

Software Process Improvement



Modeling Return-on-Investment (ROI)

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Definitions



Definitions

Definition	Source
Actual value developed by comparing program costs to benefits	Rachlin97
Measuring magnitude of benefits relative to costs	Lim98
Net benefit after expending some level of resources	Poulin97
Profit computed by dividing net income by assets used	Reifer02

Methods



Methods

Methods	Source
Mathematical programming, goal programming, transportation-assignment, branch and bound, decision tables, decision trees, forecasting, PERT/CPM, inventory, Markov chains, waiting lines, simulation, heuristic programming, game theory, dynamic programming	Turban94
Expected value, optimal decision policy, decision trees, value of information, Monte Carlo simulation, dynamic project modeling, parameter method, moments method, fuzzy logic, approximate integration, etc.	Schuyler96
Breakeven analysis, cause-and-effect analysis, cost/benefit analysis, value chain analysis, investment opportunity analysis, pareto analysis, payback analysis, sensitivity analysis, trend analysis	Reifer02

Model



Model

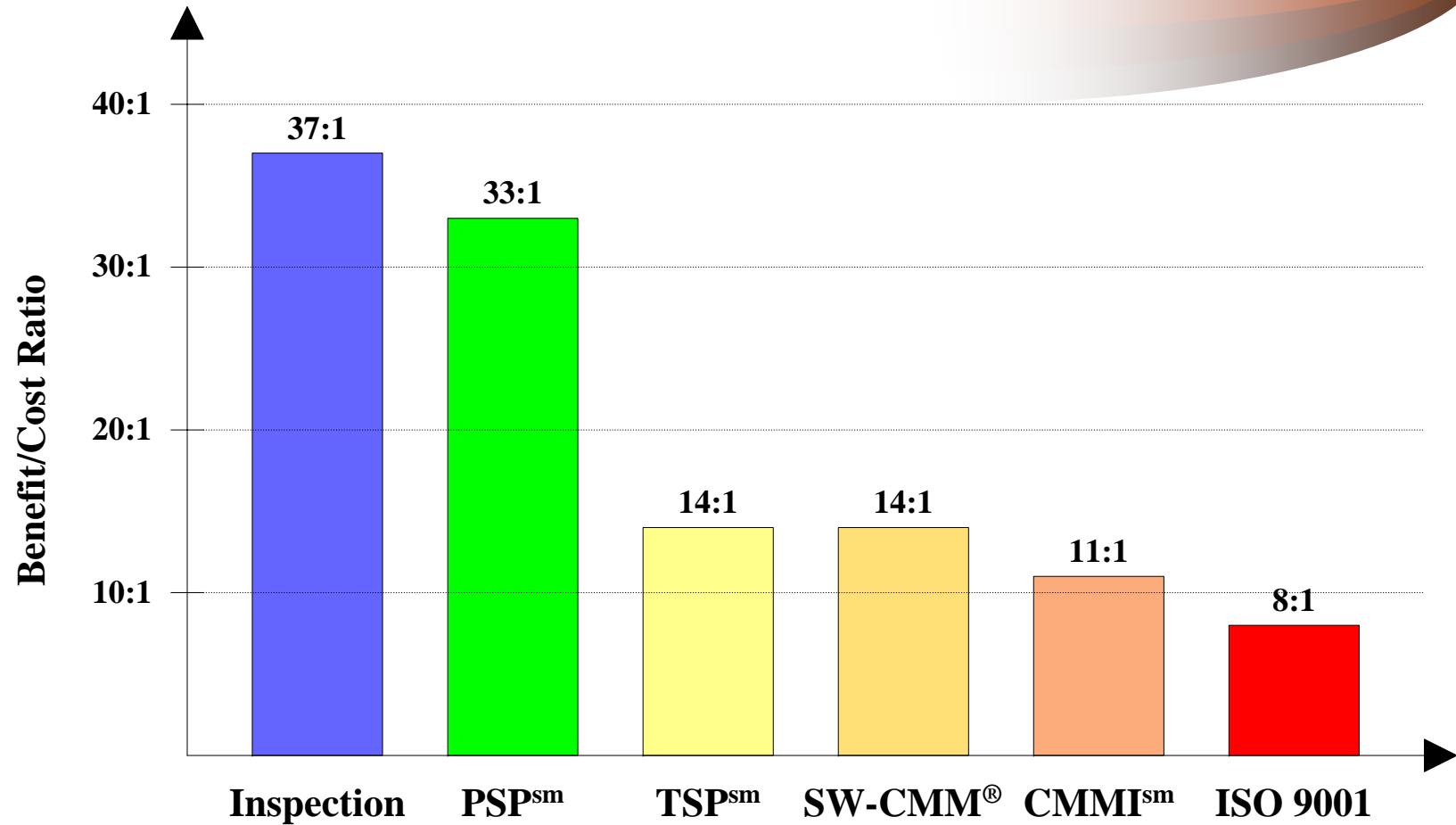
Type	Model
Benefit/ Cost Ratio	$B/CR = \frac{\text{Benefits}}{\text{Costs}}$
Return on Investment	$ROI (\%) = \frac{\text{Benefits} - \text{Costs}}{\text{Costs}} \times 100$

Rachlin, R. (1997). Return on investment manual: Tools and applications for managing financial results. Armonk, NY: M. E. Sharpe.

Examples



Examples



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Inspections

Model	Estimation
Training Cost	$(\$410 \text{ fee} + \$2,400 \text{ labor}) \times 4 \text{ people} = \$11,240$
Project Cost	$10 \text{ KSLOC} / 240 \text{ LOC per meeting} * 17 * \$100 \text{ per hour} = \$70,833$
Life Cycle Benefits	$(41,800 - 11,806 \text{ maintenance hours}) * \$100 \text{ per hour} = \$2,999,400$
Benefit/Cost Ratio	$\$2,999,400 \text{ benefits} / \$82,073 \text{ costs} = 37:1$
ROI%	$(\$2,999,400 \text{ benefits} - \$82,073 \text{ costs}) / \$82,073 \text{ costs} = 3,555\%$

Rico, D. F. (n.d./2000). Software inspection process: Technical overview [WWW document]. URL <http://davidfrico.com/sipexec-d.pdf>

PSP

Model	Estimation
Training Cost	$(\$5,000 \text{ fee} + \$5,400 \text{ expenses} + \$15,384 \text{ labor}) \times 4 \text{ people} = \$103,136$
Project Cost	$10 \text{ KSLOC} / 25 * \$100 \text{ per hour} = \$40,000$
Life Cycle Benefits	$(46,646 \text{ maint and develop hours}) * \$100 \text{ per hour} = \$4,664,600$
Benefit/Cost Ratio	$\$4,664,600 \text{ benefits} / \$143,136 \text{ costs} = 33:1$
ROI%	$(\$4,664,600 \text{ benefits} - \$143,136 \text{ costs}) / \$143,136 \text{ costs} = 3,159\%$

Rico, D. F. (n.d./2000). Personal software process (PSP): Technical overview [WWW document]. URL <http://davidfrico.com/pspecec-d.pdf>

TSP

Model	Estimation
Training Cost	$(\$9,000 \text{ fee} + \$8,100 \text{ expenses} + \$19,230 \text{ labor}) \times 4 \text{ people} = \$145,320$
Project Cost	$10 \text{ KSLOC} / 0.1685 * \$100 \text{ per hour} = \$168,500$
Life Cycle Benefits	$(45,203 \text{ maint and develop hours}) * \$100 \text{ per hour} = \$4,520,300$
Benefit/Cost Ratio	$\$4,520,300 \text{ benefits} / \$313,820 \text{ costs} = 14:1$
ROI%	$(\$4,520,300 \text{ benefits} - \$313,820 \text{ costs}) / \$313,820 \text{ costs} = 1,340\%$

McAndrews, D. R. (2000). The team software process (TSP): An overview and preliminary results of using diciplined practices (CMU/SEI-2000-TR-015). Pittsburg, PA: Software Engineering Institute.

Software CMM

Model	Estimation
Deployment Cost	$(7,109 \text{ implementation and prep hours}) \times \$100 \text{ per hour} = \$710,900$
Assessment Cost	$1,000 \text{ hours} * \$100 \text{ per hour} + \$40,000 \text{ fee} = \$140,000$
Life Cycle Benefits	$(121,643 \text{ maint and develop hours}) \times \$100 \text{ per hour} = \$12,164,300$
Benefit/Cost Ratio	$\$12,164,300 \text{ benefits} / \$850,900 \text{ costs} = 14:1$
ROI%	$(\$12,164,300 \text{ benefits} - \$850,900 \text{ costs}) / \$850,900 \text{ costs} = 1,330\%$

Rico, D. F. (n.d./2001). SEI level 2 thru 5: Cost model [WWW document]. URL <http://davidfrico.com/sw-cmm-cost.pdf>

CMMI

Model	Estimation
Deployment Cost	$(18,867 \text{ implementation and prep hours}) \times \$100 \text{ per hour} = \$1,886,700$
Assessment Cost	$1,760 \text{ hours} * \$100 \text{ per hour} + \$64,615 \text{ fee} = \$240,615$
Life Cycle Benefits	$(243,285 \text{ maint and develop hours}) \times \$100 \text{ per hour} = \$24,328,500$
Benefit/Cost Ratio	$\$24,328,500 \text{ benefits} / \$2,127,315 \text{ costs} = 11:1$
ROI%	$(\$24,328,500 \text{ benefits} - \$2,127,315 \text{ costs}) / \$2,127,315 \text{ costs} = 1,044\%$

Rico, D. F. (n.d./2001). Capability maturity model integration: CMMI cost model [WWW document]. URL <http://davidfrico.com/cmmi.pdf>

ISO 9001

Model	Estimation
Deployment Cost	$12.6 \text{ months} * 173.33 \text{ hours per month} * \$100 \text{ per hour} = \$218,396$
Assessment Cost	$640 \text{ hours} * \$100 \text{ per hour} + \$48,000 \text{ fee} = \$112,000$
Life Cycle Benefits	$(27,726 \text{ maint and develop hours}) * \$100 \text{ per hour} = \$2,772,600$
Benefit/Cost Ratio	$\$2,772,600 \text{ benefits} / \$330,396 \text{ costs} = 8:1$
ROI%	$(\$2,772,600 \text{ benefits} - \$330,396 \text{ costs}) / \$330,396 \text{ costs} = 739\%$

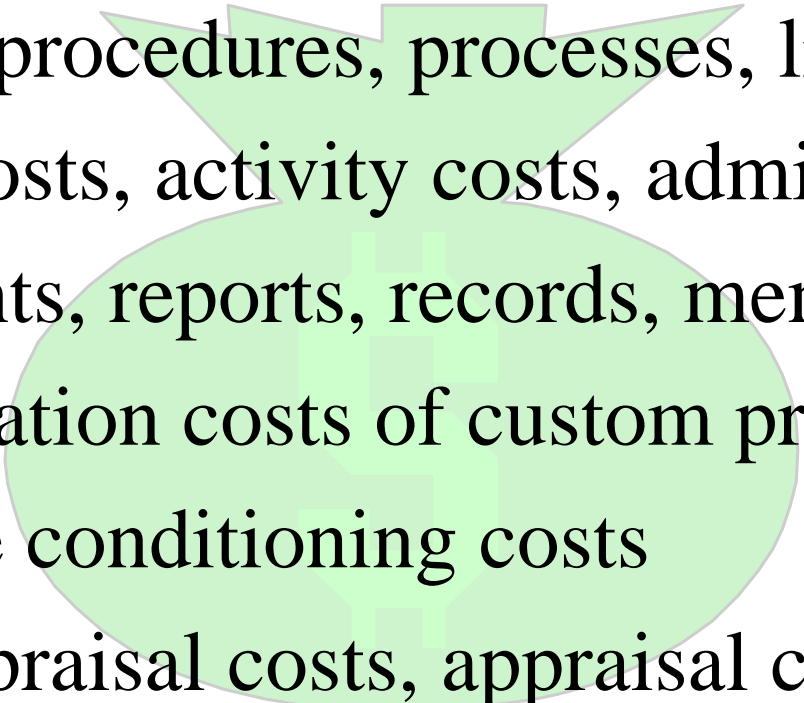
El Emam, K., & Briand, L. C. (1997). Costs and benefits of software process improvement (IESE-Report 047.97/E). Kaiserslautern, Germany: University of Kaiserslautern, Fraunhofer-Institute for Experimental Software Engineering.

Costs/Benefits



Typical Costs



- Training fees, labor hours, travel costs
 - Policies, procedures, processes, life cycles
 - Project costs, activity costs, administration
 - Documents, reports, records, memos
 - Indoctrination costs of custom processes
 - Response conditioning costs
 - Mock appraisal costs, appraisal costs
- 

Typical Benefits

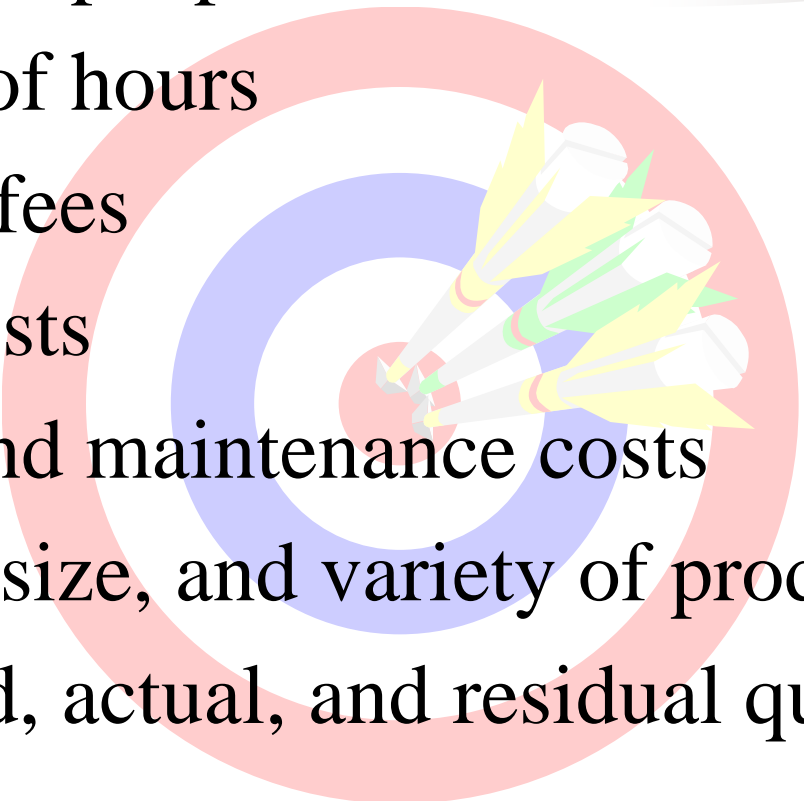
- Higher quality (fewer defects)
- Lower maintenance (less rework)
- Higher productivity (low development cost)
- Faster cycle times (quick time-to-market)
- Greater value (more product features)
- Greater variety (more product variations)
- High customer satisfaction (more contracts)

Data Validity



Data Accuracy



- Number of people
 - Number of hours
 - Training fees
 - Travel costs
 - Project and maintenance costs
 - Number, size, and variety of products
 - Estimated, actual, and residual quality
- 

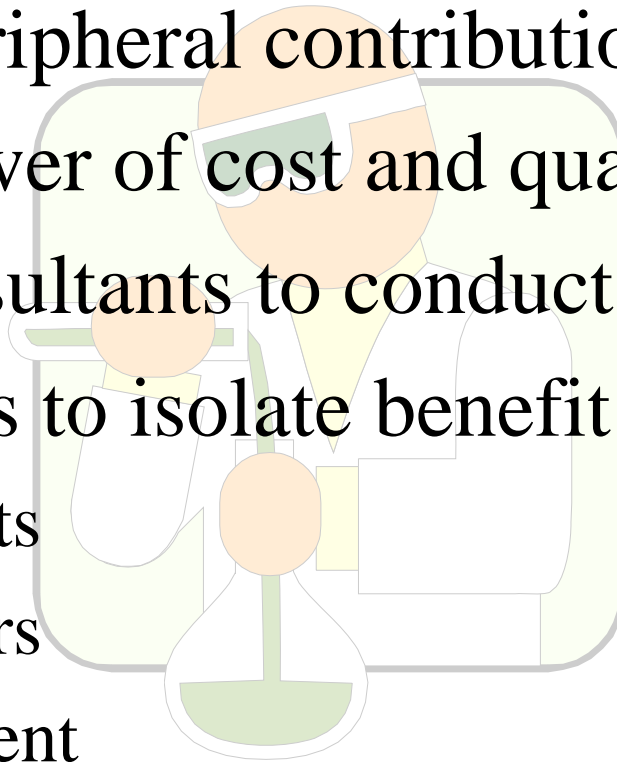
Data Completeness



- Use bottom-up versus top-down techniques
- Create complete work breakdown structure
- Include as many costs as possible
- Use fully-burdened costs
- Don't forget training costs
- Don't omit labor hours for training
- 70% of assessment cost is internal labor

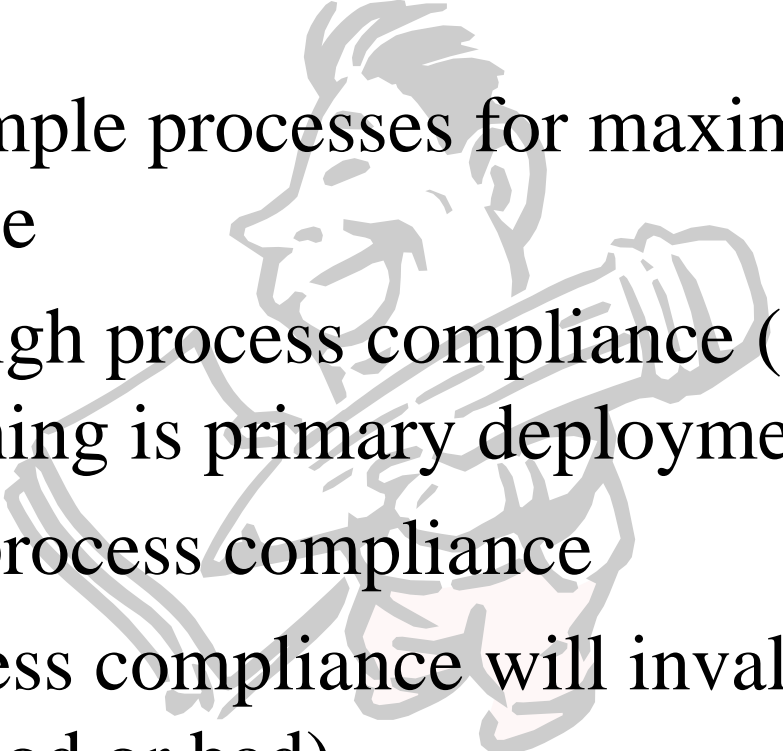
Benefit Isolation

- Use control groups to validate benefits
- Identify peripheral contributions to benefits
- Exploit power of cost and quality models
- Retain consultants to conduct benchmarking
- Use surveys to isolate benefit contribution
 - Participants
 - Supervisors
 - Management



Process Compliance



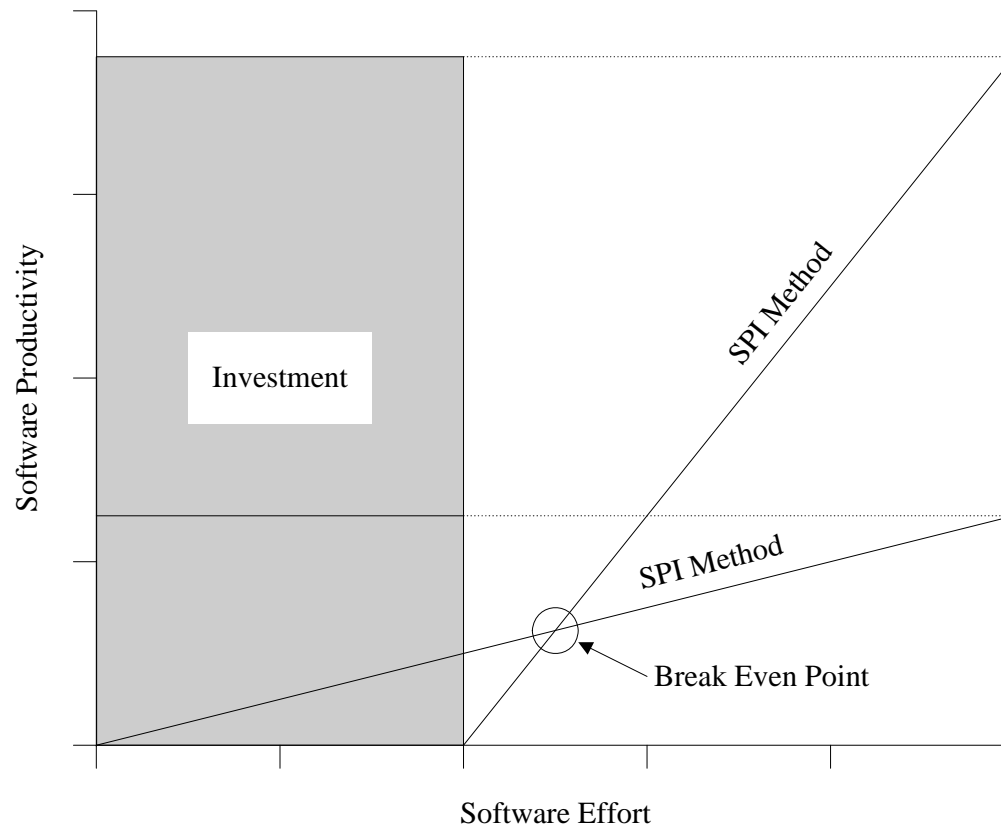
- Use professional policy and procedure principles
 - Design simple processes for maximum compliance
 - Aim for high process compliance (especially when training is primary deployment method)
 - Measure process compliance
 - Low process compliance will invalidate the results (good or bad)
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Advanced Issues

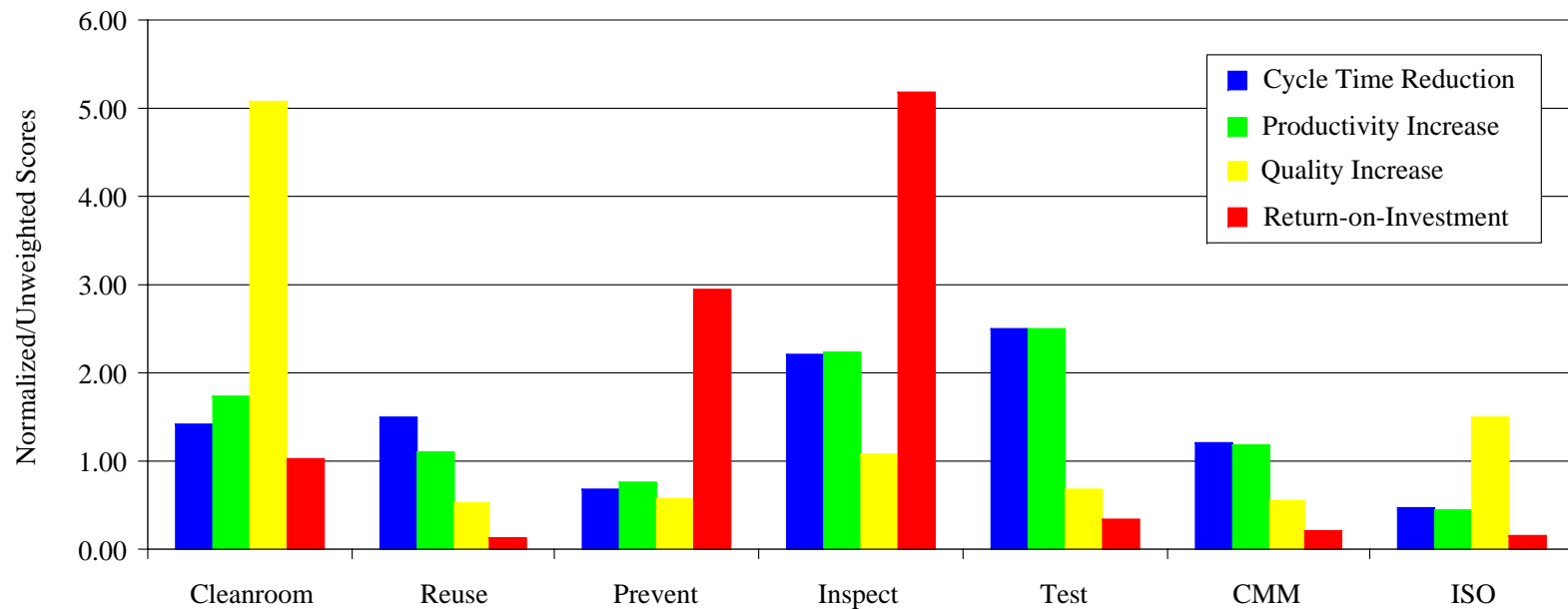


Breakeven Point

Break Even Point = Investment / Productivity Difference * Productivity Product



Right Solution



Rico, D. (2000). Using cost benefit analyses to develop software process improvement (SPI) strategies (Contract Number SP0700-98-D-4000). Rome, NY: Air Force Research Laboratory—Information Directorate (AFRL/IF), Data and Analysis Center for Software (DACs).

Common Myths

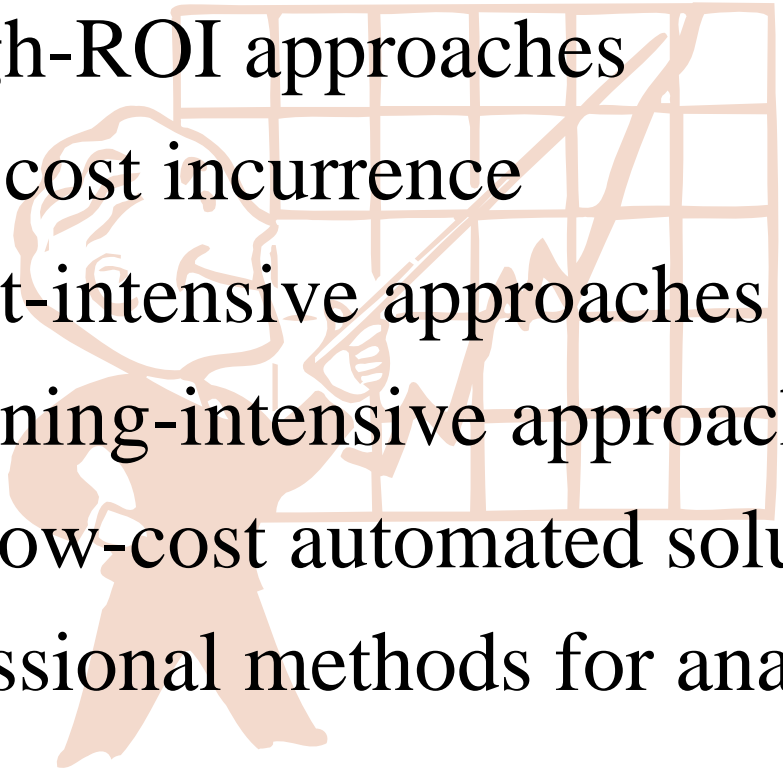
- Software process improvement has no ROI
- Process improvement takes a long time
- Process improvement is too expensive
- Process improvement can't be performed in a few hours, days, weeks, or months
- Process performance can't be measured in only a few hours, days, weeks, or months
- Process improvement is only for large, mission critical programs

Recommendations



Recommendations



- Pinpoint high-ROI factors
 - Target high-ROI approaches
 - Minimize cost incurrence
 - Avoid cost-intensive approaches
 - Avoid training-intensive approaches
 - Look for low-cost automated solutions
 - Use professional methods for analyzing ROI
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Further Readings



Further Readings

- Rico, D. F. (2001). Cost & benefit analysis: Choosing a SPI method for maximum return on investment (ROI). 2001 Joint Euroforum/Dutch Software Process Improvement Network Conference (SPIDER '01), Netherlands.
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- Reifer, D. J. (2002). Making the software business case: Improvement by the numbers. Upper Saddle River, NJ: Addison-Wesley.
- Turban, E., & Meredith, J. R. (1994). Fundamentals of management science (6 th ed.). Boston, MA: McGraw Hill.
- Schuyler, J. R. (1996). Decision analysis in projects: Learn to make faster, more confident decisions. Upper Darby, PA: Project Management Institute.