  
Centro de Investigación en Matemáticas  
Av. Universidad no 222, 98068 Zacatecas, México  
{mirna.munoz, jmejia}@cimat.mx  
De Amescua Antonio  
Departamento de Informática, Universidad Carlos III de  
Madrid Avda. de la Universidad no. 30, 28911  
Leganés, Madrid, España  
amescua@inf.uc3m.es

Calvo-Manzano Jose A., Cuevas Gonzalo, San  
Feliu Tomás  
Departamento Lenguajes y Sistemas Informáticos e  
Ingeniería de Software  
Universidad Politécnica de Madrid, Facultad de  
Informática  
28660 Boadilla del Monte, Madrid, España  
{joscantonio.calvomanzano,gonzalo.cuevas,tomas.sanfeliu}@upm.es

**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 helps SMEs in the implementation of software process improvements, one of the main barrier that stopping SME's 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



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

Success Factors	Authors							
	[30]	[25]	[19]	[13]	[2]	[5]	[22]	[17]
<b>ORGANIZATION</b>								
Analyze organization stability	✓		✓	✓	✓			✓
Awareness on SPI need			✓	✓	✓			✓
Build a SPI culture	✓		✓	✓				
Set rewards programs	✓		✓	✓				
Resources availability	✓	✓	✓	✓	✓	✓	✓	✓
Efficient mechanism of communication	✓	✓	✓	✓	✓	✓	✓	✓
<b>STAFF</b>								
Commitment of stakeholders and senior managers	✓	✓	✓	✓	✓	✓	✓	✓
Stakeholders involvement	✓	✓	✓	✓	✓	✓	✓	✓
Training on processes	✓	✓	✓	✓	✓	✓	✓	✓

Training on SPI	✓	✓	✓	✓	✓	✓	✓	✓
<b>SP</b>								
Adequate assessment frequency	✓	✓	✓	✓	✓	✓	✓	✓
<b>SPI</b>								
Guides the SPI program	✓	✓	✓	✓	✓	✓	✓	✓
Based on real needs	✓	✓	✓	✓	✓	✓	✓	✓
Use an incremental approach	✓	✓	✓	✓	✓	✓	✓	✓
Support and/ or infrastructure	✓	✓	✓	✓	✓	✓	✓	✓
Use of previous SPI work		✓	✓	✓	✓	✓	✓	✓
Choose an adequate reference model/standard	✓	✓	✓	✓	✓	✓	✓	✓

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

Features	Kuaiti Tool [31]	Assessment tool [32]	A Six Sigma Framework [33]	MoProSoft Integral Tool [34]	KMT [35]	PCM System [36]	SPIINI [37]	Tureikan [38]	SysProVal [14]	METVAICOMPETISOFT [16]	tspa tool [7]
Process assessment	✓	✓			✓	✓	✓	✓	✓	✓	✓
Snapshot of processes	✓	✓			✓	✓	✓	✓	✓	✓	✓
Guide the process selection		✓	✓			✓	✓		✓	✓	✓
Generate SPI plans	✓						✓	✓	✓	✓	✓
Tailor models and standards according to the organization needs										✓	✓
Provide process modeling support			✓		✓		✓	✓	✓	✓	✓
Describe the SPI activities	✓			✓				✓		✓	✓
Support the identification of risk related to SPI			✓							✓	✓
Provide configuration management support	✓			✓				✓	✓		✓
Collect and manage information that are generated by performing SPI	✓	✓	✓	✓	✓			✓	✓		✓
Do not require special knowledge of the organization	✓	✓	✓	✓						✓	✓
Developed for a web environment			✓	✓				✓	✓		
Represent a low cost*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Clear roles definition	✓			✓			✓				✓

\* Even when the feature represent 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 especial 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.

#### ACKNOWLEDGES

This work is sponsored by el Consejo Nacional de Ciencia y Tecnología (CONACYT), el Centro de Investigación en Matemáticas (CIMAT)-unidad Zacatecas y la Universidad Politécnica de Madrid a través de la Ctedra de Mejora del Proceso Software en el Espacio Iberoamericano

#### REFEREENCES

- [1] Pino J.F., García F., and Piattini M. "Software process improvement in small and medium software enterprises: a systematic review". *SQJournal*, vol. 16, pp. 237-261. 2008.
- [2] García I., Pacheco C., and Cruz D. "Adopting an RIA-based tool for supporting assessment, implementation and learning in software in software process improvement under the NMX-1-059 02-NYCE-2005 standard in small software enterprises". *Eighth ACIS International Conference on Software Engineering Research, Management and Application*. 2010.
- [3] Wymenga P., Spanikova V., Derbyshire J. and Baker A. *Are EU SMEs recovering* . Annual Report on EU SMEs 2010/2011. Rotterdam, Cambridge. 2011. disponible en: [http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/index\\_en.htm](http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/index_en.htm). 2011.
- [4] Ihabib M., Ahmed S., Rehmat A., Khan M.J. and Shamail S. "Blending Six Sigma and CMMI - an approach to accelerate process improvement in SMEs". in *Multitopic Conference*. 2008. INMIC 2008. IEEE International. pp. 386-391. 2008.
- [5] Mishra D. and Mishra A. *Software Process Improvement in SMEs: A Comparative View* . Computer Science and Information Systems, Vol. 6, No. 1, 111-140. 2009.
- [6] Cuevas G., De Amescua A., San Felu T., Arcilla M., Cerrada J.A., Calvo-Manzano J.A. and García M. *Gestión del Proceso Software*. Universitaria Ramón Areces. pp. 472. 2002.
- [7] Mathiassen L., Ngwenyama O.K. and Aaen I. *Managing change in software process improvement* *Software IEEE*, vol. 22, pp. 84. 2005.
- [8] Kautz K., Levine L., Helley B., Johansen J., Kristensen C. and Nielsen P. *The Role of Networks in the Diffusion and Adoption of Software Process Improvement (SPI) Approaches* pp. 8. 2004. 2004.
- [9] Oktaha H., García F., Piattini M., Ruiz F., Pino F.J. and Alqueira C. "Software Process Improvement: The Competisoft Project". *Computer*, vol. 40, pp. 21-28. 2007.
- [10] Potter N. and Sakry M. *Making Process Improvement Work- Developing a Plan*. Addison-Wesley. 2006.
- [11] Morgan P. "Process Improvement- Is it a lottery?" *Software Development Magazine: UJML, Agile, Programming, Software Testing, Quality Assurance and Project Management*, vol. 2008.
- [12] McCaffery F., Pikkarainen M. and Richardson I. "Ahaa --agile, hybrid assessment method for automotive, safety critical SMEs" in *Software Engineering*, 2008. ICSE '08. ACM/IEEE 30th International Conference on. pp. 551-560. 2008.
- [13] Dyba T. "An empirical investigation on the key factors for success in software process improvement". *IEEE Transactions on Software Engineering*, vol. 31, 2005.
- [14] García I. and Pacheco C. "Toward Automated Support for Software Process Improvement Initiatives in Small and Medium Size Enterprises", R. Lee & N. Ishii (Eds.): *Soft. Eng. Research, Manage. & Appli.* 2009. SCI 253. pp. 51-58. 2009.
- [15] Instituto PyME. *Las PYMES en México- clasificación oficial de las PYMEs de acuerdo a su tamaño*. Disponible en: [http://www.institutopyme.org/index.php?option=com\\_content&view=article&id=134&Itemid=177](http://www.institutopyme.org/index.php?option=com_content&view=article&id=134&Itemid=177)
- [16] Pino F.J., Pardo C., García F. and Piattini M. "Assessment methodology for software process improvement in small organizations". *Inf.Softw.Technol.*, vol. 52, pp. 1044-1061, October, 2010.
- [17] Raja Zurina Raja Mohamed Ali and Suhaimi Ibraim. *An iSPA Model evaluation based on Critical Success Factors and Selected criteria to Support Malaysia's SME Environment*, pp 225-230, 2010.
- [18] G. Villas Boas, Cavalcanti da Rocha, Ana Regina and M. Pecegueiro do Amaral. "An approach to implement software process improvement in small and mid-sized organizations". 2010.
- [19] Cater-Steel A.P. "Low-rigour, Rapid Software Process Assessments for Small Software Development Firms". in *Proceedings of the 2004 Australian Software Engineering Conference*, pp. 368, 2004.
- [20] Allen P., Ramachandran V. and Abushama H. "PRISMS: an Approach to Software Process Improvement for Small to Medium Enterprises". 2003.
- [21] Tosun A., Bener A. and Turhan B. *Implementing of a Software Quality Improvement Project in an SME: A Before and After Comparison*. *Software Engineering and Advanced Applications*. Euromicro Conference. pp. 203. 2009.
- [22] Sivashankar M., Kalpana A.M. and Jeyakumar A.E. "A framework approach using CMMI for SPI to Indian SME's". in *Innovative Computing Technologies (ICICT)*, 2010 International Conference on. pp. 1-5. 2010.
- [23] García I. and Pacheco C. "A Web-based Tool for Automatizing the Software Process Improvement Initiatives in Small Software Enterprises". *Latin America Transactions. IEEE (Revista IEEE America Latina)*, vol. 8, pp. 685-694. 2010.
- [24] Tore D. "Factors of software process improvement success in small and large organizations: an empirical study in the Scandinavian context". *SIGSOFT Softw.Eng.Notes*, vol. 28, pp. 148-157. September, 2003.
- [25] Guerrero F. and Eterovic Y. "Adopting the SW-CMM in a small IT organization". *Software IEEE*, vol. 21, pp. 29-35. 2004.

- [26] Laporte C.Y., Desharnais J., Abouelfattah M. and Bamba Juan-Claude. "Initiating Software Process Improvement in Small Enterprises: Experiment with Micro-Evaluation Framework". 2005.
- [27] Habra N., Alexandre S., Desharnais J., Laporte C.Y. and Renault A. "Initiating software process improvement in very small enterprises". *Inf.Softw.Technol.* vol. 50. pp. 763-771. June. 2008.
- [28] von Wangenheim C.G., Rossa J.C., C. Salviano and von Wangenheim A. "Systematic Literature Review of Software Process Capability/ Maturity Models". *Proceedings of International Conference on Software Process. Improvement and Capability dEtermination (SPICE)*. 2010.
- [29] Pusatli O.T. and Misra S. "A discussion on assuring software quality small and medium software enterprises: an empirical investigation". *Technical Gazette.* vol. 18. pp. 447-452. 2011.
- [30] R.M. De Araujo and M.R. Da Silva Borges. "The Role of Awareness Support in Collaborative Improvement of Software Processes". in *Proceedings of the String Processing and Information Retrieval Symposium & International Workshop on Groupware*. pp. 343. 1999.
- [31] Strevel C. "Kuali: Herramienta Auxiliar para la implementación de MoProSoft." *DevDays. Intellekt*. 2005.
- [32] Yoonjung Choi, EunSeok Lee and Sujung Ha. "The management of software processes with software process improvement tool based on ISO 15504". in *Advanced Communication Technology*. 2005. *ICACT 2005. The 7th International Conference on*. pp. 933-936. 2005.
- [33] Pan Z., Park H., Baik J. and Choi H. A six sigma Framework for software process improvement and its implementation. *14th Asia-Pacific Software Engineering Conference. IEEE 2007. DOI 10.1109/ASPEC.2007.43 pp 443-453.* 2007.
- [34] Cardenas E., Oktaba H. Guardati S. and Laureano A.L. **Agents, Case-Based Reasoning and their relation to the Mexican Software Process Model (MoProSoft)** , 31st Annual International Computer Software and Applications Conference (COMPSAC 2007). 2007.
- [35] Alagarsamy K., Justus S. and Iyakutti K. **Implementation specification for software process improvement supportive knowledge management tool** . *IET Software.* vol2. No. 2. pp 123-133. DOI 10.1049/iet-sen:20070086. 2008.
- [36] Hee-Gyun Yeom and Sun-Myung Hwang. **A Design of Tool for Software Processes Assessment and Improvement** , 2008 *Advanced Software Engineering & Its Applications.* DOI 10.1109/ASEA.2008.29.2008.
- [37] T. Makinen and T. Varkoi. "Assessment driven process modeling for software process improvement". in *Management of Engineering & Technology*. 2008. *PICMET 2008. Portland International Conference on*. pp. 1570-1575. 2008.
- [38] Villaroel R., Gómez Y., Gajardo R. and Rodríguez O. **Implementation of an Improvement Cycle using the CCompetisofit Methodological Framework and the Tutelkan Platform** , 2009 *International Conference of the Chilean Computer Science Society.* DOI 10.1109/SCCC.2009.20. 2009.