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Process improvement for small firms: an evaluation of the RAPID assessment-based method

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Abstract

With increasing interest by the software development community in software process improvement (SPI), it is vital that SPI programs are evaluated and the reports of lessons learned disseminated. This paper presents an evaluation of a program in which low-rigour, one-day SPI assessments were offered at no cost to 22 small Australian software development firms. The assessment model was based on ISO/IEC 15504 (SPICE). About twelve months after the assessment, the firms were contacted to arrange a follow-up meeting to determine the extent to which they had implemented the recommendations from the assessment.

Comparison of the process capability levels at the time of assessment and the follow-up meetings revealed that the process improvement program was effective in improving the process capability of 15 of these small software development firms. Analysis of the assessment and follow-up reports explored important issues relating to SPI: elapsed time from assessment to follow-up meeting, the need for mentoring, the readiness of firms for SPI, the role of the owner/manager, the advice provided by the assessors, and the need to record costs and benefits. Based on an analysis of the program and its outcomes, firms are warned not to undertake SPI if their operation is likely to be disrupted by events internal to the firm or in the external environment. Firms are urged to draw on the expertise of assessors and consultants as mentors, and to ensure the action plan from the assessment is feasible in terms of the timeframe for evaluation. The RAPID method can be improved by fostering a closer relationship between the assessor and the firm sponsor; by making more extensive use of feedback questionnaires after the assessment and follow-up meeting; by facilitating the collection and reporting of cost benefit metrics; and by providing more detailed guidance for the follow-up meeting.

As well as providing an evaluation of the assessment model and method, the outcomes from this research have the potential to better equip practitioners and consultants to undertake software process improvement, hence increasing the success of small software development firms in domestic and global markets.

Keywords: software process improvement; assessment-based SPI; ISO/IEC 15504; Small-medium firms.

1. Introduction

Assessment-based software process improvement (SPI) programs are based on formal frameworks and promote the use of systematic processes and management practices for software engineering [1]. These approaches identify best practices for the management of

software engineering. When applied, SPI programs enable organisations to understand, control and improve development processes.

Faced with an enormous choice of methods, tools and techniques, software development managers need evidence that their investment in new practices will produce benefits [2, 3]. Unfortunately, many approaches are adopted 'based on anecdotes, gut feelings, expert opinion and flawed research, not on careful, rigorous software engineering experimentation' [2]. Therefore, researchers are urged to undertake evaluative research involving realistic projects with sufficient rigour to ensure that any benefits identified are clearly derived from the concept in question [2]. Although past studies have discussed issues which inhibit adoption of SPI, empirical research on software process innovation is largely lacking. Consequently, there is insufficient knowledge about which innovations are effective, and which factors influence their adoption. It is vital to understand the processes currently used, and to evaluate the effectiveness of process improvement programs, or investments in SPI are wasted [4].

This paper provides an evaluation of an assessment-based SPI program which was carried out in 22 small software development firms in Australia. The outcomes of the program were analysed as part of a doctoral thesis [5] and aspects of the program have been reported previously [6, 7] . Analysis of the capability levels at the time of assessment and later follow-up meeting revealed that the process improvement program was effective in improving the process capability of many of these small software development firms [6]. An association was found between assessed capability levels and the experience and education level of staff employed by the assessed firms; also, the process capability of firms varied depending on the industry sectors targeted by firms [6]. The readiness of small firms to undertake an assessment-based software process improvement (SPI) program was previously discussed along with the actions taken by the firms and reasons for lack of action [7].

The evaluation reported in this paper is based on an analysis of the documents compiled during the SPI program. The goals of the analysis were to:

- discuss factors related to small-medium software development firms that are inhibitors or incentives to process improvement;
- suggest improvements to the RAPID program.

The next section (§2) explains the background of the SPI program, the assessment model and method. In §3, the method used to evaluate the RAPID program for this paper is detailed. The outcomes of the program are summarised (in §4), and then the discussion (§5) considers issues related to the SPI program. Finally, recommendations are made to small firms and assessors to ensure maximum benefit is gained from investment in SPI programs, and specific improvements to the RAPID program are suggested.

2. Background

Software Engineering Australia (SEA) (Queensland) provided funding for the Software Quality Institute (SQI) to deliver a process improvement program to 22 small software development firms. Some of these firms had previously participated in SQI training, and others had responded to a survey of Queensland software developers conducted by SQI for SEA. Each firm participated in an initial process assessment and the progress of 20 of the firms was reviewed at a follow-up meeting about 12 months after the assessment. Follow-up meetings were not held with two firms as they had withdrawn from the program.

2.1 RAPID Model

The process improvement program used the Rapid Assessment for Process Improvement for software Development (RAPID) model and method [8]. The RAPID method as applied in these studies is based on the Technical Report (TR) version of the emerging international standard for software process assessment ISO/IEC 15504 (SPICE) [9]. The ISO/IEC 15504 standard has been validated through an international series of trials. Due to the resource constraints in small firms, and also the SPI program funding limitations, the assessments were restricted to one day each. To enable each assessment to be performed in one day, the scope of the assessment was narrowed to eight key processes: requirements elicitation, software development, configuration management, quality assurance, problem resolution, project management, risk management, and process establishment. As shown in table 1, all five process categories of ISO/IEC TR 15504 are represented.

Table 1 RAPID processes and process categories

Process		Process Category	ISO/IEC TR 15504 ID
RE	Requirements elicitation	Customer-Supplier	CUS.3
SD	Software development	Engineering	ENG.1
CM	Configuration management	Support	SUP.2
QA	Quality assurance	Support	SUP.3
PM	Project management	Management	MAN.2
PR	Problem resolution	Support	SUP.8
RM	Risk management	Management	MAN.4
PE	Process establishment	Organisation	ORG.2.1

The process capability dimension of the model was also constrained to meet the limitation of one-day assessments. Although SPICE provides for capability levels from zero (incomplete) to five (optimising), only questions relating to levels one to three were included in the RAPID assessment model, enabling rating levels of level 0 (incomplete), level 1 (performed), level 2 (managed) and level 3 (established). The RAPID method collects evidence only by interview, but participants may illustrate issues under discussion by reference to documents.

A set of procedures and templates was designed by the RAPID program manager, the SPICE trials coordinator and key staff from the SQI and included a demographic questionnaire, assessment plan, assessment instrument, assessment report, assessment feedback questionnaire, and final report. Examples of the RAPID questionnaires and templates are provided in [5].

2.2 RAPID assessment procedure

From a pool of nine qualified SPICE assessors, two assessors performed each RAPID assessment, one in the role of team leader and the other as support assessor [10]. The RAPID method places a strong emphasis on the experience and professionalism of the assessors. The initial assessments were conducted from August to December 1999.

At each firm, the owner of the firm or the software development manager took on the role of sponsor for the SPI program by committing the firm to the RAPID program, participating in planning the assessment, and providing staff for the assessment. Firstly, the sponsor completed a demographic questionnaire, then an assessment plan was compiled jointly by the team leader and the support assessor, and agreed to by the sponsor. The team leader and

support assessor conducted one-day on-site interviews with key people involved in managing the software development effort of the organisation. For each of the eight processes examined, the assessors followed the script of the assessment instrument to determine the extent to which the process attributes have been achieved using a four point scale: not achieved; partially achieved; largely achieved; and fully achieved. The capability level (0, 1, 2 or 3) for each of the eight processes was then determined, based on the organisation's achievement of the process attributes. A draft report was prepared identifying strengths, weaknesses, process attribute ratings and capability levels, and an action plan with recommendations for improvement to the organisation. In formulating the action plans, the SPICE approach was used ensuring improvement strategies were based on individual business needs rather than the 'maturity' approach of improvement in defined stages.

The draft report was forwarded to the sponsor at the organisation to confirm that the assessment team had accurately recorded the information discussed. Any changes suggested by the sponsor were discussed and then the assessment report was submitted to the sponsor and SQI. At this time, sponsors were requested to complete and return a feedback questionnaire reporting on the assessors, the value of the assessment, and the usefulness of the assessment. Sponsors were informed that the assessors would not see the feedback forms. The feedback forms were consolidated by a research assistant who was not involved in the assessments. Consolidated feedback was provided to the RAPID program manager and SEA. The feedback questionnaires had been previously validated through Phase 1 of the SPICE trials.

2.3 Follow-up meetings

About six months after the assessment, an assessor contacted the sponsor to arrange a follow-up meeting for each firm. Elapsed time from the initial assessment to the follow-up meeting ranged from 7 to 16 months. For nine of the firms, the follow-up meeting included a formal reassessment of some or all of the processes; the other follow-up meetings were less formal. During each follow-up meeting, the assessor reviewed the action plan with the sponsor to determine SPI progress since the assessment. The final reports for formal follow-up meetings differed from those of the informal meetings by the inclusion of process profiles and capability levels determined during the formal follow-up meetings. In some cases, the extent of the follow-up meeting was limited to a telephone conversation between the follow-up assessor and the sponsor. After the follow-up meeting, a final report was compiled and sent to the sponsor and SQI detailing the extent to which the recommendations had been implemented. Although the firms were not specifically urged to comment on the final report, they were invited to contact the follow-up assessor if they had any queries or comments. None of the sponsors responded with comments related to the follow-up reports. Recently a retrospective analysis of the program has commenced with a view to evaluate the long term effects of the RAPID program [11].

3. Method of Evaluation of RAPID program

This section identifies the materials and methods used, and limitations of the evaluation of the RAPID program. Software engineering researchers are urged to use quantitative analysis focusing on statistical analysis of numerical data, as well as qualitative analysis focusing on textual and numerical data. The use of qualitative techniques with software process research is recommended to provide opportunities for triangulation and synergy [12, 13]. In analysing the outcomes of the SPI program, quantitative methods focused on statistical analysis of

numerical data from the demographic questionnaire, feedback questionnaire and the assessment ratings in the assessment and final reports, while qualitative analysis was conducted on the textual content of the assessment and final reports. It may be tempting to sum the eight process capability levels for each firm to establish an overall measure of organisational maturity, however, the scale for process capability is an ordinal scale and is 'private' for each process. It is not valid to compare level 2 for one process at Firm A with level 2 for another process in Firm B. Therefore, the process capability level for each process for each firm is reported, not the aggregate. The highly structured technique of content analysis was applied to transform the data from the assessment and final reports into tabular form [14], so that lists of assessment characteristics could be compiled such as assessment dates, assessors, and common themes reported in the assessment reports.

Two of the authors of this paper participated in the RAPID program as assessors, and between them participated in 11 of the assessments. The third author was the overall manager of the RAPID program and the first author analysed all of the assessment and final reports, checking for themes identified in the literature, detecting recurring themes, and recording the frequency of occurrence of each theme. In four cases requiring further clarification about dates and format of follow-up meeting, the researcher discussed the reports with the relevant assessor. Although only one researcher extracted the information, the extraction was checked for validity by the RAPID program manager.

It is recognised that interviews and reports may not provided an accurate and complete view of actual practices within the organisation [15], however, temporal and financial constraints precluded further validation of responses. Furthermore, validity could have been improved if two researchers had independently coded the reports, or if the interpretations were confirmed with the sponsors of the firms involved, practices recommended by [16].

4. SPI program outcomes

Table 2 provides information about the firms, their identification numbers, the number of full-time equivalent staff, the elapsed time in months from the assessment to the follow-up meeting, the type of follow-up meeting (formal, informal or no meeting), the outcome status on a scale of one to six, and specific comments about the outcome of the program. The RAPID program identification numbers have been retained to ensure consistency with previous publications and also with the source documents. Information related to firms #6, #10 and #20 is not included in this study as these firms did not participate in the RAPID program.

Table 2 Characteristics of firms and program outcomes

Firm #	Staff FTE	Elapsed time months	Type of follow-up	Same assessor?	Outcome group	Outcome of program
1	8	15	Informal	Yes	4	Business focus changed, sold product distribution rights.
2	4	n.a.	None	No	6	Firm ceased to operate.
3	16	16	Informal	No	4	Adopted new methodology. Processes too new to assess.
4	2	16	Informal	Yes	5	Major non-business issue affected owner.
5	6	7	Formal	Yes	1	Improved QA and PM processes 1 level each.

Firm #	Staff FTE	Elapsed time months	Type of follow-up	Same assessor?	Outcome group	Outcome of program
7	6.5	12	Informal	Yes	4	Relocated. Improved CM process.
8	55	10	Formal	Yes	1	Improved 7 processes a total of 8 levels.
9	5.5	10	Formal	Yes	1	Improved 6 processes a total of 9 levels.
11	7	13	Informal	No	5	Management restructure. Changed business focus.
12	6	14	Informal	No	5	Too busy due to Y2K and GST.
13	12.5	11	Formal	No	1	Improved PR and PE processes 1 level each. GST and Y2K impacted.
14	17.5	14	Formal	No	3	Improved QA, PE processes, and documentation.
15	7.5	13	Informal	No	5	Needed mentoring, difficult to unfreeze current practices.
16	5.5	13	Formal	Yes	3	Increase in staff, # of projects.
17	10	9	Informal	Yes	4	Lost key staff. GST major impact.
18	10.5	9	Formal	Yes	1	Improved 4 processes a total of 4 levels.
19	3.5	11	Informal	Yes	4	Disrupted by break-in at premises. Reduced operation.
21	15	12	Formal	Yes	1	Improved CM process 1 level.
22	65	13	Informal	Yes	5	1 day assessment too brief to be valuable.
23	60.5	11	Formal	Yes	2	Improved attribute. Efforts inhibited by multiple sites.
24	17	n.a.	None	n.a.	6	SEA membership lapsed, no follow-up meeting held.
25	3.5	12	Informal	No	4	Some changes implemented.

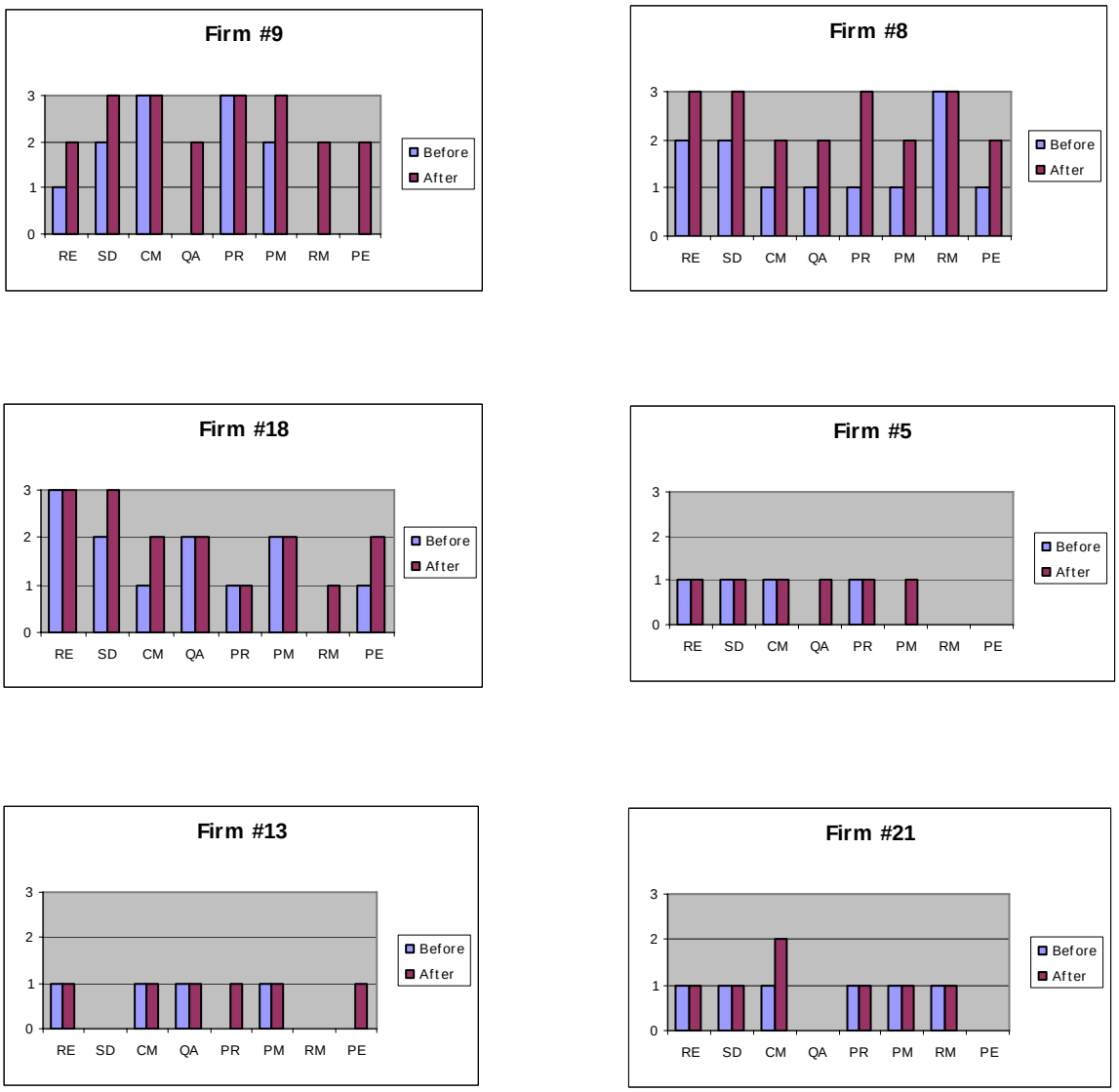
Outcome group. As summarised in table 3, nine firms were formally reassessed, and six of these are allocated to outcome group 1 as they had improved their process capability levels (#5, #8, #9, #13, #18, #21). The other three formally assessed firms are placed in outcome group 2 and 3 as they exhibited improvements, but not enough to gain a higher capability level rating (#23, #14, #16). A further 11 firms participated in the follow-up meetings, but were not formally reassessed. Of these 11 (informally reassessed), six firms reported that they had implemented some of the recommendations (group 3: #1, #3, #7, #17, #19, #25); and five firms did not report any improvement, but provided reasons why the recommendations had not been actioned (group 4: #4, #11, #12, #15, #22). Two firms withdrew from the program: firm #2 had ceased to operate; firm #24's SEA membership had lapsed. A detailed account of the experiences of these firms was reported previously in [7].

Table 3 Extent of improvement by firms - grouped by outcome

Type of follow-up meeting	Extent of improvement	Outcome Group	No. of Firms
Formal reassessment at follow-up meeting	Capability level improved	1	6
	Attribute achievement improved	2	1
	Specific processes improved	3	2
Informal reassessment at follow-up meeting	Limited improvement	4	6
	No improvement	5	5
No reassessment	Withdrew from program	6	2

The six firms in Group 1 increased the capability level of at least one process as shown in figure 1. The extent of improvement varied from the most improved firm (#8) with seven of the eight processes improved, to firm #21 which improved the capability level of one process.

Figure 1 Process capability levels at initial assessment and follow-up meeting for Group 1 firms



Examining the extent of improvement across all eight processes, capability levels improved in all processes, with the process exhibiting the lowest capability at the time of the assessments, process establishment, improving more than the other processes. The process with the highest capability at the initial assessments, requirements elicitation, showed the least improvement. As shown in Figure 1, 22 process instances improved, providing a total overall improvement of 26 levels.

5. Evaluation and discussion

The analysis of the feedback questionnaires, assessment and final reports identified many issues related to SPI for small firms. In this section, insights gained specifically related to the firms participating in the study are explored, as well as issues relating to the plan and execution of the RAPID program. This section discusses the elapsed time from the assessment to follow-up meeting, the size of the firms, the need for mentoring, the readiness of firms for SPI, the role of firm owner/manager, and the advice provided by the assessors. Issues relating to the RAPID method are also discussed, such as the role of the assessor and the need for cost benefit metrics. These issues provide the basis for specific recommendations in the final section (§6).

5.1 Feedback questionnaires

Feedback from the firm sponsors about the RAPID program was gathered through questionnaires and by the follow-up assessors. Although all the sponsors were requested to complete the feedback questionnaires after the initial assessment, only 10 of the 22 firms returned any of the questionnaires. Furthermore, one of the feedback questionnaires was modified during the program so there were two versions of the feedback questionnaires, which made it difficult to summarise the feedback into one coherent set. Tables A.1 to A.3 in the appendix present summaries of all the responses to the feedback questionnaires.

The first feedback form solicited opinions about the competence and behaviour of the assessors. The feedback from 10 firms indicates that as well as demonstrating an understanding of the processes involved, the assessors also displayed an adequate understanding of the business. The assessors acted professionally, did not exhibit bias, and the sponsors felt assured that confidentiality would be not be breached.

The second feedback form focussed on the value of the assessment and received six responses. As shown in table A.2, most firms understood the assessment process, the purpose of the assessment activities, its results and the process profile. All of the six firms who responded to this questionnaire were of the opinion that the assessment was worth the expense and time involved.

The third feedback form used a Likert scale to record perceptions about the usefulness of the assessment. The five responses are summarised in table A.3. Generally, sponsors agreed that the assessment helped the firms to understand areas needing improvement, and also that it provided valuable direction about priorities for process improvement. Two of the sponsors were of the opinion that they needed more guidance about how to go implement process improvement, and there was general agreement that the correct staff were interviewed.

Sponsors from four of the firms provided additional comments on the feedback forms. Positive comments included "overall an extremely competent and observant review of our status" (firm #25); "the assessment method is a very effective/efficient way of introducing young organisations to the business improvement options available" (firm #4); "I would like to see your team again sometime this year to review whether we are heading a right direction in organisational improvement" (firm #23). A criticism from the sponsor of firm #17 was they "would have appreciated a copy of the assessment plan before the assessment day"; and firms #4 and #25 would have liked more information about the SPI concepts and capability level ratings.

5.2 Follow-up reports

The content analysis of the 22 assessment and 20 follow-up reports (detailed in [5]) is summarised in tables A.4 and A.5 in the appendix. This analysis revealed that nine of the firms enthusiastically commended the process improvement program, commenting that it was an effective introduction to SPI; that it provided an accurate review of the current status of development processes; and that it motivated them to improve their planning and documentation. Three firms expressed regret that they were unable to put more resources into implementing the recommendations, but the timing of the program clashed with two urgent deadlines: the modifications for year 2000, and the introduction of the Australian Government's Goods and Services Tax legislation.

Negative comments were made by only one firm (#22). With 60 full-time staff, 2 part-time and 8 contractors, firm #22 was the largest included in the program, and felt that the one-day assessment was too brief to be of any real value.

5.3 Elapsed time from assessment to follow-up

As shown in table 2, the follow-up meetings conducted were either formal reassessments of the capability of some or all of the processes, or an informal follow-up meeting discussing the extent of adoption of the recommendations. To evaluate the relationship between the type of follow-up meeting and the time period from the initial assessment to the follow-up meeting, an independent groups t-test was performed. Firms which were formally reassessed held their follow-up meetings after a shorter time period (mean 11 months) than firms not formally reassessed (mean 13 months), with the difference statistically significant (p=0.026). The extent of elapsed time could have been influenced by how promptly the assigned assessor contacted the firm to arrange the follow-up meeting, but in many cases, firms deferred the follow-up meetings, citing work commitments and pressing deadlines.

To explore the relationship of time period and program outcome, the number of firms in each outcome group was separated according to the elapsed time from assessment to follow-up meeting. As shown in Table 4, the follow-up meetings for all the firms in the highest outcome groups were held less than 12 months after the RAPID assessment. In contrast, all the firms that reported no improvement were followed up after more than 12 months. The implication is that extra time will not result in a successful outcome.

Table 4 Comparison of Number of Firms by Outcome Group and Elapsed Time from Assessment to Follow-up Meeting

Outcome Group	Number of Firms		
	Elapsed Time from Assessment to Follow-up		Total
	<=12months	>12 months	
1 Improved capability level	6	0	6
2 Improved attributes	1	0	1
3 Improved processes	0	2	2
4 Limited improvement	4	2	6
5 No improvement	0	5	5
6 Withdrew from program	No follow-up	No follow-up	2
Total	11	9	20

The finding that a shorter follow-up period may be more effective in this program is in contrast to the conclusion reached by Varkoi [17]. After analysing results from a SPICE-based SPI program involving 20 small firms in Finland, Varkoi [17] decided to extend the time-frame from 6 months for the pilot phase to 12 months for the harvesting phase, although the participants in his study considered two years to be the optimal length for an improvement program.

The RAPID assessment report provided recommendations to the firms based on a six month time-frame. This is consistent with the view held by Debou and Kuntzmann-Combelles [18] who urge that a three to five month time-frame for action plans be considered, and that it is better to adopt a narrow focus of improvement actions. The problem with a six month time-frame is that many firms (such as #3, #8, #16, #23) had designed new processes, but had not yet used them at the time of the follow-up meeting. This confirms the view of Paulk et al. [19] and Krasner [20]: it can take two years for process changes to demonstrate results.

It appears that more research is needed to investigate the optimal time period from assessment to reassessment. Although planning needs to encourage achievement of short term goals, many rewards are not evident until a much longer time-frame.

5.4 Size of firm

Previous research [21-23] suggested that some organisational factors may facilitate the adoption of the recommendations, thereby resulting in greater extent of improvement. Although organisational size has been discussed in many reports, Beecham, Hall and Rainer [24] concluded from their study of SPI problems in 12 UK companies that organisational issues are more of a problem for high maturity firms, and that project and technical problems are the concern of low maturity firms.

As shown in table 5, the very small firms (less than 10 full-time equivalent staff) tended to achieve less successful outcomes in the RAPID program compared to the larger firms. It can be seen from the summary in table 2 that three of the firms (#8, #22, #23) were distinctly larger than the other firms. Two of these firms succeeded in the program, and the third considered a one-day evaluation too brief to be of value.

Table 5 Comparison of outcome by number of staff

	Staff<=10	Staff>10&<20	Staff>20	Total
Outcome=1,2,3	3	4	2	9
Outcome=4,5	9	1	1	11
Total	12	5	3	20

Based on table 5, the effect of staff size on outcome is almost statistically significant (χ^2 test, p=0.083), although with the small overall sample size and some expected cell frequencies less than five (5) there are doubts about the actual significance of the result. Perhaps very small firms need to concentrate on immediate day-to-day business issues and consequently do not have resources available for SPI. Future research is warranted to investigate issues related to small firms.

5.5 Mentoring

Small firms need external assistance in planning and implementation of the improvements as they have scarce resources and limited possibilities to keep up-to-date with the state-of-the-art research and practice [17, 25]. On-going mentoring was not provided to firms although three firms mentioned during the follow-up meeting that lack of mentoring inhibited their SPI progress (#7, #8, #15).

To facilitate the necessary technology transfer for SPI, the role of mentor may be critical to the success of SPI programs. The effectiveness of mentors in SPI programs has been documented with the role of mentors promoted to include 'motivating, advising, supporting, encouraging, teaching, listening, solving problems, calming fears, and assisting in artefact collection' [26]. Herbsleb and Goldenson [27] analysed 138 survey responses from CMM assessed organisations and found that three quarters of these organisations understood what needed to be improved, but needed more guidance about how to improve, and more than half needed more individualised mentoring and assistance. An analysis of 37 high maturity organisations revealed that half of these successful organisations have a 'formal mentoring program to impart skills and knowledge' [28].

The analysis of the process improvement program reported here supports the view put forth by Thong, Yap and Raman [29]: for small businesses operating in an environment of resource poverty, high quality external expertise is even more critical than top management support.

5.6 Readiness for SPI

After analysing reports which indicate that the vast majority of organisations in the US and UK are at the initial level of maturity, Smith et al. [30] assert that it is clear that only a handful of companies are ready for SPI 'because their software health is so bad (that is if they have any development process at all)'. They go on to warn that in order to be ready for SPI, a visible and defined software process must already be in place. The opinion that low maturity organisations find it much more difficult to change and implement SPI is shared by Diaz and Sligo [31] based on these reasons: low maturity firms do not collect metrics; they focus on defining core processes, not on improvement; and it takes a lot of effort to get started to overcome scepticism and to be sure of management support and long term commitment. Other researchers also believe it is pointless to try to implement high maturity processes into low maturity projects [32, 33]. Recently, Rainer and Hall [34] determined that factors impacting on SPI adoption varied for low maturity and high maturity organisations. It would not be surprising if firms with higher levels of capability were better at improvement as they already have experience in developing higher capability processes, as well as an appropriate infrastructure in place to support higher capability.

It is interesting to consider the performance of the five firms (#4, #7, #8, #18, #22) which, at the time of the initial assessment, were rated level 1 or higher for at least seven of the eight processes. In this discussion, these five firms are classed as high capability and the remaining 17 firms are referred to as low capability firms. As shown in table 2, two of the high capability firms (#8, #18) are included in Group 1, having achieved sufficient improvement to increase the capability level of some of the eight processes. Two of the other highly rated firms (#4, #7) experienced seriously disruptive events which they reported prevented them from implementing the recommendations from the assessment. The remaining high level firm, firm #22, expressed the opinion that the RAPID assessment was too brief to be of any value.

However, some of the firms with low initial capability were also successful in the program. The gains achieved by the four low capability firms (#5, #9, #13, #21) in Group 1 were certainly more modest than those of the higher capability firms, but still a notable achievement. Furthermore, seven low capability firms (#1, #3, #16, #17, #19, #23, #25) reported that they had successfully implemented some of the recommendations, citing improvements in terms of defining their methodologies, developing templates, recording problem reports, and formalising testing procedures. There were also unanticipated benefits such as providing the opportunity to review the business goals of the firms (#14). As well as providing funding for the RAPID program, SEA Qld facilitated networking opportunities for local developers through training programs and a special interest group for firms interested in SPI.

Therefore, this research indicates that low-rigour SPICE-based assessments can be effective for small firms with poorly defined processes.

5.7 Role of firm owner/manager

An interesting aspect of the SPI program was the high involvement by the owner of the firm. In 14 of the 22 firms assessed, the 'managing director' or 'company director' was explicitly recorded in the assessment report as attending the assessment interviews. This owner/manager role is a characteristic of small business, for example, 70 percent of Australian small business

owners were classified as full-time operators [35]. However, the program outcomes in this study did not vary depending on whether the managing director was present or not.

Lack of senior management commitment is recognised by [36-39] as a major bottleneck to the success of SPI initiatives, but for most small firms, the business operator is often involved in all aspects of the business and would therefore instigate the SPI and participate heavily in it.

5.8 Role of assessor

It was intended that the follow-up assessments be conducted by one of the assessors who performed the initial assessment, but due to limited SQI staff availability, this was not always possible. In three of the Group 5 firms, the follow-up assessor was not one of the initial assessors. Although not explicitly stated in the follow-up reports, it is believed that if one of the initial assessors had contacted the firm for the follow-up, then the follow-up may have been more effective in terms of providing feedback about improvement progress or lack thereof. The people at the firm had formed a relationship with the two initial assessors, and a level of trust may have been established. To introduce someone new at the time of the follow-up meeting may have caused some anxiety for the firm sponsor, and the staff at the firm may have felt that the new assessor would not understand how the firm operates. They may resent the need to explain everything again, and may also be worried about confidentiality.

Research has shown that 'small firms are averse to consultants and reluctant to seek external help' [40]. This was confirmed by Hall, Rainer and Baddoo [32] who found that companies did not highly value the input of external consultants. Therefore, the assessors, as external consultants, need to develop a relationship with the developers in small firms. One of the lessons learnt in the SataSPIN project [17] was the need for continuous contact, as well as contacting the firms at least once per month, prompting a further recommendation that assessors also make contact with more than one person at each firm.

5.9 Cost benefit analysis

Only one of the follow-up meetings recorded an estimate of the investment made by the firm. Firm #17 reported that the program consumed 155 hours of staff time and included the purchase of Visio software. Most of the firms did not know the extent of resources involved because they did not have a measurement process in place. Low maturity firms typically do not record metrics for effort or defects. Each firm invested time in preparation and involvement in the RAPID assessment and follow-up meetings. At each firm, senior members of the software development teams worked with the sponsor to review the recommendations and formulate action plans. The effort of each firm in implementing the actions varied. Some firms released staff to attend training courses or to evaluate software development tools; others incurred costs to purchase and implement tools.

As evident from the follow-up meetings, the main benefits included improved quality assurance, configuration management, project management and testing. Most firms improved the standard of their documentation, this action quickly returned dividends for one company which lost a key developer. A further important benefit to one company was the competitive advantage provided by quoting the capability ratings in promotional material. Although such benefits are difficult to quantify in financial terms, the firms involved perceived such outcomes as providing real value.

6. Conclusion and recommendations

Based on the issues discussed, two sets of recommendations are formulated to assist small firms undertaking assessment-based SPI, and also to improve the RAPID method.

Recommendations to small firms undertaking assessment-based SPI. From the above analysis of the assessment and final reports, the following recommendations are made to assist sponsors, and also assessors involved in SPI projects:

1. Before commencing SPI, ensure the organisation is stable and not undergoing major disruptions from internal or external events. Despite the lack of a visible and defined process, small firms can benefit from SPI provided they can spare resources to focus on the improvement initiatives.
2. Firms are advised to draw on expertise of external assessors/consultants as mentors.
3. The SPI action plan, derived from the assessment recommendations, should differentiate between short term objectives achievable within the evaluation time-scale, and longer term improvement initiatives.

Improvements to RAPID method. The evaluation of the SPI program highlighted areas of improvement and the following recommendations are made to improve assessments:

1. To nurture a relationship of confidence and trust, assessors should meet the sponsor prior to the assessment, rather than planning the assessment by phone/email. The sponsor needs to be provided with a brief overview of the assessment model and also the assessment plan prior to the assessment. During the time period from the initial assessment to the follow-up assessment, encourage the assessor to contact the sponsor at least on a monthly basis to provide ongoing support and develop trust, and ensure where possible that the follow-up assessor is one of the initial assessors.
2. To overcome the situation where the feedback questionnaires were not returned, it is suggested that the feedback questionnaire is left with the sponsor at the time of the assessment, and the sponsor return the questionnaire with the comments on the draft of the assessment report. Ensure that the feedback questionnaire is returned prior to providing the assessment report to the sponsor. Although the feedback questionnaires had been validated during the SPICE trials, a number of questions need to be reconsidered and reformulated for future use. For example, to suit the response scale, question 8 in table A.1 should read: ‘In your judgement, the assessors who conducted the assessment were competent’. Furthermore, although question 7 in table A.3 (People weren't fully honest with the assessment team) may be relevant in a large organisation with many developers, it is not pertinent for assessments of small software firms in which the sponsor typically participates in the assessment.
3. Include a template for sponsors to record all costs and benefits from the time of the initial assessment to the follow-up assessment. If firms kept a record of SPI effort, costs and benefits, these details could be summarised in the final report, and published as success stories of SPI for small firms. These accounts of SPI success would encourage other small firms to embark upon process improvement. Managers are loath to adopt standards without information about trade-offs between increase in quality and the cost of achieving that quality [41].
4. Although a template for the final report was included, limited guidance was provided to the follow-up assessors. The program could be improved by including a procedure in the RAPID method for the follow-up meeting.
5. Devise a second feedback form for the sponsor to complete at the time of the follow-up meeting. Whereas the initial feedback provides valuable information about the

assessment, comments relating to the follow-up meeting will provide the opportunity to improve the format and protocol of the follow-up procedures.

This research answers the call to reduce the scepticism and uncertainty which exists in relation to the accuracy and usefulness of software process assessments and the improvements based on them [42]. Although there are many published accounts of assessments, there is little reported about reappraisals or follow-up assessments except for large high maturity organisations [22]. Furthermore, this analysis has provided recommendations to improve assessment-based SPI programs, especially for small software development firms. As well as providing validation of the assessment model and method, the outcomes from this research have the potential to better equip practitioners and consultants to undertake software process improvement, hence increasing the success of small software development firms in domestic and global markets.

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Table A.1 Feedback Questionnaire Summary - About the Assessors

Question	Response – 10 responses	N
1. Was it clear why the assessees provided the information that they did during the assessment?	Almost always	6
	More often than not	4
2. In your judgement, was the information provided by the assessees during the assessment within the scope of the assessment?	Almost always	10
3. Were you concerned during the assessment about possible breaches of confidentiality by the assessors?	Sometimes	2
	Rarely	8
4. Did the assessors appear to have any biases during the assessment?	Sometimes	1
	Rarely	9
5. Did the assessors demonstrate understanding of the processes being assessed?	Almost always	10
6. Did the assessors demonstrate an adequate understanding of the OU and its business?	Almost always	4
	More often than not	6
7. In your judgement, did the assessors behave in a professional manner during the assessment?	Almost always	10
8. In your judgement, how would you characterize the competence of the assessors who conducted the assessment?	Almost always	9
	More often than not	1
9. Did you verify the competence of the assessor?	No	3
Additional questions from 2nd version of form	Response – 6 responses	N
10. How closely did the assessment meet your expectations?	Almost always	1
	More often than not	5
11. To what extent did the assessment report reflect the understanding reached at the site visit?	Almost always	2
	More often than not	4
12. How closely do the findings from this assessment reflect your own understanding of your organization's capabilities?	Almost always	2
	More often than not	4

Table A.2 Feedback Questionnaire Summary - Value of Assessment

Question	Response - 6 responses	N
1. Overall, how would you characterize your understanding of the assessment process and its results?	Excellent	2
	Good	4
2. Was the process profile produced by the assessment clearly stated and easy to understand?	It was very clear and understandable	2
	Almost all was clear and understandable	4
3. To what extent did you understand the purpose of the activities that took place as part of the assessment?	The purpose of all the activities was clear	5
	Some of the activities had a clear purpose, but some not	1
4. To the best of your knowledge, within the scope of the assessment, how accurately did the process profile indicate the OU's major problems?	Very accurately	3
	Generally accurate	2
	Not very accurately	1
5. Did the process fail to identify any problems within the scope of the assessment?	Yes	1
	No	1
6. Did the process wrongly identify anything as a problem?	Yes	2
	No	1

7. To the best of your knowledge, how well did the assessment results characterize the OU's strong points?	Very well	4
	Reasonably	2
8. Do you believe that the assessment was worth the expense and time expended?	More than worth the expense and time	4
	On balance, worth the expense and time	2

Table A.3 Feedback Questionnaire Summary - Usefulness of Assessment

Questions 5 responses	SA	Agree	Disagree	SD	Don't Know
1. The assessment provided valuable direction about priorities for process improvement within the OU.	1	3	1		
2. The assessment helped us better understand what needs to be improved.	1	4			
3. We still need more guidance about how to go about process improvement	1	1	2	1	
4. The assessment improved awareness, buy-in, and support for PI among the technical staff in the OU		2	2		1
5. The assessment was impractical; it took too long and cost too much			2	3	
6. The wrong people or projects were selected to participate in the assessment (e.g. people that were interviewed or those who filled up questionnaires)			2	3	
7. People weren't fully honest with the assessment team			2	3	
8. It was easy to understand the processes followed by the OU in terms of the Assessment Model that was used	1	3		1	
9. The assessment Model that was used provides real direction for long-term software process improvement	1	3		1	
10. There are important areas that the Assessment Model that was used does not address		1	1	1	2

Table A.4 Summary of frequency of issues identified by firms through content analysis of assessment reports

Factor/Issue	Number of Firms
Managing Director attended assessment	14
Needed Tools for CM or to enhance /extend existing tools	7
Need system/tool to record/track problems	8
Testing needed to be formalized	10
Shortage of available staff	3
Rely on competent staff and informal standards (rather than documented processes)	13
ISO9000 in progress/complete	5/4
Intranet development underway to enhance communication	5
Current situation OK, but need formalization as growth expected	8
COTS developer	8
None or insufficient measures related to problems (bugs)	8
None or insufficient measures related to development effort	14

Table A.5 Summary of frequency of issues identified by firms through content analysis of final reports

Factor/Issue	Number of Firms
Positive conclusion regarding effects of SPI program	9
GST and Y2K deadlines impacted on available resources for SPI	3
Business problems	7
Staff turnover problems	3
Testing processes improved	7
New processes developed but not yet in use	4
Mentoring would have helped	3