Evaluation of Software Process Improvement in Small Organizations

Pedro E. Colla[1] and Jorge Marcelo Montagna[2]

[1] EDS ASFO – Av. Voz del Interior 7050 -- EDS Argentina
pedro.colla@eds.com
Facultad Regional Santa Fé – Universidad Tecnológica Nacional
pcolla@frsf.utn.edu.ar
[2] INGAR - Avellaneda 3657 -- CIDISI – FRSF – UTN
mmontagna@santafe-conicet.gov.ar

Abstract. At the domestic and regional level most organizations willing to participate in software development projects at international off-shore markets operates at small or medium organizational sizes and therefore isn't included by the organizational scales referred at the typical SPI bibliography. A systemic model is then implemented aiming to get an initial understanding over the behavior of the different variables involved, their contribution to the improvement effort, outcome sensibility to model parameters, the systemic relations at large and the limits derived from the holistic interaction of all.

Keywords: Software Process Improvement, SPI, CMMI, Simulation, Dynamic Models. Small Organizations, Software Engineering Economics. Net Present Value.

1 Introduction

When software development is performed at *Small and Medium Enterprises* (SME) organizations the management dilemma is how to justify the investments required to undertake *Software Process Improvement* (SPI) [1,8] initiatives. This organization size segment operates in a business context where bigger competitors, quite of a global scale, can perform similar actions leveraging much larger structures and therefore being able to better absorb the investment impacts produced by the SPI initiatives.

The consideration of this problem bears relevance after the fact that SME sized organizations seems to be the largest proportion of the companies providing off-shore development services to the demanding technology markets at US and Europe. In these markets the buyers routinely ask provider organizations to present objective proof of their Software Engineering capabilities thru the adherence to some formal quality model, and in many cases specifically to concrete SEI-CMMI maturity levels.

At the same time an SME organization must consider competitors of similar scale which not introducing significant improvements on their core processes enjoy a short term competitive advantage and less margin erosion.

Most scenarios and results captured by the bibliography [2,3,15,16,17,20,23,24,28,38] reflects the experiences of large scale organizations leaving smaller ones wondering

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whether an SPI approach is realistic for them, frequently leading to the *a-priori* estimation that formal SPI initiatives are simply outside their realm of possibilities.

Even though SPI efforts attempted at SME sized companies has been documented previously [4,9,21,25] the focus is often placed at qualitative or methodological factors rather than quantitative ones; it seems the implicit assumption is for SPI efforts to be unconditionally a good initiative no matter what the business context where the company operates really is.

This notion has been challenged by several authors [14,18] where the actual affordability and suitability of formal CMMI oriented SPI initiatives for SME is questioned from different perspectives.

Previous work from the authors [11,12,13] outlined a comprehensive framework which helps in the modeling of organizations attempting to implement SPI initiatives and allows understanding the different organizational parameters involved in the business decision, the outcome that might be expected and the level of risk associated with it.

This paper proposes a contribution by focusing on the specific group of small companies (less than 25 persons) trying to understand the dynamic behavior of the different variables associated with the SPI effort outcome in order to evaluate possible strategies to address the initiative and the likelihood of it results.

The model is built by identifying the main factors defined at the organization level, the external context and the intrinsic components of the SPI effort as reflected in the available bibliography, specially some concrete references to small organizations (see *Investment Modeling*)..

In order to handle the dispersion of the parameters reported by the bibliography a Monte Carlo simulation technique is used where the system variables, the uncertainty of the results, the sensibility to different investment strategies and the limits for a reasonable return can be explored (see *Model Execution*).

Finally some limits of the approach and conclusions are explored (see *Conclusions*).

1.1 CMMI as the Reference Model

The SEI CMMI v1.2 reference model seems to be the choice to guide the deployment of SPI efforts through the formulation of a framework to help develop a comprehensive process that unveils the organization's technologic potential at delivering software products. Positive correlation between the maturity level and better performance is backed up by many industry and academic references [1,2,3,8,15,17,20,23,24,28, 36,38].

The SEI-CMMI model specifies what *generic* and *specific goals* must be satisfied at *Process Areas* through the usage of generic and specific *practices* [36], actual details of the defined process is left to each organization to decide.

Although other reference models can equally be eligible for this purpose, the SEI-CMMI model receives significant industry acceptance at a global scale, a long standing record of application and some metrics for the results obtained by different organizations [20]. The assumption in this paper is SEI-CMMI v1.2 to be the reference guiding the SPI effort.

1.2 SPI at Small and Medium Enterprises

The importance of the Small and Medium Enterprises (SME) has largely been recognized as one of the main drives beneath the global provision of off-shore services.

Laporte [27] identifies that 70% of the organizations providing off-shore services from a number of emerging economies have 25 or less persons with some extreme segments having 60% of the organizations with less than 5 persons.

Staples [37] discussing a cross-section survey on CMMI trends reports 38% of the companies to have less than 20 persons while 23% were in the range 20 to 200 persons.

CESSI [6] in their 2005-06 survey reports for Argentina, a growing player in the offshore market, 75% of the technology companies has a staff of 25 persons or less.

SME needs SPI

SME needs to address SPI efforts for a variety of reasons. Conradi [14] elaborates on the reduction of the Procurer Risk as an incentive for smaller companies to provide convincing evidence of their capability to deliver large projects in front of the companies requiring their services.

Garcia [19] identifies as reasons the need to deal with a partner company, to fulfill subcontracting requirements or to follow corporate mandates.

Coleman [10] cites the ability to demonstrate the capability to fulfill deliveries where complex requirements are involved at large and mission critical environments. A number of other sources [2,15,16,17,23,24,28] identify the quest for operational efficiency improvements associated with SPI as the reason to take over such efforts.

McFall [30] justify the importance of CMMI based maturity level evaluations as one of the reasons beneath the strategic direction took by Indian companies towards converging to high maturity levels in order to compete in the global landscape; Indian companies now accounts for more than 55% of the total number of CMMI Level 5 organizations worldwide.

SME are reluctant to adopt SPI

Beyond the good reasons and the consistent drive for a SME to initiate and sustain SPI efforts still this segment is reluctant to adopt these initiatives in significant numbers.

Staples [37] cites on a work investigating the reasons why CMMI isn't adopted that SME considers SPI initiatives as plain infeasible to adopt because of cost, applicability and time to implement reasons. Further elaboration on the reasons for this segment of organizations not to embrace SPI initiatives is to have a business context more variable than larger companies. The smaller companies seems to place higher focus on Product Quality than Product Quality Assurance, therefore shifting their focus to engineering practices such as agile methodologies rather than process practices such as CMMI.

Coleman [10] also mentions resistance from top management and key staff as one of the main reasons for SPI efforts not taking place at SME.

Conradi [14] elaborates on the underlying tension between disciplines vs. agility operating at SME organizations as one of the main roadblocks for such efforts to occur. They speculate that ideally SPI initiatives should take 6-12 months for implementation in order to be adopted in this segment.

SME recognizes the value of SPI

Contrary to what the previous sections seems to infer SME organizations understand the value of SPI initiatives and are willing to consider them, especially companies operating at off-shore software development markets because of recognizing the value embedded in these initiatives.

McFall [30] reports that 57% of the companies in the segment of smaller organizational size have some sort of structured development methodology in partial or full usage, up to 90% of the organizations surveyed are willing to engage in a SPI initiative.

Coleman [10] reports 70% of the SME surveyed to have deployed either Agile development processes such as *Extreme Programming* (XP) or iterative/incremental methodologies such as *Rational Unified Process* (RUP) and alike.

CESSI [6] reports in Argentina 22% is considering investment in the quality of services as a top priority.

Finally Staples [37] report that 82% of the organizations surveyed are willing but for a variety of reasons not able to engage in SPI although they are considering as comparable alternatives to address Agile methodologies instead.

2 SPI Business Case

In order to address a SEI-CMMI based SPI initiative the organization will require to undertake a significant effort into defining and deploying policies, plans, processes, instruments and metrics associated with the satisfaction of each one of the *Process Areas* of each *Maturity Level*.

A business case needs to be made in order to evaluate the business justification for the SPI investment to be made and also as an instrument to evaluate the best strategy to undergo it.

2.1 Benefits of SPI for Small and Medium Enterprises

Different sources consistently reports the benefits of addressing SPI initiatives at SME as coming from expectations of better Incomes, Operational efficiency improvements, reduction of the uncertainty of the organizational delivery and a number of intangible benefits regarding customer and staff satisfaction, brand recognition and better fulfillment capabilities in general.

On engaging an SPI initiative a SME seek new business or increased business [41] derived from the fulfillment of bidding requirements, customer vendor selection policies or plain competitiveness; few reports exists on the magnitude of such increase suggesting in most cases would be an strategic reason not easily subject to evaluation, either the company embraces the SPI effort or moves to compete in a market which doesn't require it.

Even having no choice than to perform the SPI effort the organization still needs to select a deployment strategy that maximize the value of the effort thru the maximization of the returns or the minimization of the costs or both.

Operational improvements has been widely reported [3,15,17,20,24,28,30] as to come from the drastic reduction of the Cost of Poor Quality (Rework). Tvedt [39] also

captures the cycle time improvement as one of the operational benefits achieved after completing the SPI initiative.

The preferred view for the purposes of this paper is the one set by Clark [7] where all operational improvements are summarized as the 4 to 11% reduction of development effort to produce similar development sizes as the organization grew each maturity level.

Although not necessarily reporting concrete data the bibliography focused on smaller companies [4,9,21,25] suggest that SME companies might expect similar or better operational improvements after SPI efforts than their larger counterparts.

Other critical factors

Some authors [2] highlight the other intangible benefits such as the image improvement, staff motivation, customer satisfaction and corporate culture as strong reasons to implement SPI.

Small and medium sized organizations in particular will depend critically for their survival on several other factors [16,32,37,40] such as the quality of the human resources, the establishment of agile organizational relations, the business model flexibility, the legal context, the organizational model adopted and the decision speed as well as interrelation fabric between areas, the debt taking capability, the critical adaptability speed and the very low capacity to survive on a restricted cash flows environment among others.

Although very important the previously enumerated factors are difficult to incorporate in a model like the one presented by this paper; however all of them can conceptually be considered increasing or decreasing the strengths of the organization and therefore changing the certainty of their results.

As the certainty of the results ultimately drives the risk under which the organization operates these factors should largely be represented by the risk premium component of the opportunity cost the organization uses to evaluate their investment decisions. The model then assumes that incorporating the opportunity cost on the model some of the critical factors, even partially, can be captured.

2.2 Costs of SPI for Small and Medium Enterprises

Garcia [19] identifies SME to face similar groups of cost factors to embrace SPI initiatives, especially by adopting a reference model such as SEI-CMMI, these cost factors would be *appraisal definition* and *deployment* costs. While larger companies can leverage their size into cushion the impact of the first two factors SME has a clear advantage on having the chance of lower deployment costs because of their smaller size.

Coleman [10] reports smaller assessment costs on SME per appraisal event with 100 to 200 Staff/Hours of appraisal preparation effort. Reported cycle time for deployment seems to be aligned with numbers reported by larger organizations in the order of more than 20 months per level with a total of 3 ½ years to achieve CMMI Level 3.

Garcia [19] reports smaller companies being able under pilot conditions deploy 1 to 2 Process Areas per month getting a deployment cycle time in the order of 10 months per level.

An SME in Argentina [40] reports 20 Months to achieve CMMI Level 2 which is aligned with the bibliography of larger companies but much smaller 12 months as the cycle time to upgrade to CMMI Level 3 once operating at Level 2. Another in the same market [35] reports 18 months as the total transit to achieve Level 3 and 18 Months additional to achieve Level 5 thereafter. These ranges of values suggest smaller organizations might have an edge on moving faster on SPI initiatives. The same source reports the level to sustain the processes as about 0.8% of the total staff. Available data seems to point to the direction that even cycle time can be reduced the effort measured as the proportion of the organization devoted to the SPI effort is similar to what the bibliography reports at to be required by larger companies [10,19,35].

Garcia [19] highlights the need for smaller organizations to adopt packaged (canned) methodologies with a well defined mapping with CMMI as the way to drastically reduce both the deployment effort and cycle time; this is also backed up by learned lessons by Argentina's organizations [35].

The fact that SME organizations looks at iterative/incremental methodologies such as RUP or Agile development methods in lieu of the satisfaction of their SPI needs are excellent news after several authors such as Paulk [33] already demonstrated a good alignment of XP methodologies with the CMMI requirements. This alignment can be extended even for the highest maturity goals as Maller et al [29] clearly stated. A similar favorable comparison was made by Reitzig [34] and Cintra [5] among others on the good coverage of the different SEI CMMI maturity level requirements by RUP.

3 Investment Modeling

This paper integrates a previous published effort from the authors [11,12,13] into building a comprehensive model to be used as a framework to evaluate the SPI effort at organizations with emphasis on parameters found in Small companies with a staff of 25 persons or less.

The complete framework won't be described in detail here because of space restrictions but a high level overview is provided in the following sections, a summary of the transfer functions can be seen at the *Appendix II* and the complete model at the referred bibliography.

3.1 Model Parameters

The model captures the relation between a number of organizational parameters, assumed to be factors subject to decisions being made by the management such as the target *CMMI Level* (CMMI), the *Total Organization Staff* (N), the expectation of the length of the *investment horizon* (t_p), the *opportunity cost* (r) used to discount investments and the *Cost per Engineer* (C_{PE}) among others. The outcome of the model will be the *Net Present Value* (NPV) of the investment once all *cash flows* F(t) are considered and discounted using the *continuous opportunity cost* (δ) [Ec10].

Benefit Streams

The modeling approach used the *Productivity Income* (I_{prod}) as the return of the SPI effort to represent the savings achieved compared with operating in a lower level of maturity; this is considered the source of return and the main financial reason to justify it. The magnitude of this factor is assumed to be an equivalent fraction (K_{prod}) of the *Total Organization Size* (N) as reflected by [[Ec 6].

Assuming the organization achieves the target maturity level after the assessment a fraction of the resources would still be required to maintain, adapt and evolve the implemented process framework in order to ensure a consistent usage and the continued alignment with the organizational goals, the effort to perform this activity is the *Software Engineering Groups Effort* (E_{sepg}) which will be a proportion (K_{sepg}) of the Total Organization Staff (N) as shown by [[Ec 5].

The net *flow of benefit* (V_i) the organization are going to receive as shown by [[Ec7] will occur since the appraisal is completed at *Implementation Time* (t_i) and as long as the *Investment Horizon* (t_p) allowed by the organization to collect resources last. This timeframe is often called the *Recovery Time* (t_r).

Although it would be reasonable to expect organizations to realize benefits as they move through the implementation of the different practices a conservative approach taken in this model is to assume all benefits will realize only after the organization is formally evaluated on the target maturity level.

Even if the nature of the SEI-CMMI improvement process, with several non-rating instances of appraisal, allows for a comprehensive evaluation of the organization progress at implementing the different Process Areas the factual data [44] still suggest the final appraisal success is not guaranteed. A surprisingly high number of appraisal failures observed [36] requires the consideration of the *Appraisal Success Rate* (ξ) corresponding to each maturity level (see *Appendix I*), the result is to reduce the expected returns as shown in [[Ec8].

Implementation Costs

The organization will need to invest a significant fraction of the their resources through the definition of a mature process as a *Software Process Improvement Effort* (E_{spi}) which would require a proportion of the *Total Organization Staff* (N) to be allocated to the SPI activities (K_{spi}) given by [[Ec 1].

The implementation has to be followed by an deployment effort aiming to ensure the implemented processes are effectively used by the organization at large thru a *Training Effort* (E_t). Walden [41] and Gibson [20] provide some data on the magnitude of this effort.

The training effort is composed by the *Training Preparation Effort* assumed to be related to the number of *Process Areas* (N_{PA}) to be evaluated on the target maturity level and the effort to deliver the training which is made by the *Training Effort per Person and Process Area* (E_{PA}), the total Training Effort will then be as in [[Ec2] and assumed to be distributed evenly through the entire SPI initiative.

At the same time the formal assessment of the maturity level will require a Class "A" appraisal (SCAMPI-A); to prepare for it the *Appraisal Preparation Effort* (E_{ap})

and the *Appraisal Delivery Effort* (E_{ad}) will be required by the organization to get ready and perform the appraisal. Also the organization will need to fund the *Appraisal Costs* (C_a) for consultancy fees and other event related expenses.[[Ec 3]. The total *Appraisal Effort* (E_a) is considered to be incurred mostly toward the end of the implementation period and it is given by [[Ec4].

Opportunity Cost Evolution
As the organization operates with higher maturity levels their delivery will be subject to less uncertainties and therefore a lower operational risks has to be expected; assuming a rational investment decisions are made this can be factored as the reduction of the opportunity cost used by the organization. A reduction in the opportunity cost allows the organization to collect higher returns faster from investment and therefore can be perceived as a value creation from the SPI effort. At the same time as the organization can operate with higher certainty many of the intangible benefits mentioned in the previous section can, at least partially, be captured by the modeling effort. Harrison [22] identified the *Risk Variation Factor* (λ) as the sensitivity of the opportunity cost to the variation of the uncertainty; the authors [11,12,13] estimated the magnitude of this variation for different SEI CMMI levels, the model then incorporates the variation of the NPV because of this factor thru the [Ec11] and [Ec12] as seen on *Appendix II*.

4 Model Execution

In order to be computed the model it is implemented using the GoldSim® platform[1] where the variables, relations and typical value distributions are defined as per the Equations explained in the referred work and shown in *Appendix II* for further quick reference.

When computed in this way the NPV evolution can be seen at Figure 1; the expenditures in the deployment of the SPI actions drives the NPV to become more and more negative; towards the end of the implementation time (t_i) the rate of change accelerates as the expenditures reaches a maximum when appraisal related costs are incurred.

Once the new maturity level is obtained at time t_i after a successful appraisal the organization starts to collect productivity gains net of the process maintenance costs which drives an improvement of the NPV until it eventually, if allowed enough time, become positive, the moment in time the NPV becomes positive is where the investment has been fully paid back in financial terms.

The fact most variables can not be assigned with unique values but for ranges or probabilistic distributions makes the model to be far from being deterministic; the bibliography reports ranges and in some cases suggest some possible distributions; this information is used to run the model with an stochastic methodology in order to evaluate the possible results; a sample outcome for a given run would be, as seen in Figure 2, where a typical probability distribution of the NPV is shown.

[1] GoldSim © ™ Simulation Software (Academic License) http://www.goldsim.com

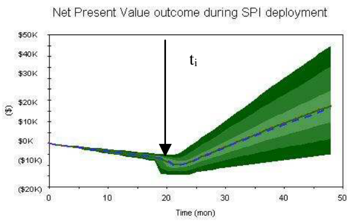

Fig. 1. NPV evolution with time on a typical SPI simulation run

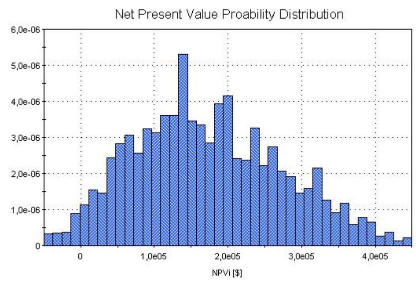

Fig. 2. NPV Probability distribution for a typical SPI simulation run

By computing the area below the NPV distribution curve for values where a positive result is obtained the probability of a project success can be assessed; each organization could then match their own risk acceptance profile with the investment parameters that yield an acceptable outcome.

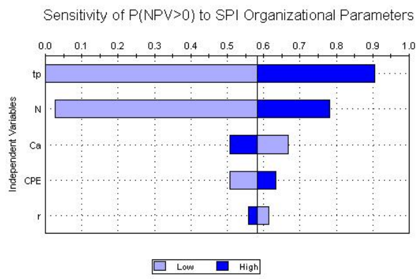

Fig. 3. NPV Sensibility to Organizational Factors

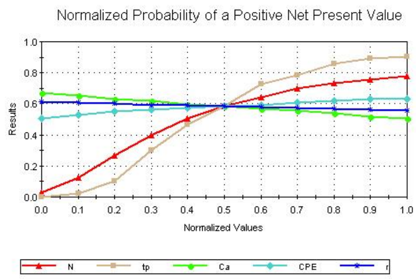

Fig. 4. Sensitivity of the NPV to variation of Organizational factors

The results of a run with variations in all major parameters for an organization trying to acquire CMMI Level 3 is shown in Figure 3; the model highlights increases in NPV as to be sensible mostly to the Organizational Size (N), the Investment Horizon (t_p) and to a lesser degree to the Cost per Engineer (C_{PE}), increases in these factors also increases the NPV outcome.

The Appraisal Cost (C_a) and the Opportunity Cost (r) increases play against the NPV results.

Several scenarios are explored where a typical organization is assumed to have a staff of 25 persons, trying to achieve a CMMI Level 3 maturity in one step, allowing a total investment horizon of 48 months, operating in the offshore environment with a typical cost per engineer of USD 30K per year and expecting an opportunity cost to be effective annual rate of 15%. All scenarios are ran varying one of the parameters through the range of interest while keeping the rest set at the previous values in order to be able to evaluate the variation dynamics.

A summary of the results can be seen at the Figure 4 where the outcome variation is shown as the different model parameters are varied thru the allowed range.

Organization Size Sensibility

The probability of a positive Net Present Value increases with the organization size as seen in Figure 5 and become above a 50% chance with organization of 13 members or higher; for organizations sizes of 25 members or higher the probability is reasonably high suggesting the organization has good likelihood of achieve the target maturity level.

Investment Horizon Sensibility

The probability of a positive Net Present Value increases with the investment horizon accepted by the organization as reasonable to recover the investment; values in the range of 36 months or higher as seen in Figure 6 yield a higher likelihood of a positive return. This value is still much greater than the 6-12 months timeframe previously discussed as being expected by SME.

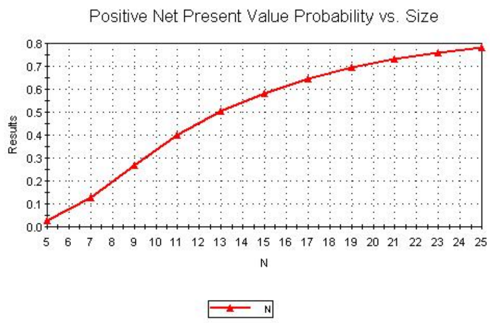

Fig. 5. Sensitivity to Organizational Size

Appraisal Cost Sensibility

A duplication of the Appraisal Cost varies the probability of a positive NPV by some 17% (see Figure 7) suggesting that the sensitivity for the entire SPI process to this factor is relatively small; unless the absolute expenditure involved lead to cash flow problems to the organization the model suggest this value should not be of primary concern to the organization.

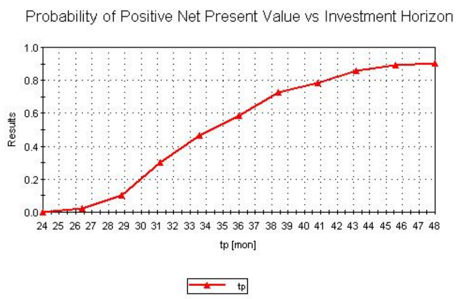

Fig. 6. Dependency from Investment Horizon

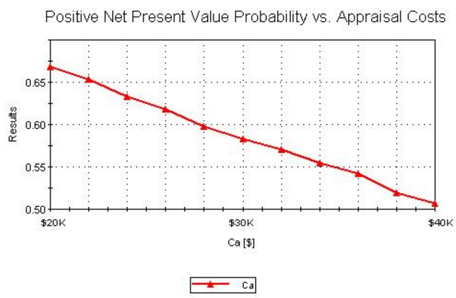

Fig. 7. Dependency from Maturity Appraisal Costs

Cost per Engineer Sensibility

As the Cost per Engineer increases the probability of a positive NPV increases (see Figure 8); this might be explained by the higher absolute returns obtained after productivity gains to offset faster the fixed costs the SPI process has.

Opportunity Cost Sensibility

As the opportunity cost used by the organization increases the likelihood of a positive NPV reduces (see Figure 9); this behavior could be explained after a higher discount rate to require faster or bigger returns to achieve a similar value. This could explain organizations working with higher risk to be less inclined to embrace SPI initiatives.

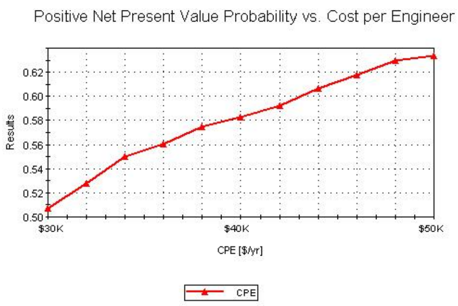

Fig. 8. Dependency from Cost per Engineer

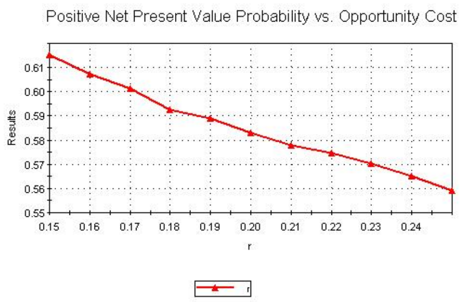

Fig. 9. Dependency from Opportunity Cost

4.1 Limitations and Further Work

Many simplifications has been adopted in the formulation of the model, therefore the results has opportunity for improvement and should be taken as preliminary; the ranges used for the parameters requires further research and confirmation. Additional factors are needed to identify supplemental motivations for organizations with lower Cost per Engineer to embrace SPI efforts often than these with higher costs as the observation seems to infer.

The assumption of similar results using either the Staged or Continuous representation of the SEI CMMI model used in the evaluation framework deserves further validation.

Finally, the model also requires incorporating additional factors such as the intangible organization impacts obtained from the SPI effort; a better calibration based on maturity improvement experiences from organizations at the National or Regional level would be an important improvement to perform in order to verify the ranges of results obtained in the bibliography holds.

5 Conclusions

The work suggest the usefulness to enable small organizations facing a SPI investment decision with the ability to use the model as a tool during the decision process; the match between the outcome of the model and results reflected by the bibliography

are encouraging.. For this organizational target to have the possibility to evaluate the trade-offs between different investment scenarios is one of the benefits of the approach, even considering further work is required to refine the parameters used and the need to capture some additional elements to better explain the empirical evidence.

The usage of the NPV as the main evaluation of the investment seems to add flexibility and to better capture the realities of the financial pressure SME have when facing this type of investment.

The preliminary execution of the model suggest that maturity improvements to up to CMMI Level 3, which is typically considered the gate to participate in larger international projects, can be achieved by small organizations with reasonable risk and organizational sacrifice.

A realistic investment horizon seems to be higher than 36 months, the probability of a successful investment with smaller horizons although not zero is considerably smaller. This result strongly suggest the imperative to sponsor smaller companies by providing fiscal, economic and financial support to help hedge the SPI initiatives requiring a larger investment cycle than their business context could allow. The need of placing emphasis in methodologies, best practices and tools to reduce the implementation time as a gate factor for smaller companies to become enabled to operate as high maturity organizations is strongly suggested by the results.

The appraisal cost has a lower impact in the overall investment performance than often assumed by small companies; although in need of being optimized the results suggest this is not necessarily a priority direction to be taken by the industry.

The organizations operating in highly volatile market segments would have objective issues on implementing formal projects unless there are incomes or underlying assets outside the software development projects that gets impacted in their valuation because of the higher certainty. However if these organizations factors the lower uncertainty level they will operate at higher maturity levels that this might create financial incentives to embrace SPI initiatives as well.

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Appendix. I-Model Parameters

Small Organization Software Process Improvement Modelling

Parameters to achieve an initial formal maturity increase to SEI-CMMI Level 3 thru an SPI process.

Parm	Name	UM	Min	Med	Max	Reference
Ksepg	% Organization to SEPG	%Org	0,8%	0,8%	0,8%	[15,20,30,35]
Kprod	Productivity Gain after SPI	%Org	8,0%	22,0%	48,0%	[07]
Kspi	% Organization to SPI	%Org	0,8%	0,8%	2,3%	[15,20,35]
Ca	Assessment Costs	FTE	8,0	12,0	16,0	Based on $20K-$30K-$40K range
Eae	Appraisal Execution Effort	FTE	2,7	2,7	6,5	[09,20],10Persx2Wks+3Persx2Wks
Eap	Appraisal Preparation Effort	FTE	0,6	0,9	1,3	[09,10,20]
ti	Time to Implement	Months	18,0	20,0	32,0	[10,15,18,20,35,37]
Etp	Training Preparation Effort	Hrs	12,0	18,0	24,0	[Authors estimation]
Epa	Training Effort per PA-Person	Hrs	4,0	6,0	8,0	[20,41]
	CMMI Level		**λ(**)**	**Npa**	**ξ (*)**	
	Level 3		0,633	21	94%	

(*) McGibbon [44] and SEI Assessment Data Base [50] / (**) Colla & Montagna [11,12,13]

Appendix. II-Modeled Relations and Equations

[Ec 1] $E_{spi} = K_{spi} \times N$	[Ec2] $E_t = \lfloor (E_{PA} \times N) + E_{tp} \rfloor \times N_{PA}$	[Ec 3] $E_{ca} = \left(C_a / C_{PE} \right)$
[Ec4] $E_a = E_{ap} + E_{ad} + E_{ca}$	[Ec 5] $E_{sepg} = K_{sepg} \times N$	[Ec 6] $I_{prod} = K_{prod} \times N$
[Ec7] $V_i = \left(K_{prod} - K_{sepg} \right) \times N$	[Ec8] $V_i = \xi \times \left(K_{prod} - K_{sepg} \right) \times N$	[Ec 9] $NPV = \sum_{t=0}^{n} \frac{F_t}{(1+r)^t}$
[Ec10] $NPV = \int_0^{\infty} F(t) \times e^{-\delta t} dt$ $\delta = Ln(1+r')$	[Ec 11] $\lambda = \frac{\mu_i}{\sigma_i} \frac{\sigma_o}{\mu_o}$	[Ec12] $r' = r_f + \lambda \times (r - r_f)$