A Detailed Software Process Improvement Methodology: BG-SPI

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Abstract. Software Process Improvement (SPI) methodology is defined as definitions of sequence of tasks, tools and techniques to be performed to plan and implement improvement activities. Well-known SPI frameworks like CMMI and ISO/IEC 15504 define SPI methodologies in an abstract manner. We developed an SPI methodology, BG-SPI, providing a ready-to-use SPI scheme with guidance on an iterative SPI lifecycle, composed of task definitions with details on resources, tools, roles, participation of groups, process assets, and other process specific supporting items. Utilizing BG-SPI with support of SPI experts, organizations can easily plan and manage SPI lifecycle. BG-SPI methodology is applied over 10 organizations with different size, sectors and SPI motivations. This paper explains BG-SPI and provide insight on how a detailed SPI methodology helps the SPI projects in various aspects.

Keywords: Software process improvement, SPI, SPI methodology, SPI lifecycle, CMMI, ISO/IEC 15504.

1 Introduction

Software Process Improvement (SPI) focuses on improving the time, cost and quality of engineering and management practices in software organizations. SPI initiatives in software organizations are frequently performed based on well defined reference models such as CMMI and ISO 15504.

SPI methodology can be defined as definitions of sequence of tasks, tools and techniques to be performed to plan and implement improvement activities [3]. SPI methodologies are described as part of or in relation to well-known process improvement frameworks like ISO/IEC 15504 [4], CMMI [6]. Other SPI frameworks that describe SPI methodologies are SPIRE[7], SATASPIN [8], PRISMS [9], MESOPYME [2], MoProSoft [10], MPS [11]. Related parts of the two most frequently used reference models, ISO/IEC 15504-4 [5] and IDEAL[12] define SPI methodology in a broad sense. They emphasize the importance of planning SPI activities, name the key activities and concepts and describe their relations. Despite detailed descriptions of reference models, tools and techniques and types of assessment methods, the existing frameworks do not provide a detailed SPI methodology to plan and manage SPI initiatives.

R.V. O'Connor, J. Pries-Heje, and R. Messnarz (Eds.): EuroSPI 2011, CCIS 172, pp. 97–108, 2011.

In the methodologies defined, the organization of key concepts and implementation details are left to the practitioners. They suggest SPI programs to be organized in waterfall-like lifecycle and in a top-down fashion [7, 9]. As a result organizations frequently do not utilize these methodologies and define their own approach to manage the SPI projects.

We have developed BG-SPI (Bilgi Group Software Process Improvement Methodology), that provide detailed guidance on how to conduct SPI including the lifecycle, tasks, approach, resources, tools and other supporting assets. Utilizing BG-SPI with the support of independent SPI experts, organizations can easily plan and manage the SPI lifecycle by tailoring a ready-to-use SPI scheme. Compared to traditional approaches, BG-SPI provides an agile approach to conduct process improvement in short term increments with a clear long term roadmap. BG-SPI includes detailed inscriptions of SPI activities, also process assets and documentation. Organizations that utilize BG-SPI eliminate the demotivation to conduct SPI caused by ambiguity, achieve short term benefits and overall enable SPI projects to be conducted more effectively.

BG-SPI is utilized to conduct SPI activities in ten different software organizations with different characteristics. SPI consultants from Bilgi Group have been involved to guide the application of the methodology. It is observed that utilizing a detailed SPI methodology enhances the SPI application in many ways. In this paper, we explain the BG-SPI and present the benefits observed in the SPI activities of the organizations.

The rest of the paper is organized as follows. Section 2 provides general information on SPI methodologies. Section 3 explains BG-SPI with its process description. Section 4 discusses SPI experiences utilizing BG-SPI and the results. Section 5 discusses the conclusions and lessons learned.

2 SPI Methodologies

SPI methodologies defined as part of SPI frameworks are composed of high level activities or phases. They provide guidelines and highlight points to be considered while organizing the SPI activities. For example, ISO/IEC 15504-4 [5] suggests defining an SPI lifecycle and an action plan in Process Improvement Programme Plan. Other than highlighting major headings of the action plan, many decisions are left to the practitioners. Similarly, IDEAL [12] advises the activities to be determined in the “improvement agenda” of the SPI strategic plan. The practitioners on the other end need a practical SPI scheme, specific guidelines on how they will organize and conduct SPI; and detailed descriptions of activities.

The frameworks for small and medium sized organizations provide more detail on the implementation of SPI, as these organizations require ready to use descriptions. MESOPYME [2] provides a specific implementation approach. With the same perspective of this study, [2] discusses that specific implementation solutions are required to plan SPI activities, and “current methods do not provide guides to elaborate these elements”. The solution is using “action packages” to start SPI activities in process areas, proven to be successful in their experiences.

SPIRE [7] is a framework suggesting a more traditional approach as the SPI methodology. With a waterfall lifecycle, it focuses on benefits of SPI and maintaining the plan. Being an earlier framework, it provides an experience base. PRISMS also utilize waterfall lifecycle, focusing on business goals to identify key process areas [9]. With a top-down approach, planning is conducted by quality experts and implementation by process owners, as does OWPL [19].

ASPE-MSC [20] explains a detailed SPI methodology with an iterative lifecycle, emphasizing the SPI plan preparation. Competisoft [13], an evolution of MoProsoft [10], defines an incremental improvement process influenced also from agile methodologies. The model defines the roles, expected work products and a template for these products. Consultant guide is also suggested at Competisoft. SATASPIN [8] provides a good example of distributed SPI initiatives.

All these frameworks focus on the fact that organizations need more guidance to initiate and conduct SPI, suggesting solutions for different aspects they focus. They all infer a top-down paradigm, usually with a centralized mechanism. The lifecycles vary. As the roles to be involved, some suggest well-defined allocation of the responsibilities and involvement of external experts. They are based on and encourage use of a well-known SPI framework like CMMI or SPICE.

Our experiences also support that the initiating step of SPI is the most critical, as organizations find it hard to plan the activities without a guidance. To overcome the problems and provide a well-defined SPI guidance, we developed an SPI methodology called BG-SPI. It utilizes the ideas and best practices from the summarized SPI frameworks, together with other standards and experiences. BG-SPI methodology is explained in the next section.

3 BG-SPI Methodology for SPI

BG-SPI is an SPI methodology that defines a process to implement SPI activities in an iterative lifecycle. It also includes related process assets that organizations can utilize as a baseline to fulfill the requirements of SPI models and standards like CMMI [6], SPICE [4], ISO 9001:2008 [15] and IEEE Software Engineering standards [16, 17, 18]. BG-SPI follows the outline of SPI process suggested by commonly known models like IDEAL [12], ISO/IEC 15504-4 [5]. It also incorporates the best practices suggested by other more detailed SPI frameworks like MESOPYME [2], OWPL [19], ASPE-MSC [20], PRISMS [9], MoProSoft [10]. BG-SPI presents a well-defined set of activities for a practical SPI implementation by providing a ready-to-use SPI scheme and generic set of process definitions and assets. BG-SPI is utilized and enhanced in many SPI initiatives of different kinds of organizations.

From a high level perspective, BG-SPI process is similar to those of the ISO/IEC 15504 Part 4 [5] and IDEAL model [12]. However, BG-SPI aims to provide a specific guide. The SPI process of BG-SPI is depicted in Fig. 1. The process is modeled using eEPC notation [24] which is based on activity flow. The columnar view is used, where the activities of the roles (shown at the top of the columns) are depicted along the related column. Each step of the methodology is explained in the following sections.

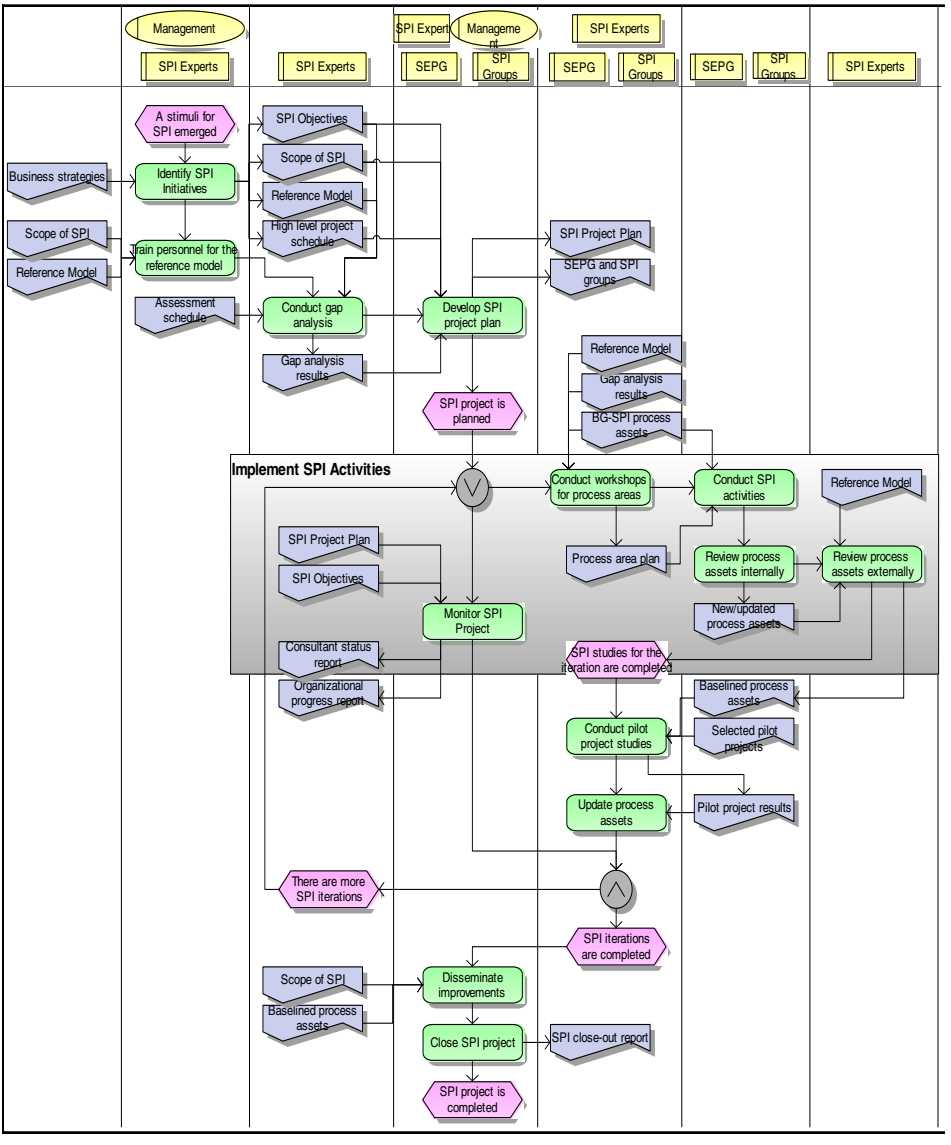

Fig. 1. The implementation process of BG-SPI Methodology

3.1 Identify SPI objectives

This step starts when an SPI stimuli emerges at the organization. For some, the main stimulus is certification enforced by industry, while some consider marketing, or some are only motivated to cut costs, improve timeliness and quality aspects of their processes.

At this point, with an external view, it is important to determine organization's real expectation from SPI, normalize it with respect to business strategies, and document as "SPI objectives". Organizations may select to apply SPI in some or all of its related departments and project types, determining the "scope of SPI".

Considering the business strategies and the SPI stimuli, "reference model" for assessment and improvement is identified as CMMI or SPICE. Considering organization-specific issues and target maturity level, high level details and tailoring to reference models are identified. A "high level project schedule" is developed.

3.2 Train Personnel for the Reference Model

In this phase, the organization is ready to initiate technical SPI activities. Considering the scope of SPI, the related organizational units are identified. Training and workshop sessions of the chosen reference model are conducted. To provide a common understanding of the SPI activities, a general SPI training is conducted. In this way, awareness and knowledge of SPI is disseminated for the related organizational units. The workshops also establish a baseline for the next step of conducting gap analysis.

3.3 Conduct Gap Analysis

To identify the current state of the organization, an assessment is conducted by SPI experts to evaluate the conformance to the reference model. SPI experts are a group independent of any process area studies and they are frequently consultants. A detailed "assessment schedule", including interviews and related personnel, is identified. Conducting the assessment, the gap between the reference model and the current state is identified, analyzed and documented as "gap analysis results".

The assessment is critical, as it is the basis for revealing the improvement opportunities and determining the detailed SPI schedule. Moreover it has a distinctive importance as it is the initial step to actively disseminate and internalize the idea of SPI in the organization. The personnel coordinating the assessment usually become the ones in software engineering process group (SEPG) (as used in IDEAL [12]), the group coordinating and managing the SPI project. Also, the personnel in assessment interviews provide insight on who should participate in the future process area improvement groups (named here as SPI groups).

3.4 Develop SPI Project Plan

Materializing the results of the gap analysis and utilizing the inputs of the previous steps, the improvement lifecycle model is identified and SPI activities are planned in "SPI Project Plan". This step is conducted as a project planning process, ending with a work breakdown structure, schedule, resources and budget.

Implementing SPI as a project is suggested by most of the SPI frameworks like ISO/IEC 15504-4 [5], IDEAL [12, 22]. Although this is a common approach, we encounter problems in practice. Our experiences show that it is hard to get acceptance for the idea to conduct SPI as a project, as it is much different from development projects. To assure its benefits, the management level is explained that by means of

managing SPI activities as a project, allocation of resources and monitoring of objectives can be assured. Technical people are explained that they can transparently dedicate their time to SPI activities and expose their efforts and the results clearly to the management level. In this way, internalization of SPI is highly enhanced. Hence, this supports that determining project drivers for an SPI implementation is an important factor to enhance the commitment of individuals [21].

During SPI project planning, existing SPI know-how and assets are tailored. First, a "Software Engineering Process Group (SEPG)" is established. A ready to use list of responsibilities is suggested to and tailored for the organization. SEPG is defined as the group to coordinate and monitor all SPI activities, be the communication point among all stakeholders, manage and synchronize all assets and report to the upper management.

Involving process owners in SPI activities from the start is important to provide ownership and confidence for SPI [23]. Considering this, the groups responsible for the process areas (named as "SPI groups") are identified. They are usually assigned for the high level process groups like management, engineering, support and process management. Within these SPI groups, lower level responsibilities are identified for specific process areas. The SPI project plan is established and approved by all related groups including management, SEPG and SPI groups. In this way, commitment is obtained for the SPI activities.

BG-SPI suggests an iterative lifecycle model for the SPI activities. The project is composed of iterations that are micro-improvement cycles of about 6 months. It is of high importance to prioritize the goals and divide the increments accordingly [1]. Considering this point, the allocated time for each process area is identified using the results of the gap analysis. The cycles are identified to cover all processes of a high level process area like support and management areas. This also simplifies the organization with the SPI groups and implementation of the pilot projects.

If not required otherwise, initial processes are determined as the ones focusing on process definition and improvement. In this way, the approach to define processes, build up organizational process asset repository, and determine approach for improvement is identified at the beginning. The studies for the rest of the process areas utilize this approach to develop their own process assets, which assures a standard way of process development from the beginning. This approach also lets the studies to start with only the SEPG and SPI experts together. In this way, the group establishes an internalized workshop format and utilizes it for the rest of the studies.

During the gap analysis, organization's training needs are revealed. The identified training needs are integrated with the project plan. The trainings are placed before the start of the related process area workshops. In this way, it is ensured that the SPI groups are knowledgeable and motivated for the related SPI studies.

In all SPI iterations, implementation of related processes in pilot projects, and incorporating identified improvements are planned. Even if some processes are found to be meeting the requirements of the reference model fully during gap analysis, they are placed in the schedule so that that process can be synchronized with the new studies and further improvement opportunities can be identified.

3.5 Implement SPI Activities

This step in BG-SPI process is composed of several activities and shown with gray area in Fig.1.

The first activity is "conduct workshops for process areas". The approach of BG-SPI for implementation requires a strong participation with SPI experts. For each process area as identified in the SPI project plan, SPI experts and related SPI group starts with a workshop. Workshops are usually organized once in a week or two weeks. A predefined workshop format is followed. SPI experts start the workshop with an introduction of the reference model for that process area. The findings from the gap analysis are discussed. The generic process definitions and assets provided in BG-SPI methodology ("BG-SPI Process Assets") are analyzed. Organization specific characteristics and practices are discussed by working over these assets. The possible utilization and adoption to BG-SPI assets are identified. Available organizational assets, infrastructure and tools are evaluated, alternatives and solutions are discussed to fit to SPI objectives. Accordingly, a list of to-do's is identified, including the process definition, process assets, organizational activities, decisions to be given, infrastructures to be established and reviews. All these activities are planned in a "process area plan" with the consent of SPI experts, including work items, responsibilities, resources and dependencies.

Second activity is "conduct SPI activities". After the workshop the SPI group, with the coordination of SEPG, conducts the activities as planned in detailed process area plan. Before SPI expert review, prepared assets undergo an internal review mechanism, the activity of "review process assets internally". During the activity of "review process assets externally", the SPI experts verify the processes for conformity to the reference model and standards to be followed, compatibility with the existing and newly defined organizational assets and consistency between the processes. In the next workshop, open and completed work items are revised and discussed. The completed process assets are baselined and placed under configuration control.

The other activity during this step, parallel to other studies is to "monitor SPI Project". SEPG prepares "organizational progress reports" as defined in the SPI project plan. The SPI experts prepare monthly "consultant status reports", evaluating the progress both in high and low level work items, and comparing the actual and planned status of objectives.

With this approach, smaller iterations for process areas (micro improvement cycles) are conducted within each bigger SPI iteration. With the help of the BG-SPI approach and support of the SPI experts, the roadmap is well defined, preventing the confusions in the SPI lifecycle. Also, the SPI lifecycle is continuously under control and monitored with a joint mechanism of workshops and progress reports.

3.6 Conduct Pilot Project Studies and Update Process Assets

Upon completion of an iteration, a set of pilot processes are selected to apply the improved processes. The number of projects are kept between 2-4, as too many projects would make the pilot studies hard to manage. If the project durations are too long in the organization, projects which are in different phases of their lifecycle are chosen. In this way, different process areas can be implemented in a shorter time.

The outcome of this activity is "pilot project results". These results are utilized to identify the needs for changes and update the SPI project plan. The SEPG again has a critical role to assure that project members apply the new processes, collect the negative and positive feedbacks, find out the points they cannot apply, and manage the new updates to processes accordingly.

As the pilot projects are conducted for each high level iteration, the feedbacks are obtained for the iterations, too. This enables parallel work while the group starts studies for the next iteration. The results of the first pilot projects can be utilized as input to the next iteration. Also, the step by step implementation of processes eases the adoption by the organization.

3.7 Disseminate Improvements and Close SPI Project

Upon completion of the iterations, the dissemination of new processes to all organization is started. This step is critical for sustaining the improvements in the organization, and conducted with a dissemination strategy. Usually, the implementations of the new processes are initiated with the newly starting projects. In this way, a step-wise transition occurs.

The activity of "close SPI project" is conducted when completion criteria are completed as identified in SPI project plan. The results are documented with "SPI close-out report". For continuous improvement, it is advised that SPI is conducted with recurring projects in the organization.

As discussed before, lifecycle model utilized by the SPI methodologies is a distinctive property. BG-SPI is employing an iterative life cycle. In the high level, SPI project is planned to include high level iterations including process area sets. The iterations are further divided to micro improvement cycles, each planned in more detail before the start. This approach brings both good control and flexibility for managing SPI activities; providing better response to uncertainty while providing good management practices. For the application paradigm, BG-SPI applies a distributed approach. While activities are initiated in a top-down manner with the support of the management with a high level plan covering all process areas, the technical groups (SEPG and SPI groups) initiate detailed studies in low level as planned in high level schedule.

The most important aspect of BG-SPI is its level of detail in terms of guiding SPI studies. The BG-SPI provides a well-defined template of SPI activities, which eliminates the risk of demotivation caused as the organization can't foresee its roadmap and stay in confusion. Indeed, an important part of the SPI studies is about the social aspects. The importance of management commitment is a well-known issue [14, 18]. ISO/IEC 15504-4 [5] mentions the risk of "senior management not expressing informed, sustained commitment". To overcome this issue, the involvement of the management is planned throughout the BG-SPI lifecycle, the objectives are made clear, and the results of the studies are quantified with the reports. SPI project management process is the most important tool for this, by means of which resources are allocated and SPI expectations and objectives are identified clearly. This provides not only management commitment, but also internalizing SPI studies throughout the whole organization. Changing the organizational culture to conduct SPI in a habitual way is the most critical benefit of the SPI methodology. For this, providing the management

commitment and making SPI part of everyone's work, as assured with the SPI project, is critical. Through the application of BG-SPI, it is also the responsibility of the SPI experts to highlight the achievements of the group and emphasize the benefits acquired.

A methodology which is so deterministic may have the risk of not being appropriate to many cases. We have applied BG-SPI in many different SPI studies, as summarized in the following section. The results assure that BG-SPI is applicable to many different cases, and know-how can be utilized for many other cases too.

4 Experiences on Applying BG-SPI

We have implemented BG-SPI in a number of organizations to conduct SPI activities. The size of the related units of these organizations differ. In this paper we provide our observations on 10 implementations. One of the ten organizations is a micro-enterprise, having a development team of size less than 10, and one has size 10-25. Others are larger, three having unit size between 25-50, and the rest between 50-100. The sectors and application types also vary between banking, military, government and embedded applications. The organizations from military sector has for official certification goals due to acquisition regulations in Turkey. 9 out of 10 organizations were aiming to reach a maturity level of established processes. Planned durations of the SPI initiatives were about 13-15 months. Four of the six organizations that planned certification acquired the certification successfully. The remaining two are continuing activities as planned.

At the moment, SPI activities are going on in three organizations. Five of the organizations completed their first SPI projects as planned, with or without certification. Two of them canceled the SPI initiative after covering parts of the SPI plan including definition of processes. In one of the organizations, the reason of cancellation is change in the stimuli for conducting SPI. The other had to stop the initiative due to unavailability of related resources.

Considering these experiences, we observe some factors facilitating the success of SPI. As mentioned in many studies, management commitment and involvement of process owners are found to be the key points for success. When these are not achieved on time, process improvement teams may have the illusion that the studies are going well, until they encounter a resistance at the time of the pilot projects. This is caused by the fact that process owners don't know the new processes and doubt if it is applicable for them. To overcome this, it is very critical to manage the involvement of the process owners and establish SPI as part of the organizational culture. If the management can't take actions to break the resistance, usually SPI initiatives do not achieve all of their goals.

Other principle for effective management of the SPI projects is found to be the certification goal. Organizations with certification pressure from the acquirers are much effective in planning and implementing SPI projects. This is caused by the fact that the obligation enhances the management commitment, and the personnel, rather than questioning the initiative, focus on achieving the objectives as planned.

We observed that the organizations from similar sectors encounter similar technical problems while they develop process assets, and the domain knowledge helps a lot to solve these problems. For example, military organizations usually develop huge long

projects involving many technical difficulties. Companies developing banking applications usually develop small projects attached around a framework application; which makes it hard to differentiate between maintenance and new development. Despite these variations, we haven't identified any factor of success depending on the sector. We observe that the existence of the SPI experts, especially external consultants, increase the success potential of SPI projects. Indeed, by means of BG-SPI, the dependency on SPI experts decreases as all activities are well-defined. However, the existence of the SPI experts stimulate the motivation to better allocate resources, and enable the personnel to get focused as they perceive SPI experts as a sign of management commitment. The personnel feel comfortable to know they can consult them in case of problems. Also, expensive rework in later phases is largely eliminated by an independent verification and validation mechanism.

Another aspect of BG-SPI methodology is the ready-to-use process assets. In many cases, the organization can use these time tested assets with minimum tailoring effort, and the groups can easily determine the list of action items by going over these assets. The usage of these generic process assets may bring the internalization risks for the processes. However, in our studies, we observed that this property enhanced the practicality of BG-SPI, decreasing the time to develop organizational process assets. As all of the SPI lifecycle is planned in a well-defined manner, the organization already establishes the approach to develop the assets, which prevents the feeling that the assets don't belong to them. It is still important to keep in mind that for process areas with no or very little previous implementation, the group is more eager to use available process assets of BG-SPI. However, relying on these assets makes the settlement of these processes difficult. This is a risk to consider during definition of process assets. To prevent this risk, it is important to train the personnel and increase the awareness, and motivate them to reveal the solutions matching better to the organization's way of doing things.

5 Conclusion and Future Work

In the high level, BG-SPI follows the high level approaches suggested by well-known SPI frameworks like CMMI, ISO/IEC 15504. Like IDEAL, BG-SPI divides SPI implementation into phases. To apply those, it provides detailed practical guidelines. It follows some principles of iterative and agile development philosophies to detail the activities. The iterative planning in high level, dividing the iterations more as micro-improvement cycles and increasing the planning details before starting the activities are examples of these.

Other important aspects of BG-SPI are the weekly meetings, intensive involvement of process owners, close review and reporting mechanisms. Starting the studies with process areas of organizational process definition and improvement is another highlight of BG-SPI, which is an approach to institutionalize and internalize processes. BG-SPI also utilizes the SPI experts in the lifecycle to enhance the effectiveness of SPI process, but prevents to create dependency on them, which improves the sustainability of SPI programs. In our experiences, this ready-to-use scheme of BG-SPI is found to be helpful for the critical step of SPI planning, resulted in successful SPI implementations and fostered internalization of SPI practices.

The ratio of certificated organizations is a measure of success for BG-SPI. All four of the organizations that completed the SPI activities got official certification as planned.

For the future work, we find it important to collect SPI data in a systematic way in later SPI programs so that we can derive more extensive conclusions from the experiences. These conclusions will constitute an important repository for SPI area that can be utilized by other practitioners and academicians in the field. Also, in this way, BG-SPI will be improved and better meet the needs in the field.

Another improvement opportunity we foresee is to customize BG-SPI to meet different needs of sectors. The customization can give the most benefit for process assets provided by BG-SPI. By incorporating domain knowledge into the process assets, we can speed up the SPI process definition activities during SPI implementation.

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