Volume 6, Issue 1, January 2016 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Return on Investment Based on Software Process Metrics

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Abstract— Software process development (SPD) has been on the agenda of both academics and practitioners with CMM as its de facto scheme. Many business firms have invested large sums of money in humanizing their software processes, and several research papers document SPD's effectiveness. SPD aims to generate more effective and efficient software development and continuance by structuring and optimizing existing processes. SPI assumes that a well-managed organization with a defined engineering process is more likely to produce quality products that consistently meet the client's requirements within time and budget than a poorly managed organization with no such business process. A sound process is, however, merely one prerequisite it doesn't guarantee good products. In the following sections we presented cost-benefit numbers and that measure ROI.

Keywords— Capability Maturity Model, Return on Investment.

I. INTRODUCTION

Persuasive managers to invest money and effort in improvement, and convincing them that SPD can help to solve structural troubles. Estimating how much effort to invest to solve a certain problem or estimating whether a certain intended benefit is worth its cost. Many software companies s must prioritize due to timing and resource constraints. SPD budgets are assigned and discussed quarterly, so benefits must be explicit and organizations must show sufficient ROI, or continuation is at risk.

Currency will likely be wasted and risk bankruptcy in the long run. Like any change in an organization, SPD is an investment for which the benefits should exceed the cost. One frequent argument in software practice is that measuring SPD. We propose some practical solutions on calculations and benefits of calculations to ROI.

II. REVIEW OF LITERATURE

Calculating cost and benefits is a prerequisite for investment decision making. This is just as true for SPD as for any other investment. Measuring cost and benefits doesn't have to be difficult. Being pragmatic and involving stakeholders makes quantification easy. Organizations find it relatively easy to measure cost by measuring effort but have trouble measuring benefits. However, this is owing to a serious misunderstanding of cost measurement [1] costs are much broader than effort alone. For example, cost also involves other resources, such as office space and computer infrastructure. Usually when organizations calculate cost they use a fixed man- hour-rate that they assume acceptably approaches the cost's real value.

This is a commonly accepted method. However, such a cost calculation is, in fact, an estimate. In itself, this method isn't wrong. It's a pragmatic agreement on how to approach actual cost with an acceptable accuracy level. However, if we accept that cost measurement is just a matter of estimating and agreeing on the procedure, why don't we do the same for benefits? If we agree that approaching the actual value is sufficient and we agree on the estimation procedure, we can measure benefits to the same extent as we measure cost. Measuring benefits is therefore just as easy as measuring cost. We only need to agree on the required accuracy level.

Because ROI calculations for SPD don't usually need to be very accurate, we can easily measure benefits based on stakeholder involvement [2] and estimation. ROI isn't a strong metric when calculating investments that exceed a one-year time span; in such cases, net present value is stronger.

However, for this research article, we consider only ROI, especially because any industrial investment should show short-term results within the same financial year.

III. DECISION MAKING BASED ON RETURN ON INVESTMENT(ROI)

As we mentioned, detailed ROI calculations aren't necessary. It's usually sufficient to know the ROI's relative value: is it positive, breakeven, or negative? In most industrial organizations it isn't as important to know whether the ROI is 7 or 9, knowing whether it's positive and knowing its range (for example, 5 to 10) is more than enough for most decision making. The sole reason for calculating ROI is to decide within a specific industrial context (and industry) where to invest the money. SPD is just one possible investment. The ROI of SPD differs over different situations. For example, a company with severe quality problems at customer sites can obtain a much higher ROI from SPD than a company that wants to increase productivity, because the business benefits are higher in the first case.

So, building a business case for SPD is always a specific task for a specific environment. Generic numbers on the ROI of SPD can help but one should build the business case along the lines of the specific context [3], its goals, and its problems. We can't give a generic benchmark for SPD. However, when building the case for SPD in comparison to other investments, quantifying benefits and ROI will certainly help. Furthermore, research has proven that humans make trade-off analyses continuously— if not on the basis of objective measurements then on intuition. Making explicit ROI calculations is therefore crucial for SPD because it's an investment with significant cost and sometimes invisible benefits. The ROI should therefore be visible as well to avoid incorrect intuitive evaluations.

Without numbers on SPD's cost, benefits, and ROI, it's impossible to properly decide whether SPD is worth its cost. Even if the overall SPD undertaking breaks even, local benefits might already be worthwhile. For example, if it saves a development team time, then it shortens time-to-market and developers can work faster with less pressure.

IV. INVOLVEMENT OF STAKEHOLDERS FOR BENEFIT OF ESTIMATION

Certain number obtained from stakeholder estimation is better than just determining an intangible benefit as zero. Stakeholder involvement for benefit quantification seems logical. Stakeholders see benefits' impacts and values from specific view points. Most people will agree that in practice [4], it's impossible to find a single person with a full overview on SPD benefits who can also express those in monetary terms. Multiple stakeholders should therefore be involved. For example, if you know that SPD reduces time-to-market by two weeks, you can ask the marketing department what this will bring in financial values. You will get a number or an estimated range that you can use in your calculations.

Don't forget to ask the project manager whether the project would have suffered from serious delays if the SPD actions had not been taken—a so-called "what-if-not "analysis. If so, ask the marketing department what this delay would have cost—another benefit. It's important to include all these SPD benefits and to convert them to a financial value. After all, "money" is a measurement scale that most stakeholders understand. For example, if a manager states that his other team is clearly more motivated owing to the SPD initiatives, ask the manager what price he or she would pay for that increased motivation.

Ask the manager, for example, how many training days he or she would spend on staff to acquire this increased motivation. If it is, for example, five training days, you can quantitatively estimate this benefit: number of staff number of days training. As we see, the benefit is easy to quantify as long as there's agreement on how it's done.

V. EXPERIMENT

This particular program took place in a systems development department in an industrial company that produces and services systems for fuel stations. The software team developed an embedded-software product that controls a fuel pump and manages all fuel-transaction communications. This case involves a goal-oriented measurement program that addressed developer distortions.

The measurement program aimed to find out the reasons for developer interrupt sand aimed to reduce them. During a three-month period, a six-person development team measured and improved their processes. When analyzing the cost, we find this improvement program's total cost was (320/1600) US$100,000 = $20,000. We made the calculations using 1,600 productive engineering hours per year and a yearly cost of $100,000 per engineer.

The software team's effort was 80 hours ($5,000) and the GQM measurement team's effort [5] was 240 hours ($15,000).When considering the benefits, we measured that the software team saved 260 hours in engineering effort due to the improvements (reduced number of interrupts). The GQM measurement team saved 60 hours (from reusable material). These benefits related directly to the improvement program's objectives. Therefore, the software team's financial benefits were$16,000 and the GQM team's were $4,000.

We calculate the ROI by dividing the investment's profit by the investment: (benefit – cost)/cost. However, when we consider the indirect benefits, made clear in the measurement program's feedback sessions and based on the project manager's conclusions, the benefits are higher. The project finished at least one week earlier than expected thanks to the measurements. Documentation was updated on the basis of the measurement analysis, preventing at least 260 hours of interrupts (equivalent to $16,000).

The software team's quality awareness and interruption awareness increased (which the project manager valued at least $100,000). Interruptions in other projects decreased in the same department owing to increased awareness outside the department(valued at more than $50,000).

VI. THE CMM-BASED METHOD

The second case study presents the results of an ROI evaluation of an industrial SPD program. This program used the software CMM as a starting point for improvement and applied it pragmatically as a checklist for potential improvement actions. The organization develops and services a software simulation package that can execute virtual tests using finite-element modeling. Such simulations give production companies safety feedback on products. This package's market success is, in fact, mainly due to its high ROI. Imagine the savings for a manufacturer when discovering safety flaws during the design phase rather than the delivery phase.

Available measurements were expanded with five stakeholder interviews. These interviews indicated that the SPD program's main benefits were Process documentation (description of standard processes, definition of templates and best practices, and a group-wide process-web infrastructure) Progress monitoring (periodic reporting by progress metrics and "traffic light" indicators) Software engineering role and responsibility definitions Improved product documentation

Stakeholders quantified each of these benefits and were asked for effort savings, a value range (between minimum and maximum), or a purchase value .

Every case used the lowest value of the stakeholder numbers, implying that the calculated ROI number was a minimum. One specific addition was made by adding so-called contribution percentages. Many improvements couldn't be attributed solely to the SPD program because they resulted from multiple initiatives, so the contribution to the improvement was indicated with such a percentage. Take, for example, the benefit "best practices."Best practices would have probably been documented even without an SPD program.

However, the R&D manager estimated that the SPD program had a partial contribution of about 25 percent, owing to the focus on best-practice capturing. In this example, only 25 percent of the value was measured as benefit. Table 1 shows the measurements for this case study.

VII. DISCUSSION ON CASE STUDIES AND RESULTS

TABLE I ROI CALCULATION

Cost benefits	Value (US$)	Explanation	Allocation (%)	Value
business effort	$34,500	305 person-hours with an average hourly fee of $115, measured from project accounting system	100	$34,500
External training	$15,000	External coaching hours from consulting company, measured from bills	100	$15,000
Total cost				**$49,500**
Benefits				
Process wakefulness	$18,000	Measured from value for R&D manager, through buy-in comparison: 5 days by external trainer	100	$18,000
Documented processes available	$140.000	V-model reflected in set-of procedures and standard work breakdown structure for projects; effort saving at least $4,000 per project, 40 projects per year, measured from value for R&D manager	50	$70,000
Documentation templates	$100.000	Buy-in value of good template: $1,000, 3 templates set-up, 40 projects per year, measured from value for R&D manager and engineers	25	$20,000
Best practices documented	$28,000	Effort saving of at least $800 per project, 40 projects, measured from value for engineers	25	$7,000
Requirements guidance followed	$16.000	Cost of requirements training in effort and external trainer, measured from project accounting system	25	$4,000
Project documentation updated	$5,000	Updated documentation based on findings, measured from value for R&D manager	100	$5,000
Total direct benefits				**$124,000**
Project management support	$550,000	Calculated from value for R&D manager and product manager of the overall set of project management actions (for example, traffic light progress monitoring, customer planning alignment, less late deliveries)	10	$55,000
Release on time	$180,000	Effort and cost saving from releasing on time: $30,000, 6 releases, calculated from value for R&D manager and product manager	25	$45,000
Role separation	$255,000	Effort saving of 1.5 person-years, due to role and responsibility separation, measured from value for R&D manager	75	$190,000
Total indirect benefits				**$290,000**
Total Profit				**$414,000**
Return On Investment				**1:7**

VIII. CONCLUSION

In the initial year, the SPD program cost$49,500. When measuring benefits, we distinguished between the SPD program's direct benefits and indirect benefits.

The direct benefits were valued at $124,000. The indirect benefits were valued at $290,000. This was calculated from the separate values for project management and control on-time release of the product and role and responsibility definitions. Based on these collected numbers, it was relatively easy to calculate ROI numbers, using the same formula as the previous case study.

The respective interviewed stakeholders agreed on the numbers underlying these calculations. When presenting them to the complete software engineering team, however, the engineers indicated that they didn't recognize all presented values. Apparently, not everyone was aware of the overall improvements and impacts. We concluded that more intermediate communication on SPD activities and results should have occurred, instead of just one yearly ROI analysis. This could have improved common understanding of the improvement program's benefits for the department.

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