



Framework to Evaluate SPI in Small Organizations

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Organizations of all sizes understand the benefits to consider Software Process Improvements (SPI) investments, still many of them and in particular the smaller ones are reluctant to embrace this kind of initiatives. A systemic model is presented in this article as a tool aiming to provide an initial understanding over the behavior of the different organizational variables involved and their complex interactions within a SPI effort, their contribution to the improvement effort, the resulting value sensitivity to model parameters, the systemic relations at large and the limits derived from the holistic interaction of all in order to be used as a scenario analysis tool to identify the SPI strategies which best suit a given organization business context thru the maximization of the value obtained from the investment.



Pedro E. Colla

Graduated as Electronic Engineer from UBA (Argentina) in 1981, did postgraduate studies in Computer Sciences (IBMUSE, USA) in 1991; got a MBA degree from IDEA (Argentina) in 1997, a Software Management postgrade (MU, USA) in 2003 and currently is working towards completing a Doctorate in Engineering at UTN-FRSF (Argentina), authored several papers at international conferences on the Software Engineering field. Have extensive professional experience in the IT industry in general and the software development field in particular, holds certifications in project management and quantitative quality management (Six Sigma black belt). Co-director of the Embedded Systems postgrade at the Instituto Universitacion Aeronáutico (Argentina). Work as the Applications Services manager at the Global Competency Center EDS has in the city of Córdoba (Argentina) delivering applications development and management services to a world wide customer base.

Presentation

- Introduction.
- SPI context and issues.
- Investment modeling.
- Model execution.
- Limitations and further work.
- Conclusions.



Introduction

- Software development organizations leadership dilemma:
 - **How to justify investment required to perform SPI?**
- Short vs. Long term tension.
- Competitiveness vs. Buyer pressure, specially in off-shore.
- Small & Medium Enterprises.
 - Important player, both in company numbers and participation.
 - Understand the benefits of SPI.
 - Are reluctant to embrace initiatives.
 - Fairly long cycle times and large investments needed.
 - Perception of scale issues apply, specially with formal frameworks.
 - Affordability and suitability of formal SPI (CMMi) often questioned.
 - Lack of investment evaluation tools.
- Standard tools in bibliography fails to properly capture risk.
 - Economic vs. Financial evaluations.
- Dispersed data without systemic integration.

SPI Context and Issues

- Adoption of standard reference models.
 - Many available, CMMi being probably the most commonly required.
 - Industry acceptance with long standing record of usage.
- Significant criticism being made.
 - Questioning ability to drive sustainable improvement.
 - Still concluding a pressure to improve maturity exists.
 - SMEs willing to focus on Product rather than Process.
- Competitive pressure.
 - Reference models perceived as to reduce buyer risk.
 - Complexity and scale enablement.
 - Productivity & Quality requirements.
 - Competition “arms race”.
 - Perceptions and Politics.



Model

Investment Modeling

- SPI requires a significant investment, implementation costs:
 - Effort to develop & implement
 - Policies, plans, processes, instruments and metrics.
 - Often with the involvement of the vital few core team members.
 - Deployment and institutionalization for consistent usage.
 - Formal appraisal & consolidation.
 - On-going maintenance.
- Main benefits.
 - Increased income (new customers or additional work from current).
 - Cost efficiency (less defects, better cycle time).
 - Can be modeled as a productivity increase.
 - Value protection, reduce delivery risk.
 - Other intangible.
 - Brand, Employee morale, Organizational maturity at large.

Implementation Costs

- Improvement Effort (E_{SPI}).
- Training Costs (E_t).
 - Training Preparation Effort (E_{tp}).
 - Training Delivery Effort (E_{td}).
- Appraisal Costs (E_a).
 - Appraisal Preparation Effort (E_{ap}).
 - Appraisal Delivery Effort (E_{ad}).
 - Appraisal Costs & Fees (C_a).
- Software Engineering Groups effort (E_{SEPG}).

Some costs are proportional to the organization size while others are fairly fixed and related to the model requirements.

Investment increases in relative terms as the Cost per Engineer (CPE) is smaller because of the fixed costs impact.

Investment Returns

- Difficult to factor income increases.
 - Might define the ultimate fate of the organization anyway.
 - Lack of systemic references to seize the impact.
- Difficult to factor intangible benefits.
 - Still captured by the model to a point thru the opportunity cost.
- Increase of delivery certainty.
 - Does increase the value because of the lower risk.
 - But it is entirely passed to the buyer.
 - Except for the lower opportunity cost applied by the organization.
- Operational efficiency, productivity (I_{PROD}).
 - Tangible results the organization will get.
 - Floor scenario for the investment return (conservative view).
 - Returns will be dependant on organization size (scale).
 - Partial implementation returns feasible (but ignored by the model).
 - Dependant on how far into the future the organization is willing to look.

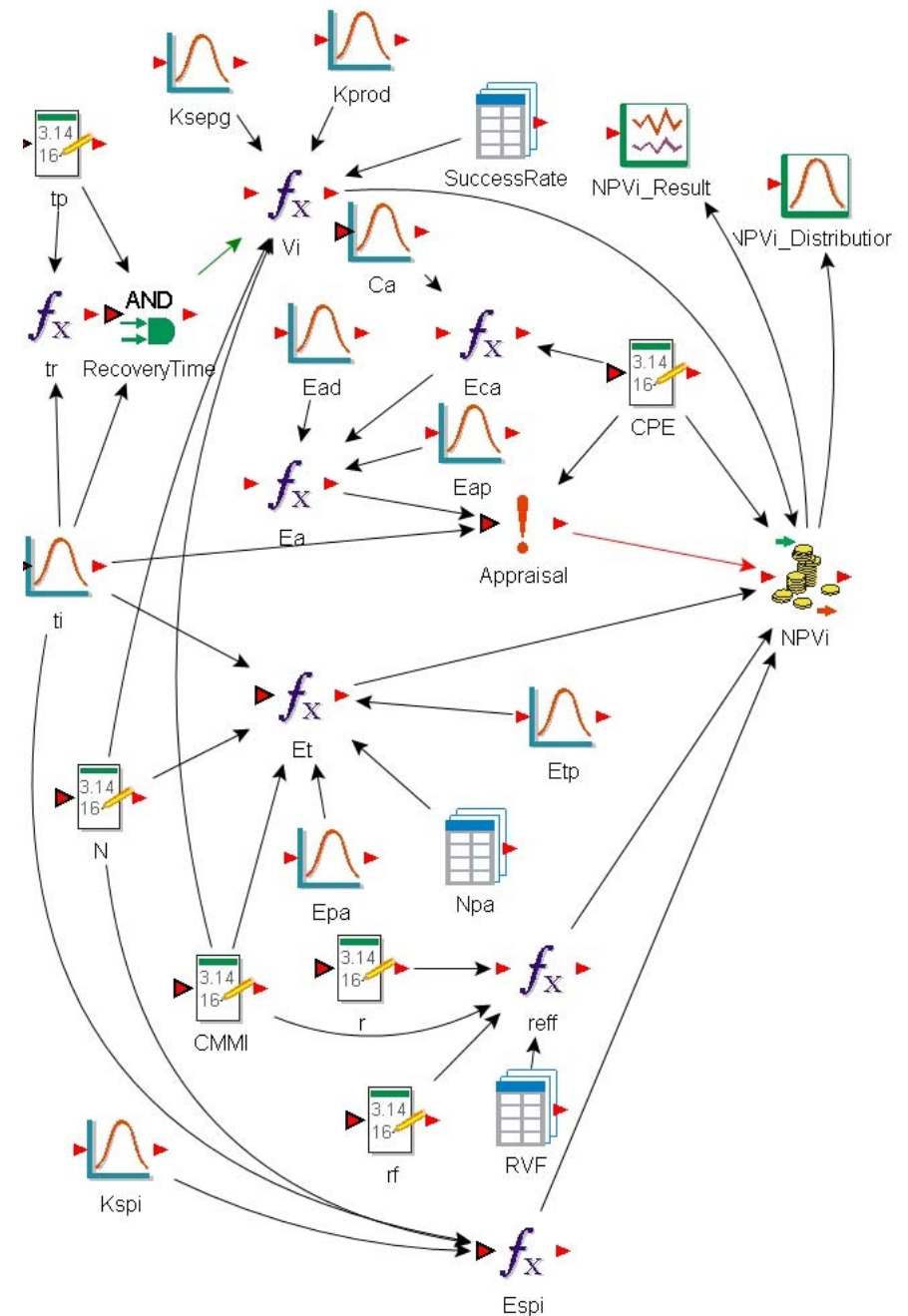
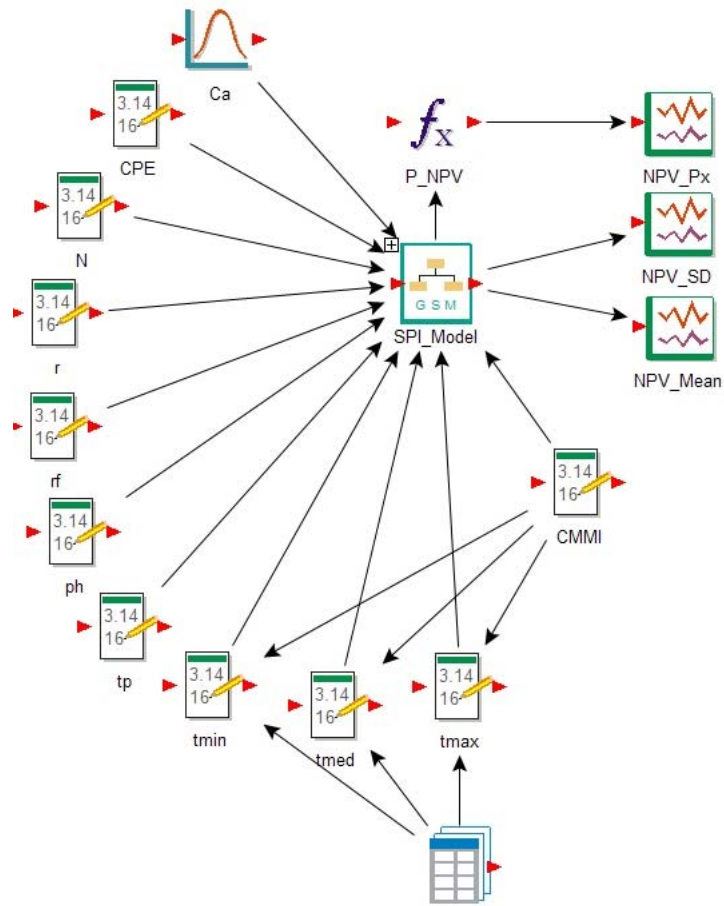
Investment Analysis

- Return on Investment (ROI).
 - Often cited as the major investment evaluation indicator.
 - Simple conceptual split between good and bad ($ROI > 1$).
 - Limited capability to factor time and risk factors of SMEs.
 - Investment horizons are critical.
 - Financial muscle and dependencies paramount to this segment.
- Net Present Value (NPV).
 - Very seldom used in bibliography of SPI.
 - Complex construct but good split between good and bad ($NPV > 0$).
 - Properly factors time and risk premiums for money.
 - Captures the overall picture for the organization.
 - Intangibles.
 - Long term survival factors.
 - Short term sources of risk.



Execution

Model Implementation



- Distribution of likely values used.
- CMMi v1.2 assumed.

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Model Formulation

$$NPV_i = PV(V_i) - PV(E_a) - PV(E_{spi}) - PV(E_t)$$

Where V_i is the difference between the productivity gains (I_{PROD}) and the effort to maintain the process (E_{SEPG}).

$$NPV_i = \xi \int_{t_i}^{t_p} V_i \times e^{-\delta t} dt - \left[\frac{E_a}{(1+r)^{t_i}} + \int_0^{t_i} (E_{SPI} + E_t) \times e^{-\delta t} dt \right]$$

Where

t_i is *Implementation Cycle Time* and

t_p Total investment horizon allowed by the organization.

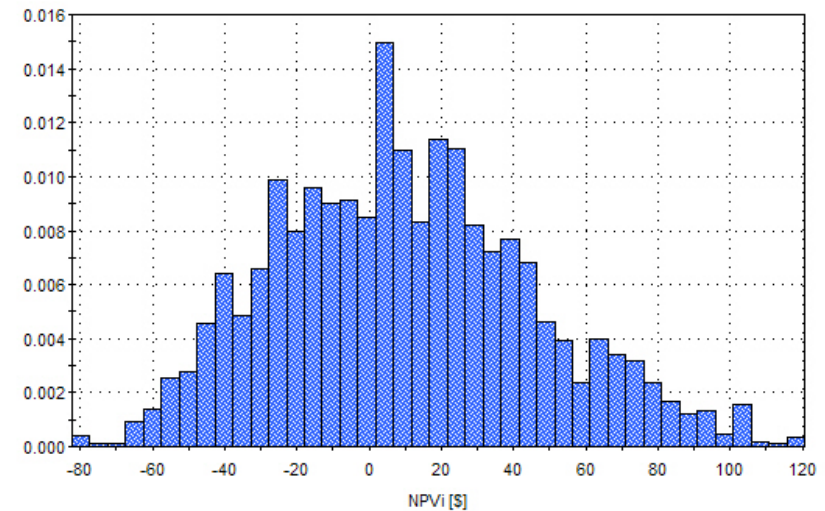
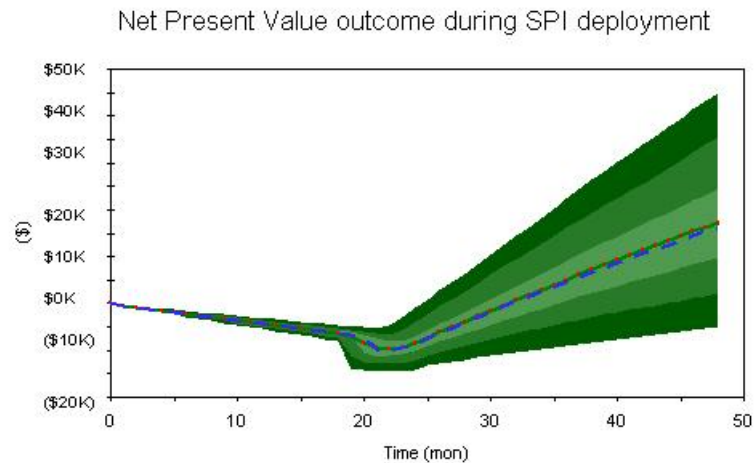
ξ represents the likelihood of a successful appraisal

δ the instantaneous capitalization rate.

Opportunity Cost

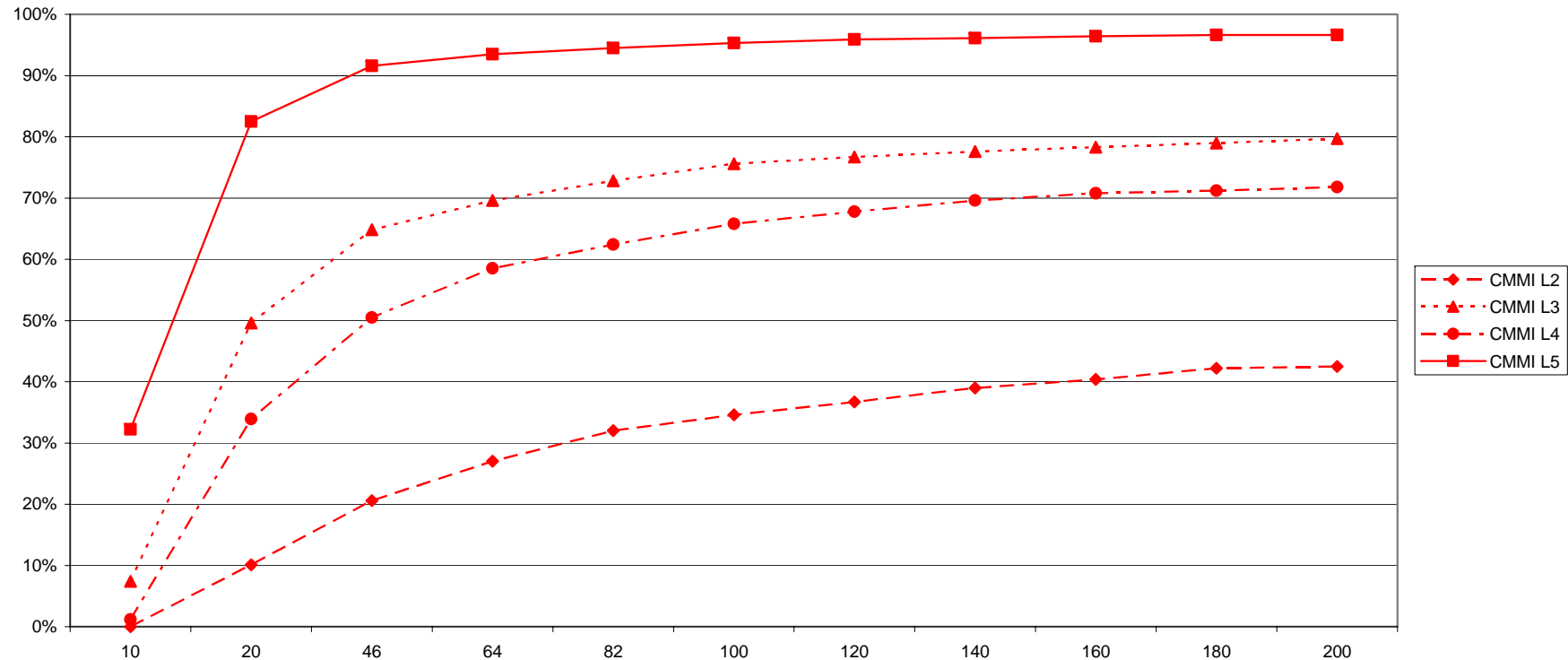
- Captures the risk (uncertainty) on the organization outcome.
 - Conceptually involves several tangible and intangible factors.
- Increased delivery certainty.
 - The opportunity cost should go down.
- Under same investment profiles.
 - The return shall be higher in the same time.
 - The return would be allowed more time to realize.
- Incorporation of the *Risk Variation Factor* (λ)
 - Additional return as a value creation effect of the SPI investment.

Model Execution



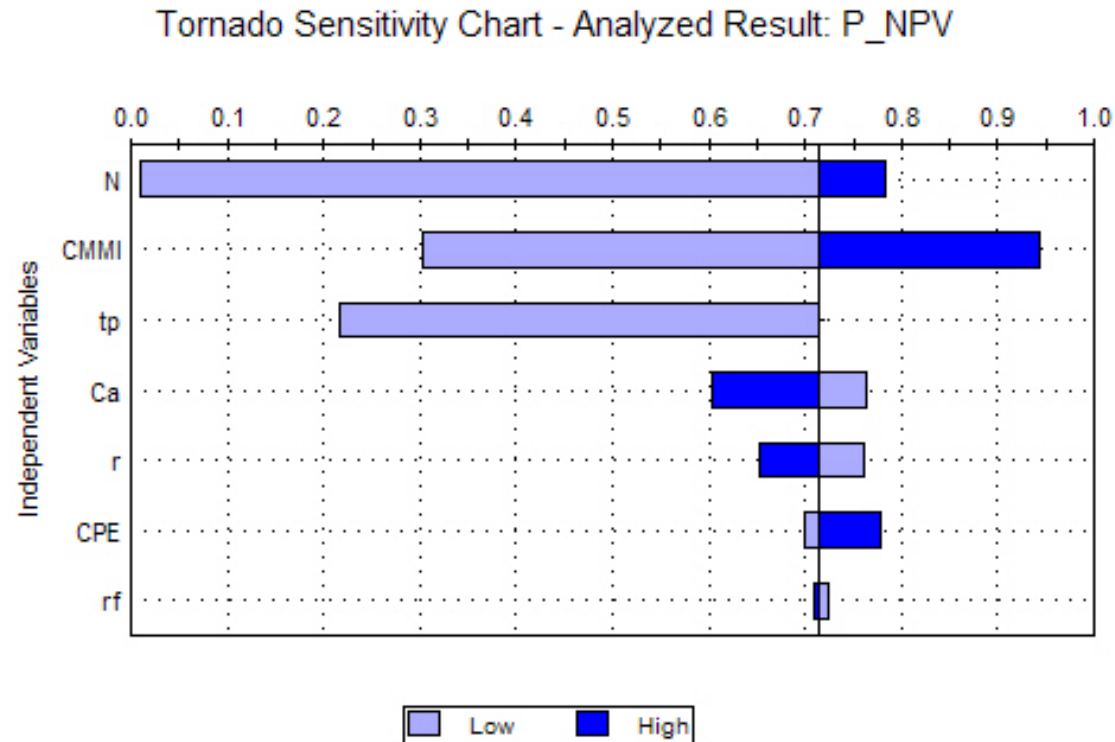
- MonteCarlo method used.
- Result from a typical run (stochastic scenarios).
 - NPV as a function of the time.
 - Probability distribution of different NPV outcomes.

Sensitivity to Organizational Size



- Entry maturity levels within reach of small SMEs.
- Higher maturity levels within range of medium SMEs.
- This is a conservative floor given the model assumptions.

Sensitivity to Organizational Factors



- Highest sensitivity with Organizational Size, CMMI and horizon.
- Medium sensitivity with Appraisal Costs, Discount rate and CPE.



Summary

Limitations and further work

- Simplifications made.
 - Data ranges taken from different sources, assumed consistent.
 - Conservative view, limited sources of income.
 - Intangible benefits partially factored.
- Validation required.
 - Ranges requiring further validation.
 - Further research needed to field test the model.
 - National and Regional sources needs to be integrated.
- Additional factors needed to explain observed reality.
 - Income increase.
 - Forces for lower CPE organizations to have higher frequency.

Conclusions

Methodology conclusions.

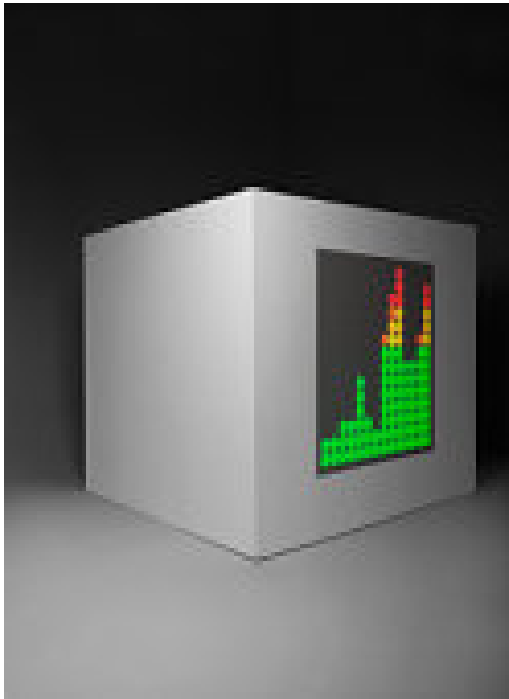
- Model formulation is complex, but evaluation is straightforward.
- Standard financial tools, easy to integrate on business cases.
- NPV better at capturing SMEs context and dynamics.
- Likelihood distribution more flexible than static business cases.

SME related conclusions (preliminary).

- Small organizations have a good case for entry maturity levels.
- Medium organizations have a good case for high end levels.
- Critical dependency on allowed investment horizon.
 - Horizon greater than what typically been perceived as affordable.
 - Hedging instruments required to help SMEs.
 - Emphasis to be placed on deployment frameworks to reduce cycle time.
- Appraisal costs impacts on overall investment not dominant.
- Benefits for organizations operating at volatile (uncertain) segments.



Q&A



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