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TOWARDS MATURE SOFTWARE PROCESS [1]

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Abstract. Software process maturity is strongly linked to the success or failure of the projects. It is also closely related with the quality of the products and the efforts necessary to develop them. Software process improvement and certification is very important for Lithuanian IT companies seeking to increase the export of their software products and services. Public procurement of IT products and services desiderates impartial criteria for supplier selection. This paper provides analysis of current situation in Lithuania and the initiatives taken in the software process improvement area. Special attention is paid for the project performed by Vilnius University, Kaunas University of Technology together with leading Lithuanian IT companies Alna and Sintagma seeking to provide methodology and tools supporting assessment, definition and implementation of mature software process.

Keywords: Software process, process model, process improvement, process maturity and capability.

1. Indroduction

Almost forty years ago the software development situation was named as software crisis so indicating sore problems with budget, schedule, and quality. Almost twenty years ago it was understood that there is no silver bullet for the solving of software related problems [1]. The main question „why software projects fail?“ was unresolved; it appeared that even smart tools did not help to decrease the number of over budgeted, underestimated, or even failed projects. The research emphasis was shifted to organizational and methodological matters.

Software process engineering is accepted as a most achieved software engineering area during last decade. Investigations in software process maturity allowed to get deep insight into software activities, define management of a software process, define quality of a software product through the quality of a software process, and introduce sound software process models helping assess and evaluate both software process and organization producing software in general.

The research achievements are noticeable but the problems of the software projects are still very actual and sharp.

As the CHAOS research performed by the Standish Group [2] shows, although the part of successful projects – completed on time and on budget, with all features and functions originally specified – is rising the part of challenged projects remains almost the same. As challenged projects there are classified the projects completed and operational, but over-budget, over the time estimate, and with fewer features and functions than initially specified. Figure 1 provides the data on the 30,000 projects tested by the Standish Group.

2. The Value of Maturity

Every action taken must help the organization to achieve its goal. Usually, any action in business is qualified according to its return on investment (ROI) computed in terms of cost of the effort relative to the expected benefit. However, businesses find that the

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notion of ROI goes well beyond expenditures and earnings in dollars because so many important quality attributes (such as safety, security system stability, and etc.) have a greater value than dollars and cents [3, 4].

The higher maturity results in cost savings, reduced time-to-market, enhanced quality, and improved predictability in meeting cost and schedule estimates. This is evidently shown in Figure 2 where statistical data for 1,300 completed projects are presented [3]. The projects were of the size of 200,000 lines of code, and the costs were calculated using a rate of $110,000/year per developer. An organization gains significant benefits by reaching higher level of maturity, for example, the average level of efforts spent by 2nd level organization is ~4 times less than needed for 1st level organization for the same size project, and 2nd level organization leaves even ~5 times less defects than 1st level organization. There are no doubts which of these organizations would be preferred by the customers.

Another important aspect is the time needed for moving to higher maturity level. According to the last statistical data [5] provided by Software Engineering Institute (SEI), for organizations that perform the CMM-based software process improvement, the median time to move from:

- maturity level 1 to 2 is 22 months;
- maturity level 2 to 3 is 19 months;
- maturity level 3 to 4 is 25 months;
- maturity level 4 to 5 is 13 months.

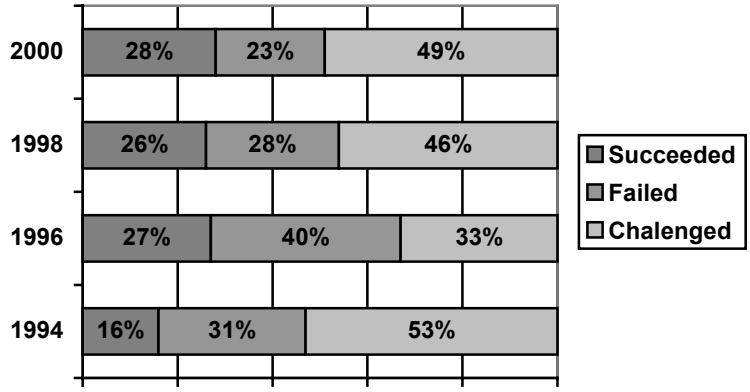

Figure 1. Project Resolution History (1994-2000)

Organization's CMM level	Calendar Months (duration)	Level of Effort (person months)	Number of Defects Shipped	Median Cost ($M)	Lowest Cost ($M)	Highest Cost ($M)
Level 1	30	600	61	5.5	1.8	100+
Level 2	18.5	143	12	1.3	0.96	1.7
Level 3	15	80	7	0.728	0.518	0.933

Figure 2. CMM[2] Project Statistics for a 200,000 LOC Development Project

3. Situation in Lithuania

Not so long time ago Lithuanian IT companies began to make steps towards externally recognized quality. In 2000, the first Lithuanian IT company "Sidabrinis tinklas" has been certified according to ISO 9001. During the last years this process has got significant acceleration: quite a few Lithuanian IT companies have already certified or are in progress certifying their software development activity according to ISO 9001. Investments into quality are forced by growing competition and customer requirements. Lithuanian IT companies striving to enter European Union and the foreign markets should demonstrate for the potential customers their ability to develop the software of required quality.

Leading IT companies have already recognized that application of a general quality standard ISO 9000 is not enough to title an organization as spending "sufficient" means on product quality. The few companies have started investigation of possibilities to use the specific standards – software process maturity models, such as CMM, CMMI, and ISO 15504 (SPICE). But most of the Lithuanian IT companies perhaps know that such exist but have not identified the need to follow them. It should be noticed that several IT companies have chosen another approach: they have started to rearrange their work according to particular process models, such as RUP (Rational Unified Process) and XP (eXtreme Programming).

Reorganization of the company process in accordance with the standards requires not only enough long preparation, including understanding of the

[2] CMM – Capability Maturity Model

standards requirements, documentation of the current way of work and mapping with the requirements, but also investments into personnel training, new method material, process measurement and so on. Therefore, only the biggest and financially strongest Lithuanian IT companies would be able on own to improve their process.

Exploring software process investigation and improvement initiatives in Lithuania, it will be observed the Baltic Software Metrics Association (BaSMA) established in 2001 seeking to propagate the best practice of software engineering and management, to stimulate software measurement activities and to organize data collection and exchange. More than 15 IT companies from Lithuania, Latvia and Estonia became the members of BaSMA. Unfortunately, the vital activity of the association lasted only about a year.

The similar mission – to support enterprise objectives through the development, provision and promotion of research, standards, competencies and practices for the effective governance, control and assurance of information, systems and technology – is strived by Information Systems Audit and Control Association (ISACA) and its Lithuania Chapter that was established in 2002 and now embodies the representatives of more than twenty companies and organizations. But ISACA activity is not pointed to software development, it more emphasizes IS audit, management, quality and security assurance.

Information Society Development Committee under the Government of Republic of Lithuania put stress on the need of the methodology that could be used in the public procurement tenders for the determination of the capabilities of IT products and services providers because currently used criteria mainly based on financial indicators are not able to guarantee the qualified implementation of IT projects.

Seeking to compete successfully in the international market Lithuanian IT companies should be able to join their forces to implement projects of needed size. Infobalt – association of Lithuanian information technology and telecommunication (ITT) companies – has started in 2004 a new project Outsource2Lithuania. The goal of the project is to achieve that the Lithuanian ITT companies take the leading position among the providers of ITT offshore outsourcing service in Europe. Currently seventeen ITT companies have joined the project.

The defined software process is one of the essential prerequisites for the companies forming effective common project teams.

It will be observed that Vilnius University and Kaunas University of Technology have already included the software process related courses into study programs, mainly at master level. However the academics have identified the lack of the practical experience in the real companies and projects.

4. Academic-industrial initiative

In 2003, Vilnius University, Kaunas University of Technology together with leading Lithuanian IT companies Alna and Sintagma have initiated the project that seeks to establish preconditions for Lithuanian IT companies to increase export of their software products and services by provision of methodology and tools supporting assessment, definition and implementation of mature software process that will enable to create software products and services of higher quality, to certify companies according to internationally recognized standards and to disseminate information on software process improvement achievements of Lithuanian companies among potential customers in export markets. Lithuanian State Science and Studies Foundation supported this project. It was entitled in Lithuanian PKP BRANDA where PKP is abbreviation of Software Process and BRANDA means Maturity.

The project participants have already had several years of experience: universities staff in the theoretical software process modeling whereas IT companies in software process models implementation.

4.1. Experience of the companies

First, it should be noticed that before starting the specific software process assessment and improvement investigations Alna and Sintagma have already received the ISO 9001 certificates. It would be wrong to name ISO 9001 as required precondition in general but Lithuanian situation is such in the most cases. One of the reasons is that ISO 9001 certification is often included in public tenders as desirable or even required criterion. ISO 9001 certificate means that the company already has experience applying standards requirement, defining and changing the business processes. This has been taken into account later in the project when developing the guidelines for process capability evaluation and improvement.

The companies' decisions to improve their software process were caused by both internal and external reasons: the demand to accumulate the company's knowledge and experience and to spread best practice among company's personnel so making the work more efficient; more and more potential foreign customers have requested to prove ability to perform their projects by providing information on software process whether it is defined and followed, how the process improvement is carried out.

Both companies have selected Capability Maturity Model for Software (SW-CMM) [6] as the basis for the own software process improvement. The determinant reason for such decisions was accessibility of the CMM material: CMM itself and plenty of additional information on its implementation, experience of other companies and various statistics are freely available on internet. In addition, SW-CMM is the simplest model.

The experience of Alna and Sintagma has proved yet again some essential principles. First, the software process improvement is not possible without necessary management support, it is generally impossible to make significant changes without support from the very top. Second, the software process improvement should be organized as internal project that as every project is planned, tracked and has needed resources allocated. This project should have enough high priority and it is very desirable to have at least one person dedicated for this project. Third, the software process improvement is complicated, resource consuming and long-term project.

The companies have chosen different approaches for the improvement of their software process. The evolutionary approach selected by Alna supposes gradual definition and improvement of the work procedures trying to accumulate the best experience in the company and to involve into process definition all related staff. Tangible advantage of such approach is that personnel involved into process definition are so committed for its success. But evolutionary approach requires substantially more investments.

Sintagma has chosen revolutionary approach that predicts the definition of unified work procedures by the members of small software improvement project team and then implementation of these procedures in the company. The inevitable problem in this case is the inertness of employees and their reluctance to accept measures proposed by others.

The experience shows that there is no single recommendation for the approach selection and the decision should be made taking into account the management traditions in the company, human factor, the size of the company and other issues.

Both companies have identified the need of external assistance in software process assessment and improvement. Therefore, they readily join the united project.

4.2. Software process model selection

The first fundamental decision that had to be made in PKP BRANDA project was the selection of suitable software process maturity model.

Software process maturity model serves as a foundation for the process definition, assessment and improvement. It should assure the usage of the same concepts, relevance with the best software engineering practices and compatibility with internationally accepted standards.

Software process modeling examines two aspects: the activities of software product development or services provision and these activities' characteristics that describe how sound they are performed, i.e. ability to meet the defined schedule, cost, scope, and quality goals.

When defining the requirements for the software process maturity model oriented at the local conditions, the decision has been taken that it should be compatible with the following internationally accepted models ISO/IEC 15504 [7], priory known as SPICE [8], and Capability Maturity Model Integration for Software Engineering (CMMI-SW) [9,10].

All software process maturity models could be classified according to their architecture (representation) into staged and continuous.

The staged representation model is intended for the assessment of the maturity of entire software process and it defines five stages (maturity levels) of sequential process improvement. The assessment result for the organization (its entire software process) is a single rating (maturity level) that allows comparisons among organizations.

The continuous representation model is intended for the assessment of the capabilities of each named process (process area), such as requirements elicitation, software design, configuration management, and etc. In this case, the assessment result for the organization is the process profile consisting of capability levels for each named process (process area) so identifying most straggle named processes. Though the capability of each process is assessed separately but this does not mean that processes are not related to each other and it is not possible to improve one process without improving associated processes.

There is no unequivocal answer which software process model architecture is more suitable. The criteria of model particularity and purposes of its application should be employed. The staged representation model is more suitable for the marketing purposes because it provides for the organization a single rating that is enough evident for its potential customers and it is easy to compare process maturity of the different organizations but it is not enough detailed and flexible because it offers a solitary sequence of improvements and does not allow to measure software improvement in more detail. The continuous representation model allows selection of the order for process improvement that best meets the business objectives of the organization but is more complicated to compare the maturity of different organizations. So, if the main purpose is software process improvement the more suitable is continuous representation model.

There is a need to emphasize that the models of different representations are not incompatible, i.e. there is a possibility to map them [11, 12].

Based on the analysis of software process investigations and practical experience of Lithuanian IT companies in software process assessment and improvement, the continuous architecture has been selected and the model worked out by PKP BRANDA project was based on the ISO/IEC 15504 previewing possibility to convert the results of assessment using the proposed model to the assessment results according to CMMI-SW staged representation.

4.3. Main results of the project

According to the plans approved the project PKP BRANDA should be finished in the end of 2005 but the results achieved may be already discussed.

Requirements definition was the first stage of the project. When defining the requirements for the software process maturity model, the essential aspects taken into account were the completeness, suitability for the process improvement in Lithuanian IT companies, the level of abstraction and compatibility with existing standards. There have been worked out the guiding principles of process capability evaluation depending on the purpose (process improvement or supplier selection), scope (partial or comprehensive), and performer (internal or external assessors). The requirements for the software process assessment, implementation and support tools have been elicited.

The second stage of the project was devoted for the development and piloting of the software process model, methodologies and tools. First, the detailed definition of the software process maturity model, which is compatible with ISO/IEC 15504, was worked out. The main purpose strived in the model description was to narrow the distance between the model's terminology and the practice of the Lithuanian IT companies. Then the assessment methodology according to the model defined was prepared.

The proposed methodology for mature software process implementation is based on the incremental improvement of company's software process concept. Despite the theoretical possibility of other approach it could be applied in practice only for newly established company. There are defined in the methodology main steps of software process improvement and recommendations for their implementation, the most common problems and their resolving techniques are highlighted.

Running trials in the companies participating in the project has tested the methodologies developed. The pilot projects have proved the essential suitability of the methodologies for the Lithuanian IT companies but at the same time the imperfections of methodologies application in practice have been identified: the usage of the methodologies still requires enough deep knowledge of the software process model and know-how of its application. The experience gained capacitates to improve the methodologies by supplementing with examples of the application and additional recommendations.

The prototype version of the tools supporting implementation of mature software process has been developed. It will be observed that the current prototype already has some advantages against the existing commercial and open-source similar purpose tools. The prototype has already helped the project team analyzing and improving the software process model. The techniques implemented in the prototype allow further enhancement of the tools and the final system could become a competitive product for the software development industry.

The results of the project have been presented and discussed at various events: the sections dedicated to software process maturity have been organized in the conference Information Technologies 2004 and 2005; the results have been presented on the international trade fair of information society technologies INFOBALT; the number of seminars has been held for the members of the project Outsource2Lithuania. Interaction has shown that Lithuanian IT companies progressively perceive the software process related matters; they have expressed interest in results of the project, especially in the opportunity to apply them in practice. Also the progress of the project interests Information Society Development Committee under the Government of Republic of Lithuania and Public Procurement Office under the Government of the Republic of Lithuania that are expecting to use the results of the project when defining the tender criteria for IT products and services providers.

5. Conclusions

Software process research and practical experience provide the standard models and best practices for their implementation worldwide but the regional factor in software process assessment and improvement should be also taken into account [13]. Therefore, investigations of the influence of local situation, tradition, cultural and other issues are important.

Analysis of the situation in Lithuania and experience of the leading IT companies have shown that the IT companies need the public sector support and the coordinated efforts in software process improvement.

The case, when IT companies take the software process improvement path already having ISO 9000 certification, is quite typical in Lithuania and requires specific investigation.

The project performed by Vilnius University, Kaunas University of Technology together with leading Lithuanian IT companies Alna and Sintagma has positively influenced the state of the art in software process improvement theory and practice in Lithuania. It has raised Lithuania IT companies' awareness of software process. The project has contributed to the achievements of Alna that became the first Lithuanian IT Company certified at Level 2 according to SW-CMM v1.1 in 2004.

The project has reached the stage of practical validation of the research results, after which verified and validated methodology and tools for implementation of mature software process will be handed over to Lithuanian IT companies.

Real cooperation among academic institutions and Lithuanian IT companies has been embodied in the project.

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