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Software Process Improvement

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Rory V. O'Connor Nathan Baddoo
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Kari Smolander Richard Messnarz (Eds.)

Software Process Improvement

16th European Conference, EuroSPI 2009
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Preface

This textbook is intended for SPI (software process improvement) managers and researchers, quality managers, and experienced project and research managers. The papers constitute the research proceedings of the 16th EuroSPI (European Software Process Improvement, www.eurospi.net) conference held in Alcala (Madrid region), September 2–4, 2009, Spain.

Conferences have been held since 1994 in Dublin, 1995 in Vienna (Austria), 1997 in Budapest (Hungary), 1998 in Gothenburg (Sweden), 1999 in Pori (Finland), 2000 in Copenhagen (Denmark), 2001 in Limerick (Ireland), 2002 in Nuremberg (Germany), 2003 in Graz (Austria), 2004 in Trondheim (Norway), 2005 in Budapest (Hungary), 2006 in Joensuu (Finland), 2007 in Potsdam (Germany), 2008 in Dublin (Ireland), and 2009 in Alcala (Spain).

EuroSPI established an experience library (library.eurospi.net) which will be continuously extended over the next few years and will be made available to all attendees. EuroSPI also created an umbrella initiative for establishing a European Qualification Network in which different SPINs and national initiatives join mutually beneficial collaborations (ECQA – European Certification and Qualification Association, www.ecqa.org).

With a general assembly during October 15–16, 2007 through Euro-SPI partners and networks, in collaboration with the European Union (supported by the EU Leonardo da Vinci Programme) a European certification association has been created (www.eu-certificates.org, www.ecqa.org) for the IT and services sector to offer SPI knowledge and certificates to industry, establishing close knowledge transfer links between research and industry.

An EU Certificates day of the ECQA (European Certification and Qualification Agency) took place as an associated event of EuroSPI 2009 on September 2, 2009.

The biggest value of EuroSPI lies in its function as a European knowledge and experience exchange mechanism for SPI know-how between research institutions and industry.

Since its beginning in 1994 in Dublin, the EuroSPI initiative has outlined that there is not a single silver bullet to solve SPI issues, but that an understanding of a combination of different SPI methods and approaches is needed to achieve concrete benefits. Therefore each proceedings volume covers a variety of different topics, and at the conference we discuss the potential synergy and the combined use of such methods and approaches. These proceedings contain selected research papers on six topics each comprising three papers:

Section I: SPI and the Testing Process
Section II: SPI Measurement and Assessment
Section III: Agile and Open Source Issues
Section IV: SPI and Management Issues
Section V: Process Life Cycle and Quality Issues
Section VI: Standards and Reference Models

Section I presents three studies on *SPI and the Testing Process*. Fernandex-Sanz et al. remind us that software testing is the commonest practice for software quality assurance and by implication should be fundamental to software process improvement. They argue that despite this importance and the effort expended on software testing, there is still a lack of knowledge of the real practices of testing. In this paper, they present the results of a survey conducted in two organizations in Spain, to highlight the key practices of software testing and to highlight relationships between these practices and software development successes. Almog and Heart extend this theme by concentrating on software test cases. They suggest that the process of software testing can be greatly improved if the concept of test cases is formally defined. Such formal definition will also enhance software testing assessment and make it easier for the automation of the generation and management of test cases. The theme of automation is extended by Connolly et al., who explore ways of supporting expert customers in the design and execution of tests cases in acceptance test-driven development. They identify a key challenge as the support needed by the expert in the reuse of existing documentation. They outline plans for the development of an automated testing model that improves adherence to practice through the provision of fully traceable artifacts.

Section II, *SPI Measurement and Assessment*, presents the results of three studies in this area. Bhatti et al. propose an extension to the Goal Question Metric model. They do this in response to their argument that measurements can be more successful if finely tuned to the needs of the organization collecting those measures. Their extension to the GQM is vital because this model has been derived from adopting a heuristic approach. Marín et al. address the notion of measurements in specific relation to functional size measurement and model-driven development (MDD) environments. They show how a functional size measurement procedure which has been developed for measurement of conceptual models of a specific model-driven development environment can help in the detection of defects in conceptual models. In a slight departure from measurements, Barafort and Rousseau present a sustainable service innovation framework that is used as a generic framework for supporting innovation and promoting multidisciplinary activities.

Section III emphasizes the need for incorporating innovative approaches and methods in approaches which may have become traditional or even conventional. Under *Agile and Open Source Issue* three papers bear testimony to this dictum. Hossain et al. explore how agile practices can be used to minimize the risk of coordinating global software development. Diaz et al. investigate the viability of introducing agile software development methods like SCRUM in compliance with the CMMi process model. In this paper, they set out to improve the understanding between these two development approaches by presenting empirical accounts that confirm the theoretical comparison between agile software development and plan-driven process models like CMMi. Soto and Ciolkowski touch on another innovative approach in terms of open source software (OSS) development. They present work-in-progress that details the development of process evaluation frameworks aimed specifically at OSS projects and discuss some lessons learned when the framework was applied to certain OSS projects.

In Section IV three studies on *SPI and Management Issues* are presented. Through an illustrative case study, Peisl et al. propose an approach to the management of innovation integrating business, process and maturity dimensions. Šamalíková et al. report

on the application of process mining techniques to (a) discover shortcomings in the change control board process in an organization during the different lifecycle phases and (b) determine improvement activities. Välimäki et al. present current best practices for global software development (GSD) in the form of process patterns for project management—evaluated by using a scenario-based assessment method—to help companies improve their own GSD processes by incorporating the patterns presented here in their processes.

Section V addresses *Process Lifecycle and Quality Issues*. In the first paper, Kääriäinen and Välimäki present a study about the history of application lifecycle management improvement in a company. O'Connor's exploration of usability techniques in the software development process of Irish SMEs that develop Web applications found that there are no process models available that meet the specific needs of Web development, and that Web developers are confused about how to implement usability. O'Connor's study also found that definitions of usability are inconsistent and that there is still a need for a definition of usability specifically for Web applications. He concludes that there is very little awareness of usability standards. In the last paper in this section, Chiam et al. propose a framework for capturing quality attribute techniques, such as safety and security, of software development. They suggest that such a framework supports process tailoring by facilitating the selection of techniques for inclusion into process models that target specific product qualities.

Finally, Section VI presents three studies on *Standards and Reference Models*. Bru et al. present a case study of the activity of a team of six young software engineers that depicts some aspects of the building and the filling of the course-of-action observatory. They argue that observing and analyzing software engineers' activity helps to reveal their theory-in-use, i.e., what governs their behavior. Bru et al. suggest that such a study may help establish links between a project process in use and a simplified process reference model, thereby helping to reduce the fit between a project-in-action and espoused SE standards. Valdevit et al. present a guide to implementing an information security management system (ISMS) in small settings. In this study they narrate the experience of Public Research Centre Henri Tudor, Luxembourg, which was charged with finding solutions to facilitate ISMS deployment in SMEs. Finally, continuing the theme of small organizations, Pino et al. introduce an improvement framework for very small organizations (VSEs). They describe their experience of validating this framework in eight companies and provide results to support the usefulness of tailored improvement frameworks for VSEs.

Recommended Further Reading

In [1] we integrated the proceedings of three EuroSPI² conferences into one book which was edited by 30 experts in Europe. In [2] you will find the EuroSPI² research proceedings published by Springer and based on EuroSPI 2005. In [3] you will find the EuroSPI research proceedings published by Springer and based on EuroSPI² 2006. In [4] you will find the research proceedings for EuroSPI² 2007 published by Springer. In [5] you will find last year's research proceedings published by Springer.

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Organization

Board Members

EuroSPI Board Members represent centers or networks of SPI excellence having large experience with SPI. The board members collaborate with different European SPINS (Software Process Improvement Networks).

The following six organizations have been members of the conference board in the last 9 years:

- ASQ, http://www.asq.org
- ASQF, http://www.asqf.de
- DELTA, http://www.delta.dk
- ISCN, http://www.iscn.com
- SINTEF, http://www.sintef.no
- STTF, http://www.sttf.fi

EuroSPI Scientific Program Committee

EuroSPI established an international committee of selected well-known experts in SPI who are willing to be mentioned in the program and to review a set of papers each year. The list below represents the Research Program Committee members. EuroSPI² also has a separate Industrial Program Committee responsible for the industry/experience contributions.

- Abran, Alain, Ets University of Quebec, Canada
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- Selioukova, Yana, Helsinki University of Technology, Finland
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- Varkoi, Timo, Tampere University of Technology, Finland
- Ventura Martins, Paula, Fct-University of Algarve, Portugal
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All six chairs, the general and the research chairs, have quite a complementary and interesting profile. Dr. Messnarz works in close collaboration with Austrian research institutions (universities of applied sciences) and large German automotive companies. Dr. Nathan Baddoo is a professor at the University of Hertfordshire, UK, and he has published scientific articles about the human factors in SPI and has performed studies at major European organizations, applying motivation techniques in SPI. Professor Juan Cuadrado Gallego is a profesor at the University of Alcala in

Spain and is a member of experience networks concerning process and product measurement. This includes experiences with and mathematical models to implement international measurement standards. Dr. Ricardo Rejas Muslera is a researcher at the University of Alcala in Spain and specialized in the field of improvement models. He recently published potential extensions for risk management in the existing assessment models. Dr. Rory O'Connor is is a senior lecturer in Dublin City University and a senior research with Lero, the Irish Software Engineering Cente. His main research interests center on software process and SPI in relation to small and very small organizations. And finally, Dr. Kari Smolander has studied software development organizations extensively and he is a professor of software engineering at Lappeenranta University of Technology.

The experience portfolio of the chairs covers different market segments, different sizes of organizations, and different SPI approaches. This strengthens the fundamental principle of EuroSPI² to cover a variety of different markets, experiences, and approaches.

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Factors with Negative Influence on Software Testing Practice in Spain: A Survey

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Abstract. Software testing is the commonest technique for software quality assurance. It is present in every development project and concentrates a large percentage of effort, there are still not many studies which address the real practice of individuals and organizations. Anyway, practitioners usually agree with the idea that software testing efficiency and effectiveness in their organizations might be improved. Two previous studies in Spain have revealed implemented testing practices in organizations and individual performance of software professionals when designing test cases should be improved. This paper presents the results of a survey designed to know if 23 factors determined by a panel of experts in 2007 may explain this situation of testing practice. Data collected reveal that none of the factors is clearly rejected as a negative influence for testing although some of them are not generally accepted. Exploratory statistical analysis reveals relations between certain pairs of items as well as a new grouping in factors.

Keywords: Software testing, survey, influence factors.

1 Introduction

Software testing is the commonest techniques for verification and validation in development projects. Every project includes a specific phase for testing and debugging. According to different statistical studies of effort distribution throughout the life cycle [1][2][3], this phase usually requires around a large percentage, around one-third (ranging from 30 to 35%), of the total effort of the project.

Different studies have tried to analyze real practice but in many cases empirical works are focused on analyzing or demonstrating the benefits of specific methods or approaches to testing. As stated in [4], there is a need of real practice empirically-based data not vested by such purpose but aimed at providing more light on this area. This type of studies is rare although, as can be seen in the following sections, there are interesting contributions. In order to gain knowledge in this area, a series of studies centered

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An Integrated Framework to Guide Software Process Improvement in Small Organizations

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Abstract. When a small organization (VSE) tackles a software process improvement (SPI) initiative, the model that is used least is the one that would guide the process improvement. We believe that this is a great failing, because it is precisely a model of this type that is the guide which is needed to articulate all the activities related to that improvement. In this vein, to support VSEs, as well as to guide them in detail when they wish to carry out SPI initiatives, we have developed an integrated improvement framework. We have done this by taking into account widely recognized frameworks and the special characteristics of VSEs. This paper introduces that improvement framework, its components and its relationship with the COMPETISOFT project. Furthermore, through case studies, it describes our experience of the application of the proposed framework in eight firms. The initial results show that it is useful, practical and suitable for addressing SPI initiatives in VSEs.

Keywords: Improvement framework, Software process improvement, Small companies, SPI, SMEs, COMPETISOFT.

1 Introduction

Although process reference models (e.g. ISO/IEC 12207, CMMI and ISO/IEC 15504-5), process assessment methods (such as ISO/IEC 15504-2 and SCAMPI) and improvement models (like ISO/IEC 15504-4 and IDEAL) used for Software Process Improvement -SPI- are available to all enterprises, studies such as [1-4] show that these proposals from SEI or ISO are difficult for the vast majority of the very small software enterprises -VSEs (i.e. firms with fewer than 25 employees, according to [5]), to apply. This difficulty comes about because of the complexity of the recommendations of the models and the consequent large investment in terms of time and resources. In addition, many organizations remain unaware of these proposals [6].

Regarding the model that guides process improvement (improvement model), we have found in [7] that this type of model is the one used least by small companies. This type of model was used by 23 (of 122) companies involved in some SPI initiative, that is in only 19% of the companies. This is a low percentage and we believe

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that this is something to be regretted and dealt with. An improvement model is precisely the guide which is needed to articulate all the activities related to the improvement, as well as all the other models involved, of course.

In this sense, and aiming to support the SPI initiatives within a VSE, we have developed the COMPETISOFT project [8]. In this project great importance was given to the model for guiding SPI activities, the goal being to carry out SPI initiatives following a systematic and coherent approach. COMPETISOFT maintains that if we are to help small companies set up and pursue process improvement, then a guideline which will address the improvement activities is needed. We should also point out that one success factor for SPI initiatives in VSEs is for the improvement effort to be guided by means of specific procedures and the combination of different approaches [7]. Given all this, one of the components of the Methodological Framework developed by COMPETISOFT is a specific *framework for guiding SPI activities* (*improvement framework*). The other two components are a Process Reference Model (based on MoProSoft [12]) and a Process Evaluation Model (this conforms with the ISO/IEC 15504 standard [9]). The aim of this paper is simply to show the different components of *the improvement framework* (proposed by COMPETISOFT's Methodological Framework) and its application in eight VSEs.

The paper is structured as follows. The next section presents related works. The Methodological Framework of COMPETISOFT is then described. Section 4 explains the *improvement framework* and its different components, and section 5 gives a description of its application in eight case studies. Lastly, an analysis is given and our conclusions are set out.

2 Related Work

There are several proposals that present a set of processes which small companies could use to reach significant benefit from process improvement. Among others, these include: MoProSoft [9], MPS.BR [10], Adept [11] and Rapid [12]. All of these proposals are related to assessment methods or process reference models and all of them define a group of processes that should be taken into account by small companies in their improvement efforts. Nevertheless, only in some of these proposals is a process related to the activities to guide process improvement described. We could mention, for instance, MoProSoft, which describes Process Management and MPS.BR, which describes Process Assessment and Improvement.

With regard to research on models that direct improvement implementation for small companies, several proposals have emerged in recent years. These include, amongst others: IMPACT [13], MESOPyME [14], PROCESSUS [15], and the application of the IDEAL model to small and medium enterprises [16, 17].

However, these proposals do not describe in detail a framework that integrates different components (such as strategies, methodologies, processes and tools) in guiding the execution of SPI initiatives on small companies. The main contribution to the subject of SPI in VSEs that this work intends to make is to guide the implementation of process improvement in detail, by means of an integrated *improvement framework* which VSEs would be able to take on.

The *improvement framework* describes five components which have been defined by taking into account: (i) widely recognized frameworks, such as ISO/IEC 15504-4 [18], IDEAL and SCRUM; and (ii) special characteristics of the VSEs, such as that: they are generally extremely reactive and flexible; they typically have a flat structure and a free-flowing management style that encourages entrepreneurship and innovation; they have limited economic movement and lightweight processes; and they do not usually have enough staff to be able to develop specialized functions that would enable them to perform complex tasks and to develop secondary products [6].

These components describe tailored and integrated improvement practices, strategies and tools aiming to offer the VSEs a framework which is useful and practical for addressing SPI initiatives. Furthermore, according to [7], the proposals that have been used to SPI on VSEs are diverse and include: adaptation and use of SPI models, establishment of software processes to guide the SPI efforts, prioritization of the SPI efforts and evaluation of a SPI programme. Only the *improvement framework* addresses (by means of its components) these improvement proposals in an integrated and explicit manner.

3 Methodological Framework of COMPETISOFT

COMPETISOFT seeks to provide a strategy for increasing the level of competitiveness of Latin-American small software organizations by means of the creation and dissemination of a common Methodological Framework for the improvement and certification of the software processes of the small enterprises. An overview of the components of this Methodological Framework is shown in Fig. 1.

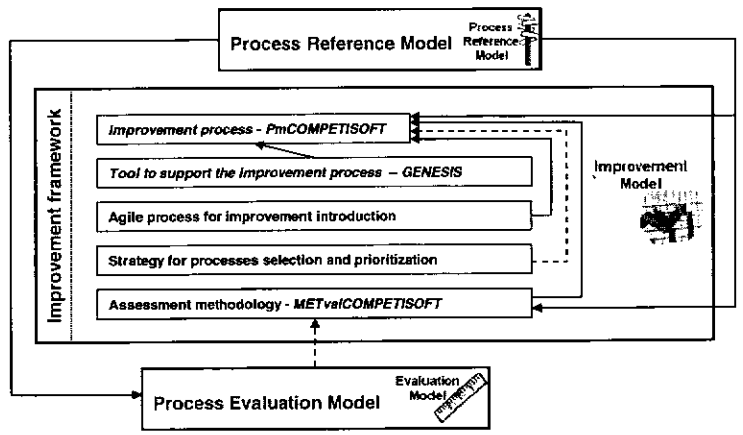

Fig. 1. Methodological Framework of COMPETISOFT

The process reference model is based on MoProSoft. In fact, we can view this process reference model as an evolution of MoProSoft, coming from the experience of researchers and practitioners in software process development and improvement. It is important to highlight that this evolution of MoProSoft has been used as a basis for

the subsequent publication of what has been called ISO/IEC 29110 Software Engineering - Lifecycle Profiles for VSE [5], by the WG 24 / SC7 of ISO.

To allow mutual recognition of formal evaluations of COMPETISOFT across Latin American countries, we suggest that each country should define its own Assessment Model, which must be in accordance with ISO/IEC 15504. In this sense, and bearing in mind the new ISO/IEC 15504-7 standard [19], AENOR (Spanish Association for Standardisation and Certification) from Spain and IRAM (Argentine Institute for Standardisation and Certification) from Argentina are currently establishing an organizational maturity model and a process assessment model to give the small software companies a new strategy for certification by maturity levels.

For the definition, refinement and application of these components of the Methodological Framework of COMPETISOFT the A-R (Action-Research) and case study research methods have been used. For the application of the A-R research method we divided the project participants into two groups: a first one, made up of *researchers* from different universities, and a second one, called the *critical reference group*, which included the information technology professionals from VSEs. Through the application of A-R we obtained continual feedback between the *researchers* and the VSEs involved, aiming to develop and refine the Methodological Framework.

4 Improvement Framework

The aim of the *improvement framework* is to provide improvement practices, strategies and tools to support improvement initiatives in small companies. This framework is influenced by the ISO/IEC 15504 (Part 2, Part 4 and Part 5), IDEAL and SCRUM models. From these proposals we have analyzed, integrated and tailored several improvement practices, in order to offer a specialized and suitable framework which meets the needs of the VSEs when leading SPI initiatives. This *improvement framework* defines five components: (i) a process called PmCOMPETISOFT, (ii) a methodology for software process assessment called METvalCOMPETISOFT, (iii) an agile process for improvement introduction, (iv) a strategy for process selection and prioritization and (v) tools to support the improvement process (see Fig. 1). All the process of this framework are described in terms of purpose, objectives, roles, activity diagram, activities, work products, and tools support, according to the process pattern established by COMPETISOFT. In the following section we give a summarised description of these elements, its brevity due to restrictions on space.

4.1 Improvement Process – PmCOMPETISOFT

This process has been defined to provide the VSEs with a guide with which to manage and lead the SPI initiatives step-by-step. The purpose of this process is to improve an organization's processes according to its business objectives, along with assisting it to carry out its SPI initiatives. This process is the backbone as well as the component integrator of the *improvement framework*. Fig. 2 shows the PmCOMPETISOFT activity diagram, which includes roles, activities and work products. A complete description of this process is presented in [20].

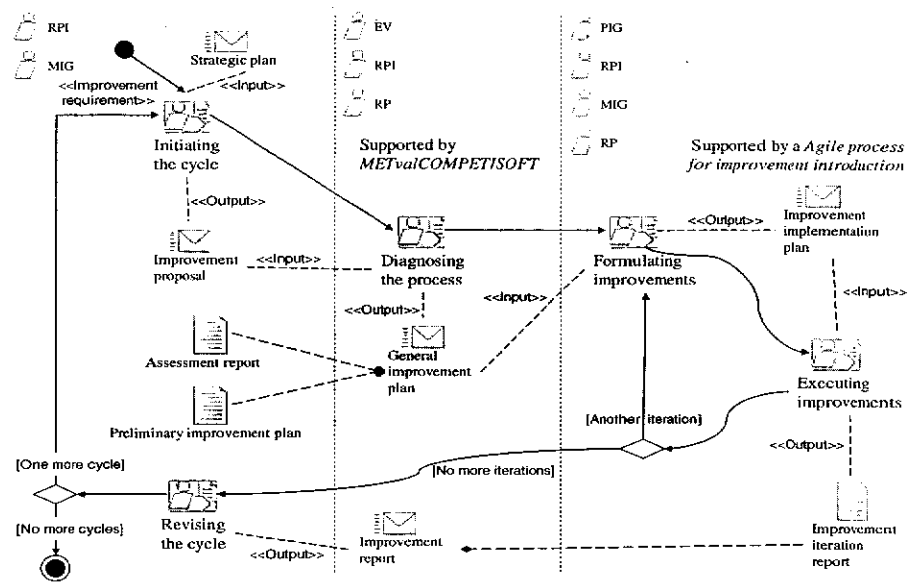

Fig. 2. PmCOMPETISOFT Activity Diagram

4.2 Assessment Methodological – METvalCOMPETISOFT

METvalCOMPETISOFT has been defined to give support to the activity of *diagnosing processes* from PmCOMPETISOFT, so as to help VSEs in the execution of an internal, non-formal process assessment. This methodology allows us to obtain reliable information about the strengths and weaknesses of software processes, along with information on opportunities for improvement. The purpose is for that information to serve as a basis for decision making about process improvement within the organization. This methodology defines:

- A process for software process assessment, called PvalCOMPETISOFT, which offers a step-by-step guide to the execution of the activity of processes diagnosis. This process breaks down into detail the activity of *diagnosing processes*. In Fig. 3, the activities, roles and work products are shown.
- A light assessment method to determine the capability of software processes and the maturity of a small organization [21]. The assessment method defines a measurement framework (conformance with ISO 15504 Part 2), which in the capability dimension has got only three levels of capability, making the model lighter, so that it can be easily applied to small organizations.
- A tool to support the execution of the assessment process and method [22].

4.3 Agile Process for Improvement Introduction

This process has been defined in such a way as to give a detailed guideline for supporting the management and performance of the activities of the cycle made up by the *formulating and executing improvement* activities of PmCOMPETISOFT. We developed

this process because in the early applications we observed that it is the iteration, composed of the *formulation and execution of improvements*, which requires the greatest amount of effort in the SPI initiative. What is more, this load falls mainly upon the organization. For the definition of this process we have used the SCRUM agile method because it provides support for project management and it focused on small teams [23]. The purpose of this process is to offer all those who are involved in the improvement cycle of small organizations an agile sub-process which allows them to take part in carrying out the improvement opportunities found and with which they have some relationship within the VSE. Fig. 4 shows a break-down of the activities for *formulating* and *executing improvements* which follow the SCRUM philosophy.

4.4 Strategy for Process Selection and Prioritization

A complete description of this strategy is presented in [24]. In this strategy we have defined a set of processes which we consider to be of high-priority when initiating the implementation of SPI initiative in VSEs. The fundamental principle of the proposal is that process improvement must be connected to the other responsibilities of software process management. The prioritization of these processes is established so as to deploy a basic process management infrastructure (as the process improvement is not an isolated activity, but is closely related to other activities of the software process management). The processes selected and their priorities are:

- First of all, the process improvement process group (PIM.1 Process establishment, PIM.2 Process assessment, and PIM.3 Process improvement)
- Secondly, the management process group (MAN.1 Organizational alignment, MAN.3 Project management and MAN.6 Measurement)
- Thirdly, the support process group (SUP.10 Change request management, SUP.8 Configuration management, SUP.7 Documentation, and SUP.1 Quality assurance).
- Finally, the engineering process group (ENG.1 Requirements elicitation, ENG.2 System requirements analysis, ENG.3 System architectural design, ENG.4 Software requirements analysis, ENG.5 Software design, ENG.6 Software construction, ENG.7 Software integration, ENG.8 Software testing, ENG.11 Software maintenance)

Base practices of the process groups of engineering and support are described in the process reference model of COMPETISOFT. The main practices of the process groups of improvement and management are likewise described in the three components of the *improvement framework* described above.

4.5 Tools to Support the Improvement Process

We have also developed a tool called GENESIS [25], which is used to support the person Responsible for process improvement (RPI) in the management and implementation of an SPI initiative and in the administration of generated knowledge.

We might add that this framework has been described with the standard SPEM 2.0 and edited with the EPF Composer, thereby generating documentation in a standard format which is updated and available to organizations through the Web.

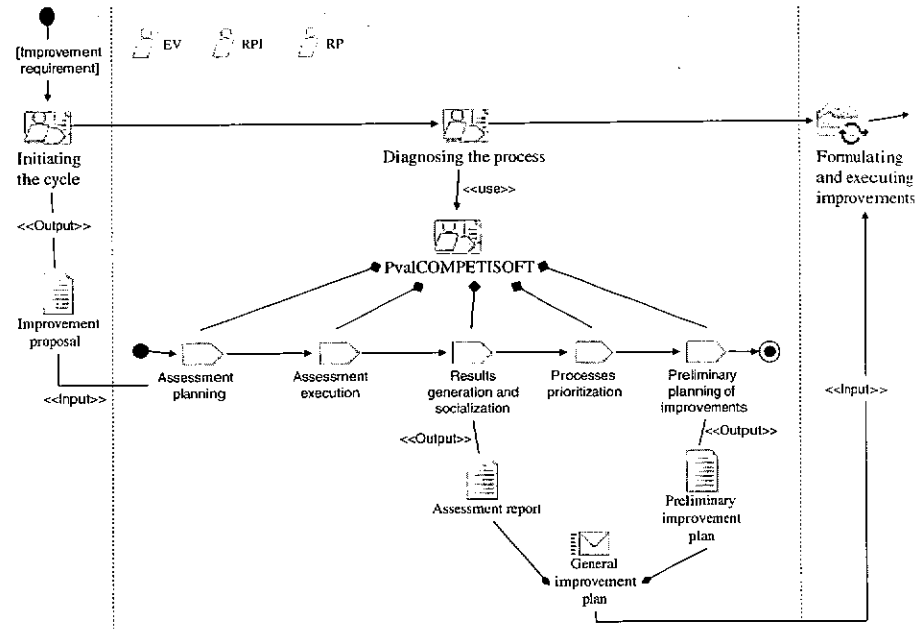

Fig. 3. PvalCOMPETISOFT Activity Diagram and its relationship with PmCOMPETISOFT

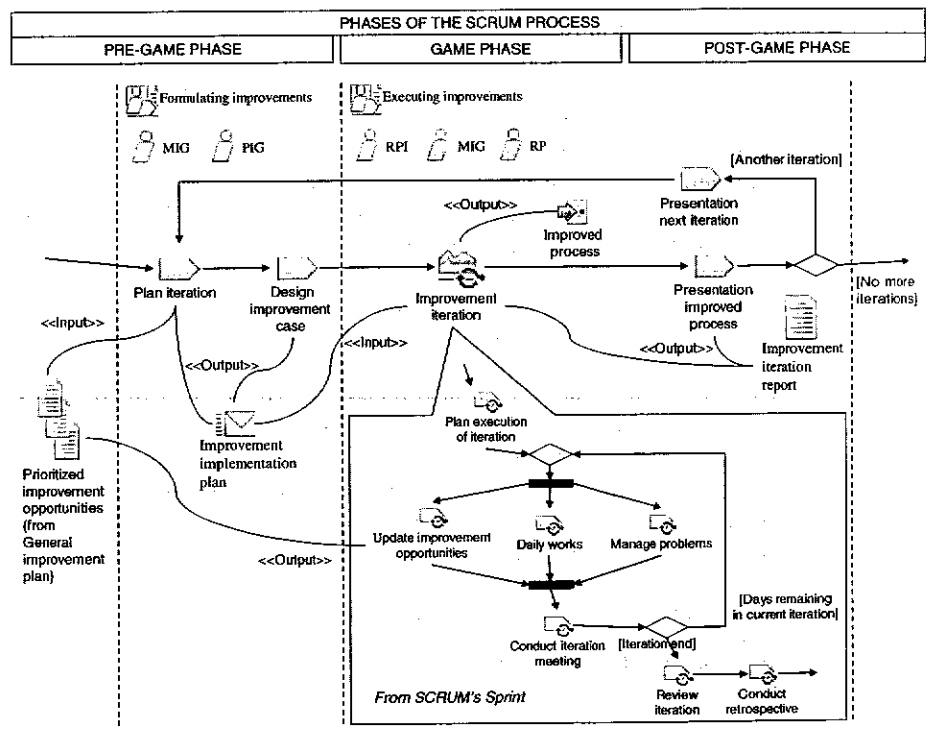

Fig. 4. Activity Diagram of the Agile process for improvement introduction

5 Case Studies

In COMPETISOFT the *researchers* carried out the intervention with the new proposals in the *critical reference group*, using the empirical variant for the execution of the action activity of A-R. That is, the *improvement framework* developed was applied by the *researchers* in the small companies (*critical reference group*) by means of the use of the case study research method. To apply the proposed framework, we have conducted eight case studies by following the protocol template for case studies presented in [26]. Lack of space means that we will then give just an overview of the case studies in terms of design, subjects, analysis unit, field procedures, data collection and limitations.

5.1 Design, Subjects and Analysis Unit

Taking into account the focus presented by [27], the *design type* of the case study in this work is multiple cases – holistic, since the strategy has been applied in the context of eight small companies. The *object of study* is a new integrated *improvement framework* through which to guide SPI in VSEs.

The *main research question* addressed by this study is: Is the *improvement framework* suitable (useful and practical) for leading Software Process Improvement efforts in small software enterprises? We identified an *additional research question* and various *sub-questions* (derived from each research question) for each component of the *improvement framework*. By means of these questions we seek to know whether these components have a useful function, if they are of practical use and whether they conform to the reality of small companies. For each component we asked about: (i) the effort of carrying out the activities associated with the *improvement framework*'s processes (related to the use practice and the reality of companies), and (ii) the capability level of the processes under analysis (the ones which need to be improved) of each company (related to useful function). In this vein, the *measures* used to investigate the research question are: (i) the effort and (ii) the process capability level. Furthermore, we also took into account the benefits described by the VSEs.

Several Latin American small software organizations have applied the Methodological Framework of COMPETISOFT for the implementation of an SPI initiative. The *participating companies* in the case studies are from Argentina, Chile, Spain and Colombia (see Table 1). The *analysis units* are the *improvement framework*'s components and the processes to be improved within each company. All of these organizations started their SPI initiative with the support of an adviser in improvement processes (who is part of the *researchers group*). In this SPI initiative we suggested to the companies that they should incorporate the processes related to Profile 1 (*Software development* - SD, *Software maintenance* – MS, and *Specific project administration* - SPA) from the Process Reference Model of COMPETISOFT.

5.2 Field Procedure, Data Collection and Limitations

The *improvement framework* was used to perform the improvement activities in each organization. That is, the procedure governing *field procedure* and the *data collection* of the case studies is closely related to the strategies, activities, roles and work products described in each of the processes defined by the *improvement framework* of

COMPETISOFT (see Fig. 2, 3 and 4 from Section 4). At the beginning and at the end of the SPI initiative in each company, an internal assessment was performed and the amount of effort used to carry out the improvement cycle (see Table 2) was also established. The information related to the process capability was obtained after analyzing and synthesizing the data of the processes chosen (those to be improved by the companies) with respect to the three process attributes and the process capability level ratings defined by the light assessment method of METvalCOMPETISOFT. The COMPETISOFT adviser played the role of evaluator (EV) and he evaluated the processes by applying interview and survey techniques.

Table 1. VSEs from the critical reference group involved in the case studies

Com.	Country	Emplo.	Path	Main areas of professional activity
E1	Argentina	8 (7)	16 years / N&I	Development of new tailored information systems with ongoing integration of new technology
E2	Chile	18 (12)	10 years / N&I	Computer Engineering projects for the agricultural (wine and food) industry.
E3	Spain	7 (6)	5 years / N	Software development on WEB.
E4	Spain	21 (15)	13 years / N	Software development through contracts and agreements with public organizations.
E5	Colombia	4 (4)	3 years. N	Software to manage and control the ISO 9001-2000 quality management system.
E6	Colombia	6 (6)	3 years. N	Web application development-oriented agricultural services.
E7	Colombia	4 (4)	3 years. N	Software to mobile telephony and devices.
E8	Argentina	12 (5)	4 years. N&I	Custom software development.

Emplo.: Number of employees in the enterprise (People in software development and maintenance)
Path: Number of years of existence of the company / scope of the market for its products (National–N / International–I)

Table 2. Initial and final capability of the organization's process and cycle effort

Comp.	Assessment	Capability of Processes									Cycle length (weeks)	Effort (hours)		
		SD	SPA	SM	BM	PM	PjM	HRM	KM	IM		Adviser (A)	Comp. (C)	Total
E1	*Initial*	-	2	-	-	-	-	-	-	-	24	40	264	304
	Final	1	2	*	1	1	1	1	1	1				
E2	*Initial*	0	1	0	-	-	-	-	-	-	20	89	255	344
	Final	1	2	*	*	-	-	-	-	-				
E3	*Initial*	0	0	-	-	-	-	-	-	-	12	15	39	54
	Final	1	*	-	-	-	-	-	-	-				
E4	*Initial*	0	0	-	-	-	-	-	-	-	12	41	47	88
	Final	1	*	-	-	-	-	-	-	-				
E5	*Initial*	1	0	-	-	-	-	-	-	-	10	42	27	69
	Final	1*	1	-	-	-	-	-	-	-				
E6	*Initial*	1	1	-	-	-	-	-	-	-	10	38	11	49
	Final	1	1*	-	-	-	-	-	-	-				
E7	*Initial*	0	0	-	-	-	-	-	-	-	10	65	23	88
	Final	1	1	-	-	-	-	-	-	-				
E8	*Initial*	0	0	-	-	-	-	-	-	-	16	71	16	87
	Final	0*	1	-	-	-	-	-	-	-				

Processes: SD (Software Development), SPA (Specific Project Administration), SM (Software Maintenance), BM (Business Management), PM (Process Management), PjM (Project Management), HRM (Human Resources Management), IM (Goods, Services and Infrastructure Management) and KM (Knowledge Management).
* Base practices of this process have been put into operation; - Process not assessed.

The case studies carried out to use the *improvement framework* of COMPETISOFT in VSEs presented in this paper have some limits:

- The observations and conclusions presented are based on eight case studies, which can limit the power of generalization. Although these companies are representative of the software industry in Latin America, the number of companies taking part in the case studies is a low percentage of the overall population.
- The bias of the case studies, because the development of daily activities by employees may proceed differently precisely because they are being observed or due to some particular kind of handling of events and data by the advisers.

6 Analysis and Conclusions

Table 2 shows that the eight VSEs have increased the capability level of their SD and SPA processes, among others. It is important to highlight that enterprises E1 and E2 have also increased the capability of processes SM and BM. It can also be observed that E1 was the company which increased its level of capability in the greatest number of processes. This increase can be observed in the established base practices, which have been reported in the Improvement Reports of each company. Through the application of the *improvement framework,* the small companies have introduced new base practices to their processes, thus allowing them to increase their capability. Based on the collected data, there is evidence that the *improvement framework* has enabled these small companies to increase the capability of their processes.

From Table 2 we can also draw the conclusion that the effort spent on improving processes per week for each organization is: E1 12.7 h, E2 17.2 h, E3 4.5 h, E4 7.3 h, E5 6.9 h, E6 4.9 h, E7 8.8 h and E8 5.4 h (including the adviser's time). We consider that the effort of applying the proposed *improvement framework* has been suitable for the characteristics of each one of the organizations involved in the improvement initiative, since employees involved in the processes improvement of each enterprise were able to take on this effort without any negative effect on their daily activities.

Some benefits which the firms have reported are:

- The companies had moved from a chaotic and unpredictable software process to a tangible one, which is currently being used on development projects.
- The companies begin to generate a knowledge base which means historic data are available when decisions are being taken.
- The companies have a more specific vision of the organization itself which has helped and motivated them to set out on the road to quality certification. For instance, E1 is currently conducting an ISO 9001:2000 certification, and E3 has started to work towards a formal assessment at CMMI level 2.

Based on the case studies carried out, the increase of the capability of the processes to be improved, the effort of applying the proposed process and the benefits described by VSEs, we consider that the *improvement framework* is suitable for leading SPI initiatives in VSEs. The results, in terms of effort, increase of capability and benefits, are an indicator that the proposed framework can be a practical and useful strategy when facing the difficulty of carrying out SPI in VSEs. Furthermore, from the case studies we have been able to confirm that the proposed *improvement framework* was executed properly by the VSEs involved in the improvement initiatives.

On the basis of the application of the *improvement framework* in the VSEs, we have obtained some lessons which are described below:

- When performing the activity of *Initiating the cycle* we had difficulty in aligning the *Improvement Proposal* with the strategic planning of the firm (see Fig. 2), because there was no Strategic Plan. However, this fact should not be viewed as a problem but rather as an improvement opportunity, since it highlights the company's 'raison d'être', goals and its strategies for attaining them, i.e., Business Management.
- Obtaining the expected results in relatively short periods was an important aspect for the motivation and involvement of the participants in a project like this. Seeing such rapid results and taking part directly of these, allowed the employees to realize the possibilities of process improvement in general, and COMPETISOFT in particular, despite the initial reticence that these projects may have caused.
- Applying the improvements in pilot projects significantly reduced the resources needed, as well as the risk associated with the implementation of improvements in the companies' key processes.
- A-R is strengthened by the Case Study because it allows more control in the execution of the proposals developed. This means an increase in the reliability of the results. By means of the integration of these two methods, a well defined structure has been obtained for the development and application of the framework in VSEs.

Given that the results of the case studies are encouraging, new SPI initiatives are planned for the eight organizations. We shall conduct a follow-up in the companies, to attempt to determine whether this strategy has made an impact on the companies' success in terms of market attributes.

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