On the Business Impact of Software Process Improvement

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Abstract

This paper describes research on the perceived impact of process improvement activities on the quality of the services provided to the (internal) customers. A questionnaire was developed to map the notion ‘quality of service’ from the point of view from both IT-departments and business customers. These assessments were measures against a subjective scale that runs from ‘insufficient’ to ‘sufficient’. This survey was used in 9 different IT-development organisations, all part of the same holding. On the basis of the internal report on this survey top-management accepted those SPI-investments were providing sufficient benefits and required a repeat at one-year intervals.

1. Introduction

ING is a multinational holding primarily active in the financial services industry. As such it has a large number of subsidiaries most of which have an internal software development organisation. For a number of years now these organisations have been actively carrying out a holding sponsored CMM-program. This study was prompted by a request from holding management for a cost-benefit analysis of this SPI-program in terms of its impact on the ING business. In section 2 the current state of the art in literature on this subject is presented. Section three described the current situation at ING. In section four the goal of the study is further refined and operationalised and in section five the development of the survey used in the study is described. Finally section 6 contains results of the study.

2. Current approaches to assessing SPI

A number of approaches can be identified in assessing (the impact of) software process improvement (SPI) activities. An obvious approach is the standard CMM (or SPICE or Bootstrap) assessment. This approach shows how far along the process of software process improvement has progressed. In itself a useful measure for management both as an indicator of current progress and as an indicator of the next steps to take, this type of assessment provides no answer to the question regarding the impact of the improvement activities.

Two other obvious approaches that are commonly followed are respectively a bottom-up approach (SPI consist of a number of activities which can be assessed individually), and a top down approach (determine the impact on the development organisation as a whole) [11].

The approach for assessing an individual activity (bottom-up) is well documented. The foundation for this approach has been laid by Basili et al [1] in the so-called goal-question-metric (GQM) based experience factory. It exists of identifying the goal of the activity, using this goal to formulate clear measurement goals and elaborating these in metrics, carrying out measurements and to use these data to provide feedback to all involved parties enabling analysis. Reports on this approach can e.g. be found in Latum et.al. [6] and Veenendaal and Zwan [10]. Within the context of this study a GQM-based measurement system was set up for a subsidiary of ING. One of the first activities was the assessment of the activity ‘structured review’. The goal of this activity is to increase productivity. Measurements were both objective (e.g. identified number of errors {very serious; serious; normal; cosmetic; remarks}) and subjective (e.g. satisfaction with the resulting document; position in the product life cycle were an error would have been found otherwise, etc.). Results were presented to all involved parties in a feedback session that resulted in the widespread adoption of the review process within the organisation. It also resulted in acceptance of GQM-based assessment in the organisation. Although this approach enables an organisation to monitor the effect of individual SPI-activities this approach will not allow statements on the effect on the development process as a whole. The performance of a process is determined by a variety of organisational, technical as well as cultural factors. In the complex and
rapidly changing software development environment the effect of a single change in a single factor cannot be separated conclusively from other influences, both planned and unplanned, that effected the process at the same time.

It is however possible to assess developments in the performance of the process over time. In a number of publications this issue of assessing the impact of software process improvement (SPI) activities on the development organisation as a whole (top-down) has been addressed. Examples are Humphrey et al. [5], Paulk et al.[7], Rooijmans [8] and Solingen et al. [9]. As a typical example of the approach found in these publications we will look at Herbsleb et al. [4]. In this publication five case studies are described that have been carries out in a structured way. Issues discussed are:

- costs of the process improvement effort (in overall amount spent and amount per engineer)
- productivity (LOC/unit of time and number of defects detected early)
- calendar time (reduction of lead-time)
- quality (reduction in number of defect reports)
- resulting in a business value (return on investment resulting from comparing costs versus productivity, quality, and lead-time) with a median value of 5.

These results are typical of the results generally observed in literature, although the return on investment as shown in the table is higher than observed elsewhere.

Both approaches can be used to support SPI activities. Both approaches are also likely to convince the management of a commercial IT-development company. The argumentation in both the top-down and the bottom-up approaches is geared to this type of organisation: all data show how the development organisation can improve its internal efficiency and effectiveness.

However, in this case we are not dealing with a commercial development organisation. Software development as such is for ING an extremely important (and costly) activity but the activity is considered to be a cost centre, not a profit centre. The primary goal of software development is to provide support for the actual primary process of ING: provision of financial services. As a result of this the primary processes being serviced by the development organisation. It home base is in the Netherlands but it has a substantial presence abroad with subsidiaries in a number of European countries, Canada, as well as the USA. Most of the relatively independent subsidiaries are supported by in house software development organisations with the holding providing centralised support services. For a number of years a holding wide SPI program has been taking place based on the SEI capability maturity model (CMM). This program is supported and monitored by a centralised ICT department at holding level. By providing training, exchange of experiences and periodic assessments significant progress takes place.

This progress is established in several ways. Regular assessments show that within the parameters of the CMM maturity scale progress could be established. Bottom-up assessment practices are in the process of being established. An informal top-down assessment indicates a ROI that is sufficient to pay for the exercise but not high enough to convince general management.

In this situation a new member of the board of directors who also happened to have a solid IT background initiated a drive to assess IT-investments in the holding more rigorously. This included not only direct investments but also indirect investments and as such included the SPI program resulting in a direct request for a justification of the program. This request was the starting point for the study reported here.

4. Research goal

The study is required to focus on assessing the impact of the software process improvement (SPI) activities on the NGI business. This is easier said than done. In this section an operational research goal will be derived from this requirement.

An extensive body of literature has been assembled on the issue of assessing the business impact of a single IT application. For a discussion on this approach see Heemstra and Kusters [3]. However, the usefulness of this approach to the question posed here is limited. Assessing the impact of SPI on the business means achieving an increase in the way in which the development organisation is able to support business process effectiveness en efficiency. This means we are not looking at the business impact of a single application, but are trying to assess the increase in the quality of the process of identifying and providing applications. In this sense, SPI activities can be viewed as aiming at improving the level of quality of service of the
development organisation and assessing SPI from a business point of view therefore entails getting to grip with this concept of quality of service.

From this, two conclusions can be drawn. The first of these is that an assessment of SPI can not be limited to an internal issue of the development department. The reason for this being that the impact of service quality is not felt by this department. The departments servicing the primary processes are the ones impacted by this (lack of) quality. Therefore they have to be involved in the assessment process.

A second conclusion is that this involvement of IT-users will need to be focused in the sense that an increase in service quality is ‘nice to have’ in itself but should only be appreciated within the context of its contribution to business effectiveness and efficiency.

This appreciation is not without its problems. A first problem is that it has to be recognised that SPI-activities are not the only factors impacting the level of quality of service. Hiring competent staff and adapting new technologies are only two out of many other developments not part of the formal SPI-effort that may have an impact on the level of service quality. Organisations following an SPI-program cannot afford to put these other developments on hold during the execution of this program. This means that in assessing developments in service quality the impact of the SPI-program cannot be separated from the impact of the other developments. In principle this would disqualify level of service quality as the basis for assessing SPI-activities. Yet if, as was stated before, we want to involve IT-users in the assessment, only this level of service quality is available since the more direct consequences of SPI are not visible to the IT-using departments. After all, these departments only see the result of all improvement actions combined and are unable to separate SPI-effects from other effects. This forces us to look at the level of service quality even though it is an indicator of total change, not just of change resulting from SPI-activities. The problems this cause should however not be overstated since most of the formal improvement activities tend to be part of the formal SPI-program.

A second and similar problem occurs when assessing the impact of changes in the quality of service provision on the business. In the end quality of service is only one of the influences that determine business profitability. The contribution of a single of these influences to the development of business profitability as a whole cannot be identified. Since these ‘other factors’ will have a significant impact on profitability as compared to the SPI-activities, this direct metric of business profitability is disqualified as an indicator. Given this, instead of identifying a direct, objective metric for assessing an increase in quality of service it is necessary to resort to the more indirect and subjective field of quality of service.

This leads to a redefinition of the goal of this study:

\[
\text{Develop a survey that enables IT-developers together with IT-users to assess (the quality of) IT services.}
\]

5. Survey development

In this section first the meaning of the quality of service will be discussed after which the survey will be designed.

The notion of quality of service itself is obviously too abstract to be used as the basis for an assessment. A more concrete handle must be provided for a discussion on this subject to be fruitful. It was decided to try and decompose the notion into a number of clear questions that together describe the field of service quality and can be formulated in such a way that discussion is possible.

For this the notion of quality of service was first decomposed into the following aspects:

- Product improvement
- Process improvement
- Improvements in the area of knowledge
- Improvement in the context of service provision

This decomposition is not new. In analysing production systems the distinction between process, product and means of production (in this case: knowledge) is normally used. Context, or organisational culture, is a logical fourth.

A further analysis of possible areas of improvement within this first level decomposition resulted in the identification of 38 questions, which were used within the study. This further analysis entailed discussions with involved parties and development of a first version; testing this version by conducting structured interviews at an ING business unit; development of a second version; testing this version by conducting interviews at a second ING business unit; finalising the list.

Based on this list a survey was developed. Although much effort had been spent in trying to formulate questions as objective as possible, in the final instance it appeared to be necessary to focus on impressions of individuals. Given this subjective nature the survey took the form of a questionnaire. This consisted of three parts. Part I was aimed at identifying the level of knowledge of the answering party and at identifying a number of specific projects the respondent had been involved in. Part II contained the 39 questions. In order to maximise the reliability of answers a number of measures were taken.

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1. First, each question was formulated as concise as possible. All questions had an identical format (‘to which degree is ..’) and were kept short.

2. Explicit use of the anchoring and adjustment principle (Davis, [2]) was encouraged by first asking answers related to specific projects in which the respondents participated and only after that ask general answers pertaining to the development organisation as a whole.

3. All questions are answered on a five-point scale. This scale does not range from ‘unacceptable’ to ‘wonderful’ but from ‘insufficient’ to ‘sufficient’, taking out any unrealistic answer options. This is emphasised by providing a target value of ‘sufficient’ for each question.

4. Since interest is aimed not only at assessing the current situation but should look at the changes observed in quality of service the questions were not only asked for the present but also for the past. In this case ‘the past’ was taken to be three years ago since this was found to predate the current SPI-activities. In a repeat of the study at any time in the future this period should be chosen so as to allow linking the answers over time (e.g. if the study is repeated in one year time the past should refer to the current study, that is: 1 year ago). This linkage provides additional validation.

Finally, the expected changes during the upcoming year were also inquired into. This not only makes expectations among responding parties explicit but also sets a target for changes in the near future. The resulting structure of a question is depicted in table 1.

The survey concludes with a third part containing a set of wrapping-up questions:
1. which areas, as identified by the questions in part II, are most in need of improvement?
2. what is the assessment of the level of service quality as a whole?

In addition to developing the survey itself also a process for collecting data was developed. Again here the focus was on improving reliability of answers. To this effect several features were included:

1. Although the study was carried out on behalf of the holding management explicit attention was paid towards feedback of results. By so employing the ‘closed loop’ principle in general data reliability is enhanced.

2. This closed loop principle was enhanced by explicitly querying both IT-providers and IT-users. This was requirement within the goal of the study but has the additional benefit that it increases the value of the results at the local level, thereby fostering a more serious attitude when answering the questions.

3. Many of the questions ask for subjective assessment of an aspect of quality of service. In such a situation reliability can be improved by allowing inter-subjective confirmation. In this case this was provided by having for each ING business unit involved a number of representative respondents from both IT-providers and IT-users.

4. Finally the quality of answers was increased by not only holding a paper survey, but by adding to this a series of structured interviews. Both the numerical results from the survey as well as the more unstructured input from the interviews were included in the final report to the holding management.

<table>
<thead>
<tr>
<th>Table 1: structure of a question</th>
</tr>
</thead>
<tbody>
<tr>
<td>To which degree is there a fit (after delivery) between IT-systems and the business process they support?</td>
</tr>
<tr>
<td>Insufficient</td>
</tr>
<tr>
<td>[Project A]</td>
</tr>
<tr>
<td>[Project B]</td>
</tr>
<tr>
<td>3 years ago</td>
</tr>
<tr>
<td>Now</td>
</tr>
<tr>
<td>In 1 year</td>
</tr>
<tr>
<td>Target</td>
</tr>
</tbody>
</table>

6. Results

The study was held in nine ING business units, one based in Belgium and the others in The Netherlands. The main conclusions of the study were:
1. SPI is progressing slowly but steadily,
2. The SPI-program is accepted at local level,
3. Both IT-developers and IT-users see the need for a continued SPI effort.

Recommendations were:
1. SPI-activities should be continued for at least two years,
2. The area of awareness and knowledge on costs and benefits needs improvement,
3. A regular repeat of the study is encouraged.

Figures 1 and 2 show some of the detailed results these conclusions were based upon. Figures 1a and b focus on the area of system quality and present the answers to questions:

a. To which degree is there a fit (after delivery) between IT-systems and the business process they support?

b. To which degree does the added value provided by systems delivered justify the costs incurred?
The general picture that emerges here is an assessment that the improvement achieved during the last three years can be repeated during the following year. Also it can be noticed that IT-developers are slightly more optimistic about their performance then their customers, an issue which is especially apparent in figure 1d which deals with business value. This last point is serious as since it is so close to the key issue. However, since it would seem the difference in opinion is decreasing over time progress in the key issue is being seen to occur.

Figures 2a and b focus on cost and benefit awareness. They present the answers to questions:

a. To which degree do IT-users exhibit cost awareness
b. To which degree do IT-users exhibit benefit awareness

The situation both in the past as well as at the time of the study was insufficient. Expectations for the upcoming period was low as well, indicating this to be an area in need of improvement. Noticeable here is the users seem to assess both their own position slightly higher. A result that would at least seem to indicate a need for further communication.
extremely low assessment to an expectation of satisfactory results within one year. Since the service provider expects not to be able to live up to this expectation a discussion on future developments is required here to prevent disappointments. Figure 3b, representing the question ‘to which degree does the IT-organisation maintains its IT knowledge’ shows a similar gap in expectations.

![Figure 3a: degree to which an IT developer acts as a service provider](image1)

![Figure 3b: degree to which an IT organization maintains its knowledge](image2)

**Figure 3: details of study results in the areas of service and knowledge**

### 7. Conclusions

In this paper an additional approach towards evaluating SPI-activities has been presented. It has been based on making visible the perceptions of the parties involved by means of a detailed questionnaire. It can be used in addition to more traditional CMM-type assessments (aimed at internal progress measurement) to enable a discussion on the business impact of SPI-activities as seen from the point of view of primary business processes that benefit from particular SPI-activities.

The results of this study have been presented to ING holding management. The results were accepted as providing a rationale for further continuation of the SPI-program under the condition of repeating the study on a regular (yearly) basis to determine the business impact of software process improvement.

### 8. Literature