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## **THE DEVELOPMENT OF A LOW-OVERHEAD ASSESSMENT METHOD FOR IRISH SOFTWARE SMES**

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### **ABSTRACT**

This paper describes the development of 'Adept', a low-overhead method of software process appraisal specifically targeted at Irish software small-to-medium-sized enterprises (SMEs). The method explicitly focuses on organisations that have little or no experience of software process improvement (SPI) programmes. Historically, it has been difficult for software SMEs to find the resources, in both time and money, necessary to engage properly in SPI. To alleviate this, we have created a low-overhead and relatively non-invasive solution to support SMEs in establishing process improvement initiatives. The paper initially describes how Adept was developed and then illustrates how the method is currently being extended to include an on-line tool that may be used by the appraised organization to perform follow-on self-assessments.

**Keywords:** Software Process Improvement (SPI), Self-Assessment, Management, SMEs, Software Process Assessment Method.

### **INTRODUCTION**

The software industry in the Republic of Ireland is a key component of the national economy. According to Enterprise Ireland (the Republic's economic development agency for indigenous business) at the end of 2004, Irish-owned software businesses comprised over 750 companies employing almost 12,000 people [6]. The great majority of these Irish-owned software firms are Small to medium-sized enterprises (SMEs) where it is calculated that only 1.9% of these firms employ more than 100 people whilst more than 60% of the total employ 10 or fewer [5].

During the late nineties the SPIRE (Software Process Improvement in Regions of Europe) programme applied the SPICE model to a variety of SMEs [13]. SPIRE case studies reported positive experiences within

Irish SMEs who liked the ability to choose SPICE process areas that were directly related to their business goals. However, research indicates that only a small percentage of Irish indigenous software development companies have implemented formal SPI assessment methods [11]. One such study emphasises that indigenous Irish software companies are reluctant to engage in formal SPI assessments because of the high cost and resources involved [4].

The picture of the software industry in Northern Ireland is similar. The findings of a survey, carried out by the Centre for Software Process Technologies (CSPT) showed that 71% of the software companies in Northern Ireland are indigenous with two-thirds of those employing fewer than 20 people [11]. The CSPT survey captured information from fifty-six software development organisations within Northern Ireland. These organisations together employ approximately 80% of the total software engineers in the region. Significantly, 46% felt that formal

SPA methods were too cumbersome and expensive, and favoured a less costly (both in terms of employee resource and finance) method, such as Class C CMMI® [10] appraisal methods.

In terms of ensuring the competitiveness and success of the indigenous software industry of the entire island of Ireland, both EI and Momentum (the Northern Ireland ICT federation) are currently engaging member companies in SPI initiatives. The Adept assessment method [9] was developed as a result of a meeting between the authors and EI in relation to how a culture of SPI could be instilled into Irish software development organisations. Initially, therefore, it was important to understand the current state of software practice within these companies and from this an assessment method was developed that could diagnose any weaknesses in a company's software process. This diagnosis would then form the foundation from which to base a path for continuous SPI that would make the company more effective in fulfilling its business goals.

## EXISTING SOFTWARE PROCESS ASSESSMENT METHODS

In order to provide guidance to our development of an assessment method that would be suitable for the Irish software industry we looked at some preliminary results from the Irish market [4] and performed a literature review of software process assessment methods used within other regions. We discovered that such assessment methods are generally based upon one of two process models: (i) ISO/IEC 15504 [7] and (ii) CMMI® [3].

We decided that the Adept method should be designed to adhere to 8 of the 10 criteria outlined by Anacleto et al. [1], for the development of lightweight assessment methods. Therefore the following criteria are adhered to by the Adept method: *low cost, detailed description of the assessment process, guidance for process selection, detailed definition of the assessment model, support for identification of risks and improvement suggestions, conformity with ISO/IEC 15504, no specific software engineering knowledge required from companies' representatives, and tool support is provided.* The exceptions being that *no support is provided for high-level process modelling* and the method is not made publicly available.

## REQUIREMENTS FOR THE ADEPT ASSESSMENT METHOD

From investigating other assessment methods, and the experiences gained by one of the authors with using the EPA method, Adept was designed to adhere to 8 of the 10 criteria outlined by Anacleto et al. [1], the exceptions being, Support for high-level process modelling and Public availability. However, Enterprise Ireland (representing the Irish SMEs), requested that Adept also take into account the following factors:

- Improvement is more important than certification and a rating is not required;
- Minimal preparation time should be required by the company;
- The assessment should be performed over a short period of time;
- Companies should be able to select assessment in process areas that are most relevant to their business goals;
- Whilst the assessment will be based upon both the CMMI® and ISO/IEC 15504 models, the SPI models should be invisible to the SMEs that are being assessed.

## THE ADEPT METHOD

Though based largely on the structure of the EPA, Adept also supports the following:

- The development of a SPI path, based upon a company's business goals, from the findings report that is produced as a result of the assessment;
- The inclusion of a stage that involves revisiting the company after a period of 3 months and re-assesses the company's SPI path;
- A generic approach. It does not highlight either CMMI® or the ISO/IEC:15504 SPI models but rather refers to general SPI, thus focusing on improvement rather than certification;
- The incorporation of Agile methodologies as possible SPI recommendations;
- Reduced resource requirements. For example, Stage 1 (Develop Appraisal Schedule) and stage 3 (Conduct site Briefing) of the EPA method, though both covered in Adept, require only half the time to perform.

## Selecting an SPI Model

The main aim of the Adept method is to encourage SPI based upon the generic SPI principles that are shared by both CMMI® and ISO/IEC:15504. So to progress Adept we had to decide whether to:

- a. Develop a completely new model that would contain new process areas based upon input from both the CMMI® and the ISO/IEC:15504 models;
- b. Base the Adept method upon relevant process areas from the CMMI® model and include input from the ISO/IEC:15504 model;
- c. Base the Adept method upon relevant process areas from the ISO/IEC:15504 model and include input from the CMMI® model.

As Irish software development companies have greater awareness of the CMMI® model [11], option (b) was preferred to option (c). Additionally, option (a) was ruled out due to the effort that would be involved in developing both a new assessment model and an assessment method. Therefore Adept consists of an assessment component for each CMMI® process area that is deemed applicable for Irish SMEs. However, even though each assessment component adopts a CMMI® process area name, it will provide equal coverage of both the CMMI® and ISO/IEC 15504 models by containing questions that relate both models.

## What Process Areas should the Adept Method Assess?

The next important key decision in the development of Adept was to decide what process areas are most applicable to the Irish software SMEs. Based on previous research into software processes with Irish SMEs [2,4,12] and the involvement in EPA, we decided to investigate the potential benefits to software SMEs of each of the process areas within the CMMI® model.

## What CMMI Maturity Level 2 Processes should be Included?

Maturity level 2 of the CMMI consists of 7 process areas. Upon investigation, six of the seven process areas were selected as they constitute the engineering management basis of an organisation and the foundation upon which an efficient software company is based [14]. On this basis, Adept includes assessment components for each of the following CMMI® level 2 process areas: *Requirements Management; Configuration Management; Project Planning; Project Monitoring & Control; Meas-*

*urement & Analysis; Process & Product Quality Assurance.* We omitted the seventh CMMI® process area at maturity level 2 (*Supplier Agreement Management*), as previous research [14] indicated that it would not be as beneficial, as other process areas, to Irish SMEs. Therefore, Adept does not attempt to provide any form of rating.

## What Higher Level CMMI Processes should be Included?

Maturity level 3 of the CMMI consists of 14 process areas. Upon investigation [4,10,14], six of the fourteen process areas, *Requirements Development; Technical Solution; Product Integration; Verification; Validation; Risk Management* were deemed applicable for Irish software SMEs and an assessment component for each was included. The process areas listed at CMMI® maturity levels 4 and 5 would be of less benefit to companies that have little or no experience in SPI and therefore an assessment component for these was not required. Therefore, in total, Adept will enable an assessment to be performed in 12 process areas.

## Should assessment in certain process areas be given priority?

While all 12 process areas may be assessed using Adept, four will be mandatory - *Requirements Management; Configuration Management; Project Planning; Project Monitoring & Control.* These process areas are critical to the success of any software development company. The choice of mandatory process areas was based upon the overlap of three factors. Firstly, priority was given to the process areas that are deemed to be the foundation of the CMMI® model. Second, priority was assigned to the process areas in which SMEs would gain most benefit [14]. Thirdly, research in Ireland has shown that these specific processes are seen as important by software SME managers [2,4,12].

## How many process areas should be assessed within a single Adept appraisal?

In an attempt to reduce the cost and time associated with the assessment, on-site interviewing should be restricted to one day. As such, we decided to limit an Adept assessment to six process areas as this is as many as can reasonably be covered within one day [14]. So, in addition to being assessed in the four mandatory process areas, companies will also be able to choose two of the other process areas. Based upon previous research into the

applicability of process areas to software SMEs [14], companies will be advised against initially selecting either the *Measurement & Analysis* or *Process & Product Quality Assurance* process areas unless they are directly linked to their business goals.

### The Stages of the Adept Method

Adept is divided into eight stages. The appraisal team consists of two assessors who conduct the appraisal between them.

Stage 1 (*Develop Appraisal Schedule and Receive Site Briefing*) is a preliminary meeting between the appraisal team and the software company wishing to undergo an SPI assessment. This stage consists of two parts. The first part involves establishing the logistics, selecting the most applicable process areas and determining the schedule of the appraisal. The second part is used by the appraised organisation to explain elements of the company structures to the appraisal team, who learn a little about the company's history, the company's business objectives and about the types of ongoing projects, along with the lifecycle stage that each project has reached. This meeting involves 2 assessors and at least one representative from the company. This meeting lasts approximately two hours. Therefore 4 person-hours of assessor time and at least 2 person-hours of company time are normally required for this stage.

During stage 2 (*Conduct Overview Briefing*) the lead assessor provides an overview of the method for members of the appraised organisation who will be involved in subsequent stages. This session is used to remove any concerns that individuals may have and to establish codes of conduct and confidentiality. This overview session involves 2 assessors and on average 7 company staff (the number of company staff involved depends upon the size of the company). The overview typically lasts 1 hour. Therefore 2 person-hours of assessor time and 7 person-hours of company time are required for this stage.

Stage 3 (*Analyse Software Documentation*) provides a brief insight into project documentation. Normally the following documents will be requested: a typical project plan, a typical project progress report, a typical approved requirements statement and any documentation relating to the company policy on configuration management. The primary source of data for Adept is through a series of process area interviews conducted during stage 4. The brief consideration of some sample documents during stage 3 is used mainly to craft further questions for stage 4. This stage will involve 2 assessors and usually 1 member of personnel from the appraised organisation. Typi-

cally, this stage will involve the company member dedicating 1 hour to retrieving the requested documents. The 2 assessors performing the appraisal will each then analyse this data for approximately 3 hours. Therefore 6 person-hours of assessor time and 1 person-hour of company time are required for this stage.

The main part of Adept is stage 4 (*Conduct Process Area Interviews*). In this stage 6 interviews take place with key staff members from the appraised organisation. Each interview is scheduled to last approximately 1 hour. However, based upon the experiences with the EPA in Northern Ireland, interviews for the process areas of *project planning* and *project monitoring and control* typically require 1.5 hours. Therefore 7 hours is required to complete the 6 process area interviews. Each interview involves two assessors, and at least one representative from the company (on average 3 staff are involved) is present for each process area interview making 14 person-hours of assessor time and 21 person-hours of company time typical for this stage. The schedule of the process area interviews should be carefully designed to follow the natural sequence of the software development lifecycle. This will assist the assessors in painting an accurate profile of the software development practices adopted by a company and responses from process area interviewees, earlier in the day, may be cross-referenced in later interviews. During each of the process area interviews, one of the assessors invokes responses from the interviewees using a combination of pre-defined and follow-up questions while the other assessor makes notes. One of the assessors use a tool which enables him/her to record an initial judgement about the responses by judging them against a discrete set of values – Red (not practiced), Amber (partially practiced), Yellow (largely practiced) and Green (fully practiced). In this way, the opinions of the questioner and not just the note-taker will also be recorded for subsequent review.

Stage 5 (*Generate Appraisal Results and Create the Findings Report*) is very much a collaborative exercise between the two assessors. The findings report will consist of a list of strengths, issues and suggested actions for each of the process areas evaluated. Global observations covering all process areas are also covered and the initial judgements recorded in the Excel tool are revised. The findings report is then developed through a review of the interview notes and the scores produced by the Adept tool for each of the 6 assessed process areas. The findings report takes the format of a Microsoft PowerPoint presentation. This stage involves 2 assessors collaborating together for six hours meaning a total 12 person-hours of assessor time is required for both these tasks.

Stage 6 (*Deliver the Findings Report*) involves presenting the findings report to the staff in the appraised organisation that participated in the interviews. This presentation involves the assessors and typically 7 company staff (this depends upon the number of the appraisal participants). The briefing normally lasts 1 hour. Therefore 2 person-hours of assessor time and 7 person-hours of company time are required for this stage.

Stage 7 (*Develop a SPI Path with the Company*) involves collaborating with staff from the appraised company to develop a roadmap that will provide guidance to the appraised company in relation to practices that will provide the greatest benefit in terms of the company's business goals. This stage involves 2 assessors and one member of the appraised organisation working together for 4 hours, thus requiring 8 person-hours of assessor time and 4 person-hours of company time.

Stage 8 (*Re-assess the SPI Path and Produce a Final Report*) involves revisiting the appraised company approximately 3 months after the completion of stage 7 and reviewing progress against the SPI path that was developed in stage 7. The outcome of this stage will be an updated SPI path and a final report detailing the progress that has been accomplished along with additional recommendations. This stage will involve the 2 assessors and one member of the appraised organisation working together for 3 hours. Additionally the 2 assessors will dedicate a further 2 hours to producing a final report in relation to the assessment. Therefore 10 person-hours of assessor time and 6 person-hours of company time will normally be required for this stage. This stage is crucial, as it provides feedback and assistance to the appraised company after a period of time, and assists in compiling research material in terms of SPI experiences.

Table 1 provides a summary of the effort required to complete each stage of the Adept method. Overall, Adept requires approximately 56 person-hours of assessor time and 47 person-hours of the appraised organisation's time. Ideally stages 1 to 7 of the appraisal process are completed over two elapsed weeks, with stage 8 happening approximately 3 months later.

Table 1: Effort Involved in Conducting an Adept Assessment

Stage	Assessment team (person-hours)	Appraised Organisation (person-hours)
1	2	1
2	2	7 <sup>1</sup> (estimate)
3	6	1
4	14	21 <sup>2</sup> (estimate)
5	12	0
6	2	7 <sup>3</sup> (estimate)
7	8	4
8	10	6
Total Effort	56	47

## EXTENDING ADEPT TO ENCOURAGE CONTINUOUS SPI

Adept assessments have recently been performed in several Irish SMEs. Companies particularly liked the fact that no preparation time was required by them prior to the assessment. Some companies mentioned that they would like to be able to engage in continuous process appraisal and that it would therefore be useful if they could measure their progress periodically. Therefore in an attempt to encourage continuous improvement among SMEs we have developed an on-line appraisal tool to enable companies to perform self-assessment of process areas that have previously been assessed using the Adept method.

This tool enables SMEs to self-assess their processes to determine if the capabilities of their software processes have improved as a result of implementing the actions suggested by the Adept assessment team during the initial assessment. The tool is only available to organisations that have previously had their processes assessed using Adept. As the tool is web-based it is easily distributed to companies and eligible companies may access the tool upon demand. This facility enables company personnel to perform a process self-assessment in an informal, flexible manner with minimal preparation time. Using the tool, performing the self-appraisal, for all 6 process areas that were originally appraised in the on-site assessment,

<sup>1</sup> Assuming 7 staff for 1 hours.

<sup>2</sup> Assuming average of 3 staff per process area interview.

<sup>3</sup> Assuming 7 staff for 1 hours.

requires no external assessor time and only a total estimated time of 6 hours from a company employee who attended the initial on-site Adept assessment.

Whilst a company may access the full range of questions that were used in the Adept method by the appraisal team, the company may only access those process areas in which they were previously appraised. The questions within each process area have multiple-choice answers. These range of answers are expressed in terms that do not require an understanding of SPI models (see figure

1). However, a facility is also provided that permits users to enter a free text answer if they feel that none of the options fully equates to their required response. This response is then automatically emailed to a member of the appraisal team who will make a judgement and provide feedback. The tool also enables an appraisal to be performed on one process area, in isolation from other process areas. A process appraisal does not have to be completed in a single session; it may be partially saved and then continued in later sessions.

Figure 1: The Adept On-Line Self-Assessment tool

Records of each appraisal are stored and used to monitor SPI over time. This information is also accessible to the assessment team so that empirical SPI information may be compiled.

### Features of the Adept self-assessment tool

The Adept Self-Assessment tool, which adheres to the Adept reference model structure, consists of a five main parts: *User Accounts*; *Process Area Management*;

*Question Management*; *Perform Process Appraisal*; *Appraisal Assistant*.

The first 3 sections: *User Accounts*, *Process Area Management* and *Question Management* are only visible to the assessment team. The only sections that may be accessed by company personnel are *Perform Process Appraisal* and *Appraisal Assistant*. The *User Accounts* section provides management features for: user registration; checking that the user is authorized; resetting user

passwords; adding user accounts; deleting existing user accounts; amending user accounts; and exiting the appraisal.

The *Process Area Management* section facilitates: the addition of new process areas; the addition of goals/practices within process areas; the amendment of existing process areas; the amendment of existing goals/practices; the deletion of existing process areas and the deletion of existing goals/practices.

The *Question Management* section enables: the addition of new process area questions to practices; the amendment of existing questions; and the deletion of existing questions.

The *Perform Process Appraisal* section enables: the user to access each process area that their company has previously been assessed in by the Adept assessment team; a user to perform the self-appraisal of one or more process areas; the assessment results for a process area to be viewed in either textual or graphical format (after the appraisal is completed); the results of the appraisal to be time-stamped; a copy of the results to be automatically stored for future reference by the assessment team; a user to partially answer process area questions in one session, then save their work and resume during a subsequent session; several users to make separate evaluations of process areas, enabling consistency checking to be performed and thereby increasing confidence levels.

## CONCLUSIONS

The Irish software industry contains many software SMEs which are driven by entrepreneurs and which often lack a quality culture. Research [4,8] has shown that software SMEs are typically not aware of SPI models or initiatives. In such an environment it is very difficult for software organisations to appreciate the global importance of having effective software processes. Part of the problem is one of education where software development managers fail both to understand how to improve their business, and to appreciate their company's technical performance with regard to international standards. To combat this requires an appropriate approach that facilitates education and initiates the engagement of software managers in a quality agenda.

Adept has been developed to assess software processes within Irish software SMEs based upon information that has been obtained from four different sources: (a) by reflecting upon the effectiveness of the EPA method to assess software processes in SMEs within Northern Ireland; (b) through investigating the characteristics of other lightweight assessment methods; (c) from the outcome of a meeting between researchers from DkIT,

Lero and Enterprise Ireland that discussed how a culture of SPI could be instilled into Irish software SMEs; and (d) through research that has been performed by Lero and DkIT in relation to Irish software SMEs. The method is designed as a low-resource assessment model for SMEs that have very little experience of SPI and can therefore help raise the level of SPI education within Irish software companies.

The method relies heavily on information obtained from interviewing company personnel and performs limited cross-referencing checks (due to the limited time available for data collection and analysis). As a result, this approach depends on the willingness of the company to engage in SPI. It is therefore vital that senior management within the company encourage their employees to answer interview questions in a truthful and supportive manner so that the resultant findings report will provide an accurate reflection of the company's strengths and weaknesses within each of the appraised process areas. As the findings report will contain a list of recommendations we strongly advise the companies concerned to actively engage and collaborate with the assessors to prioritise these recommendations into an action plan based upon the company's business goals and aspirations. We have observed that companies disliked appraisal in a complete set of process areas as they felt this may highlight multiple weaknesses which could demoralise staff and severely hinder any SPI effort. Consequently companies have indicated that they preferred to have an appraisal performed using a balanced mixture of well-performed process areas and less efficient process areas.

We are currently performing a series of software process assessments in Irish SMEs using the Adept method. The early assessments indicated that companies liked the idea of using a tool to periodically re-evaluate their processes. We have now developed that tool and look forward to incorporating it into the appraisal process.

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