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SOFTWARE PROCESS IMPROVEMENT IN LITHUANIA – UAB SINTAGMA CASE STUDY

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Abstract. Lithuanian IT companies have a growing interest in the software quality assurance and software process improvement. However, specialized software process models, such as CMM or ISO 15504 (SPICE), are not widely known. The object of this paper is a case study of the software process improvement effort in a Lithuanian IT company. CMM model was used as a basis for improvement. This paper explains why the majority of Lithuanian IT companies can be classified as small and presents how the major software process improvement issues of the case-study compare to the experiences of the small software organizations.

1. Indroduction

The concern for quality has become an international movement. A very popular way to improve quality is to improve the software process. Software process improvement (SPI) is recognized as having the potential to improve competitiveness by increasing productivity; reducing costs, defect and rework; and improving time to market and customer satisfaction [4]. SPI is by now recognized as an important endeavor for software organizations. It makes sense to use a structured model to organize the process [9] and quite many organizations use a software process model to guide their SPI effort. SPICE (ISO 15504) and Capability Maturity Model (CMM) are among the most popular software process models.

In Lithuanian IT companies there was a growth of interest in the software quality assurance and software process improvement in recent years. In the year 2000 the first IT organizations were certified to ISO 9001. By now, several other organizations have been certified to ISO 9001, and the majority of other IT organizations are considering their ability to do it. However, specialized software process models, such as CMM or SPICE (ISO 15504), are not widely known.

The purpose of this case-study is to demonstrate some of the issues with the SPI in a Lithuanian IT company and to show how they relate to the experiences of other software companies throughout the world. It is shown that Lithuanian IT companies can be defined as small software companies. The SPI issues and challenges of the small software organizations are used as the basis for the comparison.

2. SPI in Small Organizations

Numerous researches ([2], [8], [9], etc.) have shown that there is a field of problems relevant particularly to the small software organizations undertaking an SPI effort.

The first question to ask is "What is the definition of "small" and is it relevant to the Lithuanian IT companies?". It appears, that the definition of "small" is challengingly ambiguous [13]. Companies with less than 20 [3], less than 25 [6], less than 50 [1], [11] or less than 100 employees [16] can be identified as "small". The research of Brodman and Johnsen shows, that the problems of „small" organizations are relevant to all software organizations with up to 200 employees: very little correlation was seen between the size of an organization and the issues that were raised – the issues seemed to span all sized organization [2].

As only the biggest Lithuanian IT companies have more than 200 employees, the term "small" is more or less suitable to define them. Therefore a question could be raised of how the issues typical to small organizations are pertinent to the Lithuanian IT companies.

Below are presented major issues of small organizations that make their SPI a challenge.

2.1. The need for investment

One of the most widely described issues is of the financial nature. Software process improvement needs investment, which is NOT related to the company's size. There is a minimum cost that must be borne to initiate a software process improvement program regardless of company size, and thus the overhead rates

of small businesses are affected to a greater degree than those of large businesses, which have a larger base over which to spread the overhead costs [2]. So, although the management of a small organization rarely would argue that SPI would not improve their company's profitability but they cannot afford to embark on high-cost, large-scale style software improvement [15].

2.2. Lack of resources

Small organizations may find it hard to allocate resources for the SPI, limited resources are an issue even for organizations over 200 people [2]. However a clear and visible responsibility for process-related activities must be ensured, at least on a part-time basis [6]. Often the SPI takes up resources needed to deliver products [14]. As the primary business objective of the small company is to survive, it often means a limited pace for SPI activities [13,2].

Having scarce resources results in the situation when each person must perform multiple roles, and it inhibits an effective separation of project and process concerns (that means, short-term and long-term concerns), [6], which is not considered a good practice.

2.3. Cultural issues

The improvements being implemented must take into account the organization's culture. Otherwise, either they won't be adopted or they'll be adopted in an inefficient way, thus affecting process compliance and performance [6]. The success of small organizations is often due to the creativity and innovation of their employees. SPI is frequently viewed as the antithesis of these qualities, leading to bureaucracy that restricts the freedom of individuals [10]. When software heroes play an important role, the need for accompanying processes may not be seen, and the quality programs are often regarded as additional paperwork [5].

2.4. The Need to Scale the Models

Software process improvement (SPI) in small enterprises or business units requires special attention when applying models and standards which usually have been designed from the viewpoint of large organizations [16]. It makes sense to adjust the model to the particular conditions of the organization [9]. An organization will achieve little benefit from a software process improvement program if it is not tailored to the organization's needs and business environment [8].

The focus of the case-study is the SPI based on the CMM, so here are presented some of the specific challenges that small organizations face when applying the CMM model.

Projects that are small do not have the resources that a large project does to perform all the CMM activities, at least in the way the model suggests [8].

Small teams cannot cope with the overheads produced by the amount of documentation required by the CMM and they must use combined documents to reduce time [12]. For example, there are approximately 42 documents at Level 2 alone, ant it is beyond the resources of many organizations and projects [8].

There are many CMM practices that physically cannot be accomplished by a small organization - there are insufficient resources in terms of personnel to support separate, independent groups (e.g. CM, SQA), an in-house training program, and a hierarchical management structure [2].

3. Context of the Case-Study

The organization of this case study operates since 1991. Its strategy focuses on IT services, software development and system integration. The company is among the medium-sized Lithuanian IT companies, having more than 130 employees.

As mentioned above, the typical path taken by Lithuanian IT companies striving for better quality begins with the certification to the ISO 9001. The most common starting point for SPI in a small company is that they have realized the need for process improvement, but they do not know any process models [16]. Having ISO 9001 compliant quality management system, various considerations may impel an organization to explore more specialized software process models.

Sintagma's quality management system (certified to the ISO 9001 in 2000) had to be developed taking into account the needs of four company's business units (Information Systems, Business Solutions and ERP Systems, Point-of-sale Systems and Conference Systems), only two of which are largely devoted to the software development. As the organization's process was established on the ISO 9001 procedural basis, it was perceived that while it satisfies the needs of the top management, and the rest of the organization, it is not sufficient for the software projects, where resource management and budged problems remained. A question was raised what steps should be taken to further improve quality of products and services.

Keeping in mind that IS0 9001 has not been designed for typical software engineering problems [5] in 2001 the organization familiarized itself with two software process standards, namely SW-CMM and SPICE. There was an assumption that specialized process model would provide a clearer direction for the improvement of the software process. The SW-CMM was chosen over SPICE due to some considerations:

1. SW-CMM provides a road map for process improvement through the five levels [10]. While SPICE gives more flexibility, it was considered too complex.
2. Although not very popular in Europe, SW-CMM is an accepted industry standard and therefore allows easy comparison with other companies [10].

3. Management was most attracted by the general project and quality management practices [9]. The need to strengthen the project management disciplines was already identified in the course of establishment of the quality management system, and SW-CMM defines clear goals to achieve it.
4. SW-CMM is based on actual experience and reflects the best practices in software engineering and management in a large number of IT organizations.
5. Numerous success stories of how the SW-CMM, if applied properly, can improve productivity and time-to-market, and decrease product defects.

The decision was made to start a SPI effort to achieve SW-CMM Level 2 compliance. The results of this effort are presented in this paper.

4. Course of Activities

4.1. First Improvement Effort

The first improvement effort began in 2002. As the direction chosen for the SPI effort was SW-CMM Level 2 compliance, the idea was to fit the procedural base to the SW-CMM Level 2 requirements, and prepare the implementation of compatible process. The existing Quality Management System was examined. Three procedures associated with software development process were identified:

- **Contract Establishment Management** (concerns all activities before the contract is signed)
- **Contract Implementation Management** (inspection of how the contractual commitments are held, result validation)
- **Project Management** (planning, requirements for process results, control of results)

This procedural structure is close to the business perspective and satisfies the ISO 9001 requirements and management needs.

The revolutionary approach was chosen for the SPI effort, meaning that the definition of the process procedures had to be done by the SPI project group and systematic implementation of the new procedures had to be carried out in the organization. This approach does not demand great investments, however it is prone to resistance by the employees and their refusal to accept changes.

The decision was made that the employee directly responsible for Quality Management System should participate in the SPI project group, and specific software process activity descriptions should be introduced as refinements to the existing ISO 9001 procedures. This way new decisions would be presented in a familiar environment and thus easier accustomed to.

Comparison of the existing procedures and SW-CMM Level 2 practices showed that there is a sound foundation for all of the KPAs, but neither of them is fully implemented. A set of procedures was prepared, aiming at identifying unified process management practice and filling the gap between existing procedures and SW-CMM practices. New procedures were documented as "Project management methods and guidelines" and presented to the top management and the project managers.

The guidelines contain seven procedures, five of which cover five SW-CMM Level 2 KPAs (excluding Subcontract Management). The other two procedures – Project Initiation and Result Legitimation – provide consistency with existing Quality Management System. Process implementation plan was prepared. In the beginning of 2003 project managers received project-planning training in accordance with new procedures.

Eventually the revolutionary approach encountered problems, such as:

- Lack of resources, as the number of projects in the organization grew.
- A raise in the costs of project management: the new procedures contained additional work for the project managers and they had less time to spend on the technical activities of the projects.
- Inertness of the employees.

In 2003 Sintagma joined the research project carried out by the leading Lithuanian universities and software companies. The objective of the project is the creation of an SPI methodology and supporting tools suitable for Lithuanian organizations. However, despite the participation in this project, the direct effort on the SPI was paused due to the problems encountered. After being suspended, it slipped to the evolutionary approach. In order to minimize costs and counter the inertness these decisions were made:

- Involve the project managers into the process definition.
- Implement KPAs one by one.

This inevitably increases the duration of process implementation, but this approach is more assured.

4.2. Second Improvement Effort

Lessons learned in the first improvement effort were no different from the most small and not only small software organizations:

- Obtaining senior management sponsorship is a crucial component of building organizational capability [13].
- It makes sense to perform the improvement activities as a project with clearly assigned and documented roles, responsibilities and resources [9].

Problems mentioned in the previous sections implied that there is a need for higher level of determination for the SPI The following decisions were made to ensure SPI does not fall short of resources and is continually supported:

- Include SPI in the strategical company's objectives
- Initiate an internal project for SPI
- Dedicate resources for SPI

The second improvement effort began in the middle of 2004. By the time it was evident that employee resistance and project management overheads caused by the new procedures force the organization to use the evolutionary approach to the SPI, a paradigm that is effective but can be initiated with a small investment, produces fast results and then can be incremented as time and resources allow [15]. The first and most important objective was to involve project managers into the activities of SPI.

It was easy to detect that the first improvement effort was already forgotten and the improvement ways were abandoned. The SW-CMM model, specifically Level 2, was again introduced to the project managers, this time in a new light, emphasizing the need for their involvement in the process definition and implementation. As it turned out, it was too early to talk about specific procedures or implementation details, because project managers needed more extensive knowledge of the model's goals and requirements. A series of meetings were conducted to discuss recommended SW-CMM practices and how to reflect them in the organization.

As it was decided to implement KPAs one by one, the priorities were assigned. Software Project Planning and Software Project Tracking and Oversight were identified as the highest priority areas. By large extent it was because of the management's need to have more visibility into the software process and to receive more accurate data for resource management. Requirements Management and Software Configuration Management were considered important too, while Software Quality Assurance and Software Subcontract Management received the least priority.

This first phase lasted nearly six months. As a result the goals and practices for the Software Project Planning Area were examined and at the end of the year the Project Planning procedure was prepared and approved. The most important aspect is, that project managers, being involved in the process from the beginning, are concerned with the successful implementation.

Steps planned for the next phase include assessing current projects according to the procedure and preparing an action plan to raise the level of conformity.

The biggest achievements of this phase are:

- ensured participation of the project managers;
- established structure of the decision making;
- received commitment to follow the Project Planning procedure.

5. Issues and Questions

Here are presented the main issues and problems encountered in the improvement efforts.

5.1. Organizational Scope

It should to be noted, that the SPI effort was and is still carried out in the context of one department – Software Project Department – only.

It is quite justified, because the organization has a strict and precise structure, where each department has well defined functions, responsibilities and relations to other departments. In the context of SPI Software Project Department might be considered a closed entity – "organization" in terms of SW-CMM.

Software Project Department is not the only department developing software. The top management is supporting SPI initiative and keeps a close watch, and, in the case of success, the new methods are planned to be transferred to other departments as well.

This situation has the benefit of having to deal with smaller problems. However, it brings some risks too:

- Because the initiative is not carried out organization-wide, the project managers don't feel assured, that the decisions made, and procedures created, especially when they somehow involve other organizational units (for example. relations with the Sales and Marketing Department), will be supported. This way they are less motivated to change.
- By involving only one department, there is a risk, that the solutions take into account only this department specific, ant that these solutions will not be ready usable in other departments. It would be better to have participants from all departments, this way minimizing potential rework in the future.

However such participation is not achievable in the current situation:

- SPI process was initiated by the Software Project Department director, and he is still the chief champion behind the effort. But he doesn't have enough influence in other departments, to motivate their project managers to participate.
- Due to the lack of resources only one department could receive top management support, there are not enough resources for all, and sheer interest is not enough, when they have tight deadlines to meet too.

5.2. Organizational Structure

While, as mentioned, the organizational structure at the company level is well defined, the organizational structure inside the department is flat. The situation is rather typical: in small projects, teams usually have a flat structure, resulting in developers being assigned several roles due to scarce resources. This contrasts with the team structure and positions suggested by the SW-CMM practices and makes the implementation of some practices difficult [12].

Although some formally defined responsibilities exist (based more on the personal skills and career ambitions of individuals, not on the structure and needs of the software development), the general attitude can be defined as "we are all heroes – we do whatever needs to be done, the rules don't apply to us

(they just get in the way of getting the job done), we live with short cycle times and high stress" [13].

Another issue related to the organizational structure, is that Software Project department has less than thirty developers and sometimes there is not enough people to fill a formal structure of the SW-CMM. For example, SW-CMM proposes more than 25 groups and organizational roles [11], with various tasks and responsibilities. Most of the time there is not even enough people to fill all the roles proposed.

One of the solutions would be to scale the model down to the needs and possibilities of the organizations size. For the time being another approach was taken – using full SW-CMM model, but adapting (scaling) its concepts on a project-by-project basis. However it was not yet tested.

5.3. Human Factor

While SW-CMM and other models signify management commitment and support of the SPI, our experiences have shown, that it is equally important to involve the project managers into the process.

As SW-CMM level 2 focuses on management, the main users of the improved process will be project managers. There are five project managers in the department, all of them are key individuals in the organization, and have a high influence. Also, each of them has strong opinions, attitudes and expectations of the SPI. Every decision has to be approved and understood by them to the full, because if one of the managers will not approve and not support something, there is not much chance for such a solution to be implemented.

Considering this, a decision was made, that all of the project managers (also new project managers, if they appear) have to participate in the SPI process. Their responsibilities in the SPI project include providing information about methods they use or would like to use in the projects, discussing possible solutions and approving decisions.

One of the highest priority tasks is to motivate the project managers to the SPI. They have to be convinced that it will be useful and they will eventually see benefits in their day-to-day activities of project management.

For now they are only convinced that it "needs to be done", because the management needs it to be done, and they are trying to achieve that changing as little as possible.

Some possible reasons to this may be:

- Inertness and fear of change, as a result, the arguments for the SPI are not adequately considered;
- A belief, that the need to do something "better", means that now it is "wrong", and they can't agree to that ("we are all competent" [13]). In the small company environment this situation is described as the software heroes playing an important role, the need for accompanying processes not being seen [5].
- In the first improvement effort, project managers have already seen that if they persist to refuse, the process eventually dies and with it – the requirements to change something.
- The observations of some other software companies: they (project managers) do not necessarily have a good feeling about research and sometimes they even feel scared when you ask them things; they feel tested or observed [7] – are also pertinent. The project managers fear that they will be judged by the degree to which they succeed in applying new methods.

This incline is countered in several ways:

- Ensuring that everyone participates in the effort. It ensures that all the opinions are heard, and considered. And provides bigger confidence in the process. On the other hand, after participating in several meetings, project managers feel that they should be able and are expected to make some decision. They feel obliged to make decisions.
- After each meeting a report is prepared and project managers sign it off as an evidence that they participated and agree that the observations, opinions, etc., recorded are correct.
- Every decision is also signed off to ensure that it will be supported. The situation is somewhat reversed, because a more natural way is to begin with the "as is" process, not the "should be" process, with an organizational focus on process management and improvement, the "as is" and "should be" processes will converge, resulting in organizational learning [13]. However due to a high number of commitments every project manager has, and to their low motivation, commitment which is not signed is viewed sceptically, and has low chances of surviving. Having all the managers signed off the planning procedure makes sure that they have a strong commitment to adhere to it, and to look for ways to satisfy its requirements.

5.4. Lack of Resources

In large organizations the SPI decisions might be made outside the software engineering unit, but in the small organization employees often expect to be involved in all aspects of the software engineering process, therefore they expect to influence decisions that affect the way they work [10].

As already mentioned, the project managers are the key persons that must be involved in the SPI effort. On the other hand they are extremely occupied in their own projects, and don't have that much attention to give to the SPI. This problem is three-fold:

- In the terms of work-hours, they simply can't spend much time on SPI. For example in the plan for next three months, a goal was set not to

exceed 10 work-hours of a project manager per month.

- In the terms of availability: every project has its needs, moreover, project managers have certain wishes for the time of the meetings, and it often happens, that one or two days are lost, just to ensure, that everyone will be there on time that is convenient enough for all.
- Preparation for the meetings. When the meeting's purpose is to discuss some practices or suggestions, the project managers would be asked to familiarize themselves with the relevant information beforehand. However, due to the fact that SPI is not very high in their priority list, they often failed to meet this requirement, causing even greater loss of time.

While there is not much that can be done to address first two issues, to address the former, the objective has emerged to organize the meetings in such a way that there be no need for prior preparation for the project managers, and that there be a sufficient briefing at the start of every meeting. This means that the steps taken will be even smaller than before, however it should ensure that less time and effort is wasted.

On the other hand, despite tight schedules of the participants, some frequency of meetings should be maintained. Our experience showed, that it is quite possible considering everyone's schedules, and frequent enough to not forget the previous issues, thoughts and considerations, is to meet once in 1,5 week. When such frequency was established, it was noticed, that project mangers started to get used to discussing SPI problems, the communication was easier, and the resistance became not so strong. So, in the coming phases of the SPI it is planned to maintain such a frequency of meetings.

5.5. Lack of Knowledge

One of the biggest difficulties working on the software process is to ensure common understanding of various concepts and practices.

SW-CMM terminology: Due to the lack of software process traditions and terminology there is a threat of misunderstanding or incorrect interpretation of the SW-CMM model.

Best practices: The most common starting point for SPI in a small company is that they have understanding and experience of good practices [16]. However, this is not the case in Sintagma. There is not much experience throughout the organization in what is called “best practices”. It is not easy to discuss different practices, when the group doesn't know and doesn't agree on how these practices might appear applied practically.

On the other hand, project managers are concerned with technical project details most of the time, while working with the model requires more of an abstract point of view. However, it is not acceptable to eliminate them from the process of the decision-making. If there is a need for model scaling, the project managers have to understand it, and to agree on scaling and and other issues.

One of the problems is that they perceive the model as a restriction that has to be followed to the letter, and don't see the ways (considering the size of the organization, really there are few) to do it. This leads to frustration and resistance.

So far the organization has not succeeded in one of the main objectives of the SPI - to stress quality, not CMM compliance [10]. The project managers see “Achieving SW-CMM level 2” as their goal, not the process improvement. While for them it makes it easier to justify their wish not to change anything, however for the SPI it raises risks for useless solutions, made to “satisfy the requirements”.

These problems show, that in our action plan, which to be prepared in the next phase, there should be a lot of time allocated for the education of SPI participants.

5.6. Issues with Process Area Priorities

There was no formal assessment prior to prioritizing process areas the way they were prioritized. There is an opinion, that in some organizations, the problems are evident enough, that there is no need for assessment. However this approach has risks to have priorities randomly ordered.

Our motivation for giving Project Planning and Project Tracking and Oversight the highest priorities, came from the senior management perspective. Ever since the need for the SPI was identified, there was a lack of information from project managers to the senior management, especially considering resource allocation among multiple projects and insight into a project's state.

When there is a shortage of resources for the project, one of the following could be done: use slack time and reallocate resources among projects, delay something or sacrifice some of the requirements, or increase the overall number of the resources. Questions of how this could affect schedule, milestones, budget, or even scope of one or several projects, rises [17]. Information is the key to considering the alternatives and making decisions. However project planning is now in such a state, that plan information is not easily, or not at all transferable from project manager to someone else. Especially there is a lack of information on the long-term effects. Even the project managers themselves might not be able to evaluate it, because some interdependencies might not be apparent.

In such a situation it might happen that fire fighting in one project would result a chain reaction of fires in the projects, that resources for the fire-fighting were taken from.

Also sometimes there are situations when the resource is not fully utilized, which while not causing fires, might be even harder to deal with, trying to gain as much use as possible from the free resource.

Not mentioning the fact that information is vital for solving these problems, furthermore they need to be solved pro actively rather than reactively, and for this the information is needed even more. This is where project planning should help.

As for the insight into a project, the statement can define the problem that "the projects are 90% finished, 90% of the time" [17]. This situation is not satisfactory, and the senior management wants to receive information from project managers about what are the tasks for the project, what are their estimated durations, and costs, what tasks are completed etc., to have a justification of that "90%". During the first improvement effort, the so-called "project report" was adopted from IBM internal procedures, which all the managers had to complete periodically. The report contained enough information for the management, but was rather lengthy, did not require constant tracking of the project, just "on the occasion", when the report had to be completed, and was mandated "from the above" and considered not useful for the project managers. When the pressure to use it seized, the report was quickly abandoned. This is where project tracking and oversight is expected to help.

There is a problem with this approach, that the project managers themselves don't see the immediate use for them in these process areas. They see it as a additional task they will be required to do. There is a closed circle of – to accept it they have to try it, to try it they have to accept it. So there is a risk of low project manager input due to the lack of motivation. Had there been an assessment of the problems, the resistance might be lower, because it would be evident that the decisions address the problems. But on the other hand the scope and effort of the assessment might have been too big to justify the impact, because this is not the only cause of the low motivation.

6. Conclusions

This paper describes what is considered a small software organization, and what are the main challenges of such organizations regarding the SPI effort. Most Lithuanian IT organizations can be classified as small in terms of size. This case-study of one Lithuanian IT company shows, that most small company issues may be pertinent to the Lithuanian IT organizations.

The organization of the case-study encountered most of the issues common for the small organizations, especially the lack of resources, key individuals having high influence, the flat project management structure and the need to adapt the software process model used as the SPI basis to the needs and capabilities of the organization.

One of the most important small organization issues – the need for investment – was not mentioned as an important issue of the case-study, but it was mentioned as an issue which was rather painful to understand.

Some differences between "typical small", and the case-study organization were pointed out, for example, understanding and experience of good practices.

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