
The Return-on-Investment from Software Quality

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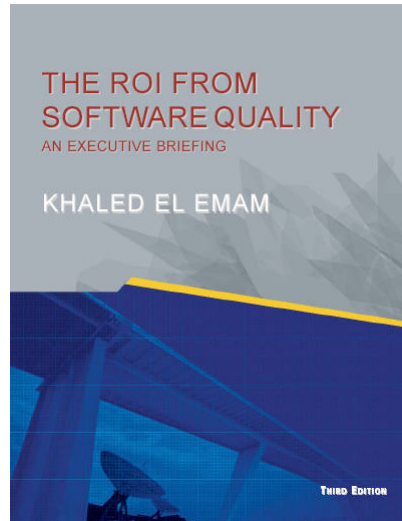
Agenda

- International Quality Benchmark
- The Cost of Low Quality
- Quality Improvement
- Benefits of Quality
- ROI Examples
- Efficiency, Profits, and Quality

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Source

- Third edition in January 2004
- All examples in this presentation come from that
- Published by the Ottawa Software Quality Association (www.osqa.org)



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Definition of Quality

Contents

- ▶ Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

- Customer Satisfaction is a commonly used measure of quality
 - Customer satisfaction embodies much more than the software product itself (e.g., service, reputation of vendor)
 - Not many organizations measure customer satisfaction (a recent survey found 1.3% of projects)
- We will use post-release defects as a measure of quality
 - There is evidence that software with many defects causes low customer satisfaction
 - Everyone will agree that software with defects is of low quality

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Are Defects Bad ? - I

Contents

- Benchmark
- ▶ Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

- Some companies claim that quality is not a business driver:
 - Most end-users emphasize usability and capability above performance and reliability
 - Contracts historically did not base reward/punishment on quality - no incentives
 - Bug fixes are packaged as new releases and sold - generate revenue
 - Deliberate insertion of defects and customer loyalty
 - Perception of quality and support contracts

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Are Defects Bad ? - II

Contents

- Benchmark
- ▶ Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

- But the probability of negative consequences is high:
 - There are increasing cases of costly litigation
 - Quality problems that lead to security vulnerabilities are a huge liability
 - Quality warranties are starting to appear in contracts
 - Low quality does increase software development and warranty costs:
 - Canadian companies spend 35% (est.) of their maintenance resources on fixing bugs
 - U.S. companies spend 28% of their maintenance resources on fixing bugs
 - Eventually low quality will lead to lower sales

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Are Defects Bad ? - III

Contents

- Benchmark
- ▶ Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

- Low quality damages a company's reputation and credibility; there is evidence that a good reputation is associated with increased sales
- There are serious national economic consequences to low quality

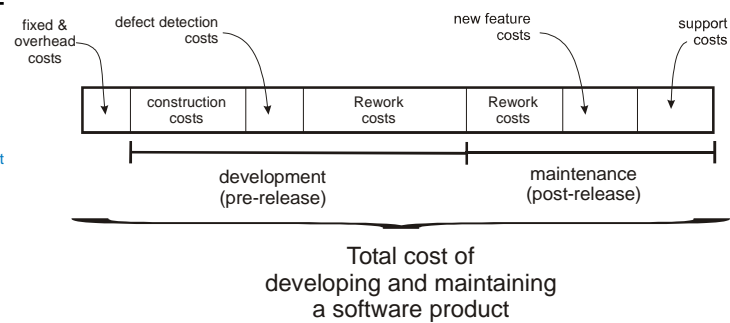
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Breakdown of Project Costs

Contents

- Benchmark
- ▶ Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End



- Consider the lifetime of a software product
- The same concept applies to multiple releases
- Large percentage consists of rework costs
- Most are labor (variable) costs

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Support Costs

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

- On average, software companies spend 8% of their revenues on support
- These costs are typically spread across projects
- The average proportion of staff employed in the support function is 15% of the total head count
- A recent survey reports that support can contribute 30% - 40% of an organizations revenue.
- Once a support contract is purchased, the renewal rate is 95% for high-end software and a respectable 75% for low-end software

(Data come from surveys conducted by the Association of Support Professionals)

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The Cost of Low Quality - I

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

- Defect detection costs (mostly testing): 22% to 36% of pre-release effort; can be as high as 90% if you include rework
- Pre-release rework around 44% of effort, ranging from 20% to 80%
- Post-release rework at the enterprise level ranges from 16% to 35%, but as high as 57% of individual effort

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The Cost of Low Quality - II

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

- The percentage of total maintenance resources devoted to bug fixes (Industry Canada):

Business Domain	Canada
Aerospace	30%
Financial	40%
Software	41%
Telecom. Equip.	50%
Telecom. Services	31%

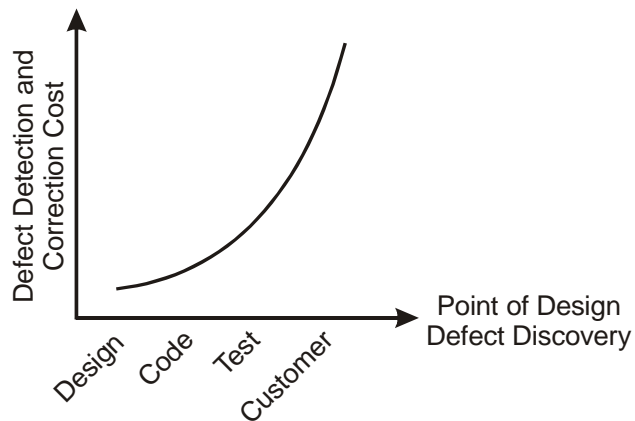
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The Cost of Defects

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End



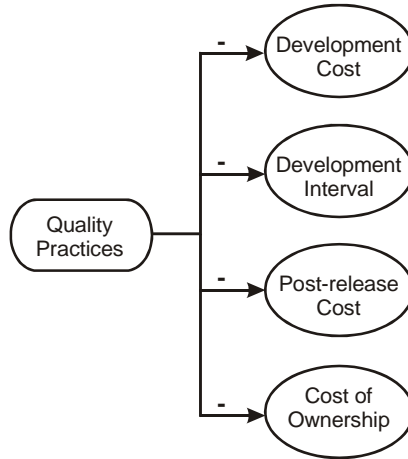
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Impact of Quality Improvement

Contents

- Benchmark
- Q Cost
- ▶ Improvement
- ROI
- Examples
- Efficiency
- End



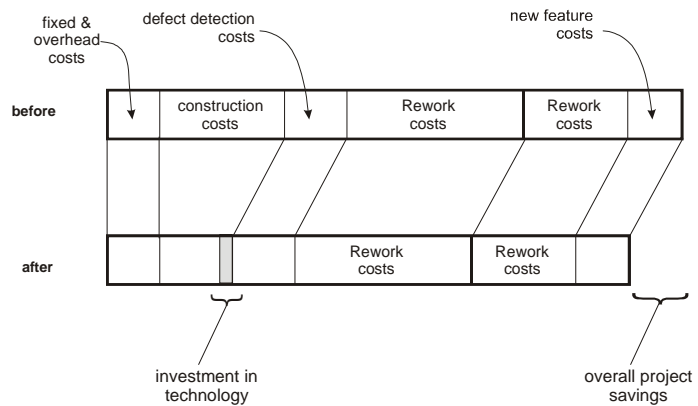
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Project Costs with Improved Efficiency

Contents

- Benchmark
- Q Cost
- ▶ Improvement
- ROI
- Examples
- Efficiency
- End



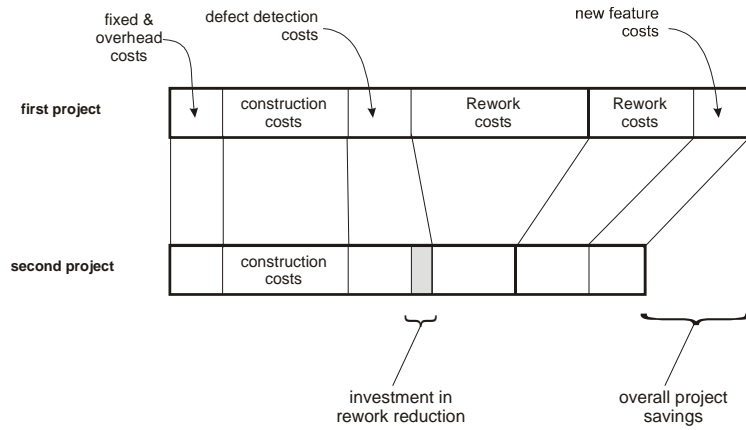
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Project Costs with Reduced Rework

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End



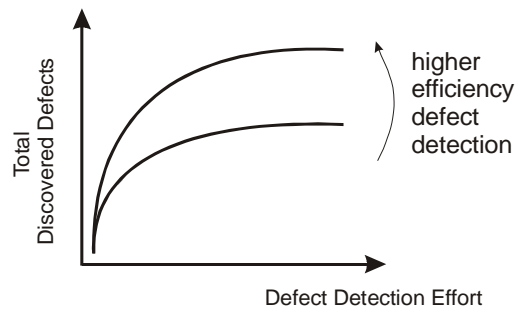
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How Defects Are Discovered - II

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End



- Pre-release defect discovery is through defect detection activities
- To improve defect detection you can either spend more effort, become more efficient, or both

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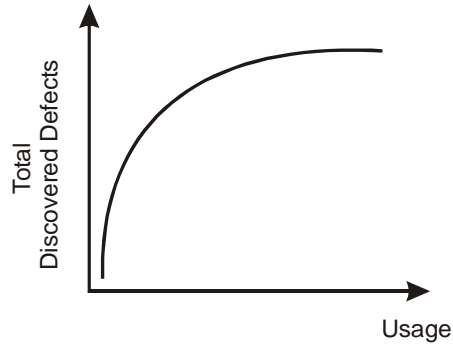
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How Defects Are Discovered - III

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

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- Post-release defect discovery is through usage
- Drivers of usage: number of users, number of machines, time, profile (experience)
- Most defects are found soon after a release

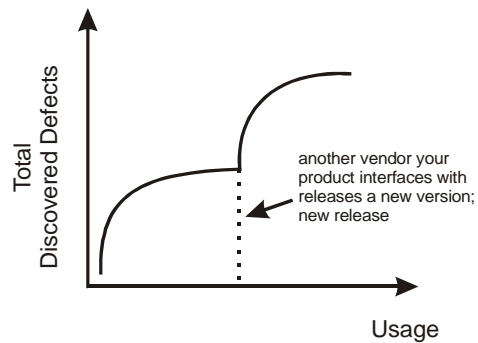
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How Defects Are Discovered - IV

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

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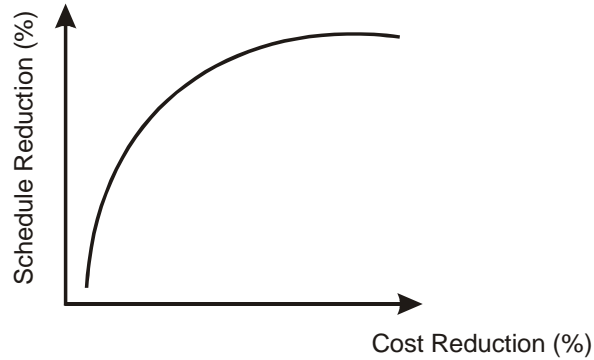
- Defect discovery may follow a step function over an extended period of time due to interactions with other products

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Schedule Benefits

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End



- Savings in effort (cost) translate to reductions in schedule as well

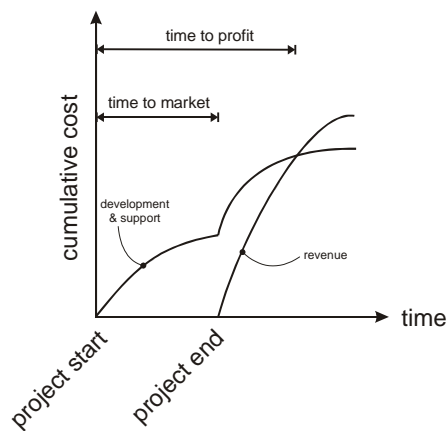
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Time to Profit

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End



- An important factor to take into account

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From the Customers' Perspective

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

- Customers suffer from low quality software (installation and post-purchase costs)
- The savings to customers if they buy better quality software can be quantified and the results are compelling
- Useful for:
 - Convincing purchasers to seek higher quality products
 - Helping make the case for vendors who decide to improve quality

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SW-CMM Maturity

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

	ML2	ML3	ML4	ML5
ML1	12.75%	27.75%	52.5%	64.5%
ML2		18%	47.25%	62.25%
ML3			39%	58.5%
ML4				40.5%

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Cost of Ownership by Domain

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

	Small	Medium	Large
MIS	62.25%	66.75%	55.5%
Systems Software	71.25%	61.5%	59.25%
Commercial	71.25%	63%	55.5%
Military	71.25%	69%	58.5%

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Cost of Ownership Within Country

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

	Best vs. Average	Best vs. Worst
Australia	53.25%	69.75%
Canada	66%	69.75%
India	72%	74.25%
Japan	63.75%	74.25%
Netherlands	60%	69%
UK	60.75%	74.25%
USA	52.5%	70.5%

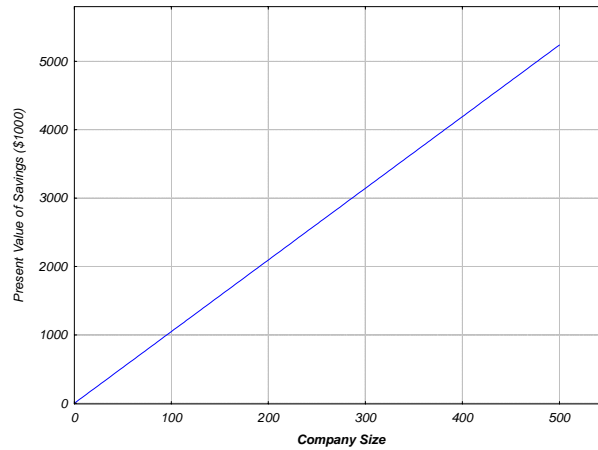
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Small Company Example

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End



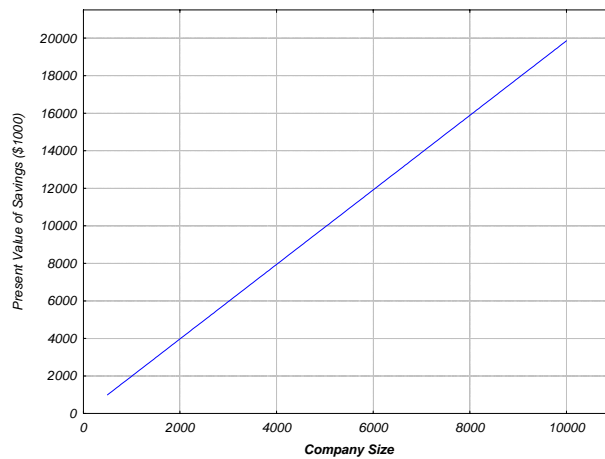
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Large Company Example

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End



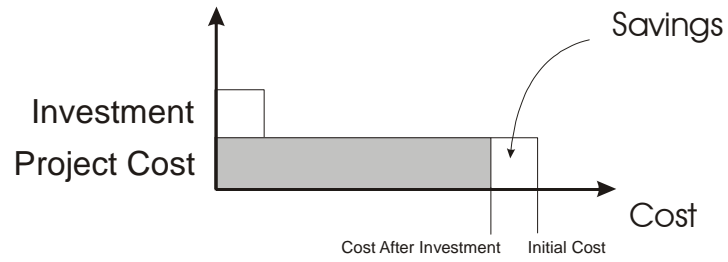
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Calculating Return on Investment (ROI) - Principles

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End



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ROI Calculation - I

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

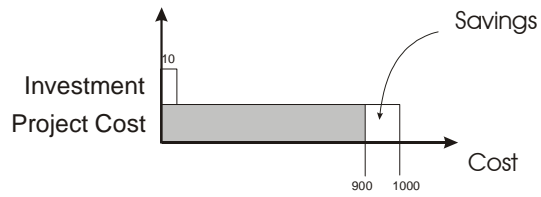
Most Common

$$ROI = \frac{Savings - Investment}{Investment}$$

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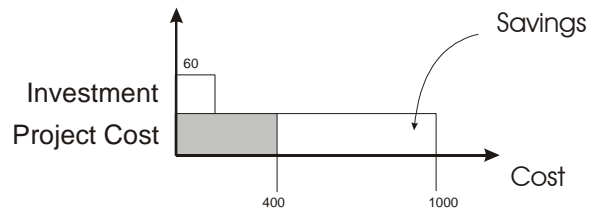
ROI Calculation - II



$$\text{ROI}_1 = 9$$

(900%)

ROI Calculation - III



$$\text{ROI}_1 = 9$$

(900%)

ROI Calculation - IV

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- ▶
- Examples
- Efficiency
- End

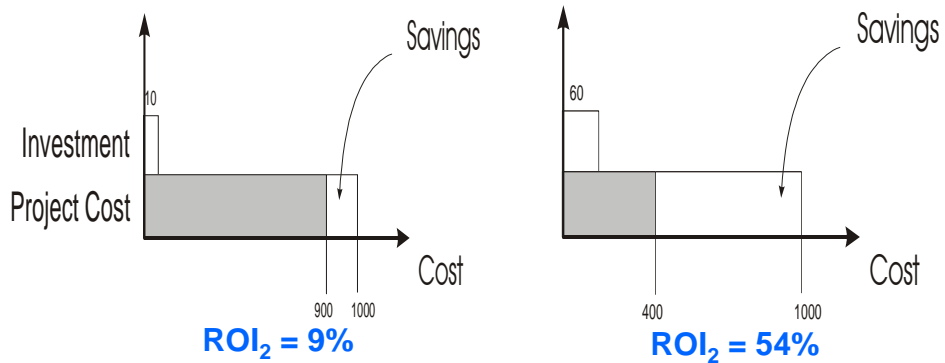
Alternative Calculation

$$ROI_2 = \frac{\text{Savings} - \text{Investment}}{\text{Original Cost}}$$

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ROI Calculation - V



Quality Management Practices

Contents

Benchmark	
Q Cost	
Improvement	
ROI	
Examples	<ul style="list-style-type: none">• Software inspections• Automatic defect detection• Risk assessment• Test first
Efficiency	
End	

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Benefits of Inspections - I

Contents

Benchmark	<ul style="list-style-type: none">• Benchmark data on the proportion of defects found (from published sources)												
Q Cost													
Improvement													
ROI													
Examples	<table border="1"><thead><tr><th></th><th><i>Minimum</i></th><th><i>Most Likely</i></th><th><i>Maximum</i></th></tr></thead><tbody><tr><td><i>Design Inspections</i></td><td>0.25</td><td>0.57</td><td>0.84</td></tr><tr><td><i>Code Inspections</i></td><td>0.19</td><td>0.57</td><td>0.70</td></tr></tbody></table>		<i>Minimum</i>	<i>Most Likely</i>	<i>Maximum</i>	<i>Design Inspections</i>	0.25	0.57	0.84	<i>Code Inspections</i>	0.19	0.57	0.70
	<i>Minimum</i>	<i>Most Likely</i>	<i>Maximum</i>										
<i>Design Inspections</i>	0.25	0.57	0.84										
<i>Code Inspections</i>	0.19	0.57	0.70										
Efficiency													
End													

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Benefits of Inspections - II

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

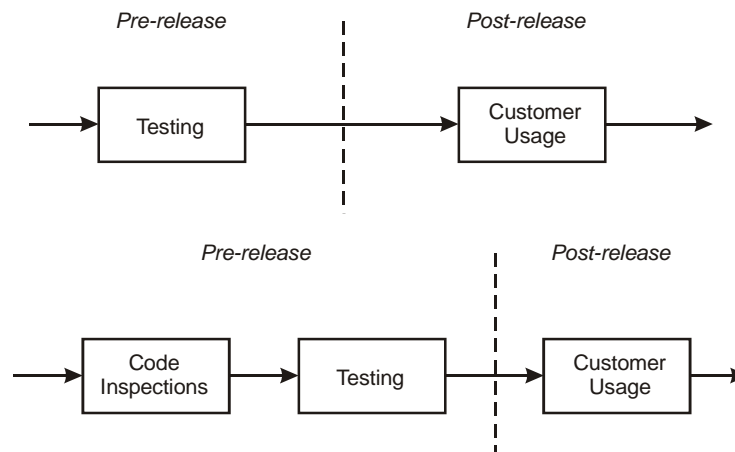
- Benchmark data on the effort spent in hours to detect and fix a defect (from published sources)

	<i>Minimum</i>	<i>Most Likely</i>	<i>Maximum</i>
Design Inspections	0.58	1.58	2.9
Code Inspections	0.67	1.46	2.7
Testing	4.5	6	17

ROI Analysis for Inspections

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End



ROI Analysis Context - I

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

- IT department in a financial institution
- Development project lasts 2 years and costs \$3m
- Maintenance period lasts 3 years with a total budget of \$3m
- The user organization has 2000 end-users
- System is 300 KLOC and 10 developers
- We wish to determine the total ROI from:
 - Code inspections
 - Test first programming
 - Automatic defect detection tool
 - Risk assessment driving inspections
- Discount rate = 5%

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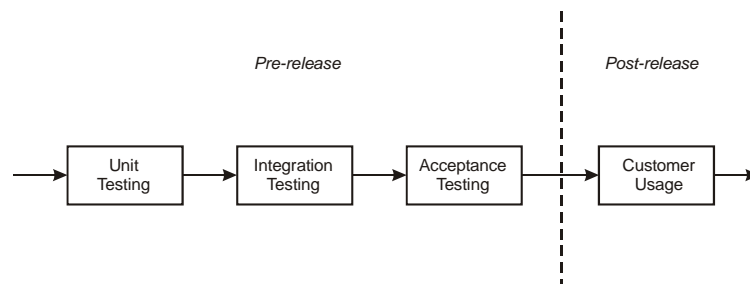
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ROI Analysis Context - II

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

- Current defect detection life cycle



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Code Inspections (before)

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- ▶ Efficiency
- End

Customer savings	\$687,762 (38.5%)
Pre-release savings	\$644,240 (24%)
Post-release savings	\$633,300 (26%)
Delivery schedule savings	8.5 weeks (8.2%)

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Sensitivity & Risk Analysis

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- ▶ Efficiency
- End

- The most influential variable is the ability of inspections to find defects
- The percentage of rework on the project is quite important as well
- The organization is quite conservative:
 - 0.8 probability of achieving at least \$855,051 total savings for the development organization
 - 0.8 probability of achieving at least \$463,752 total savings for the user organization

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Code Inspections (after)

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- ▶ Efficiency
- End

Customer savings	\$567,102 (32%)
Pre-release savings	\$516,457 (19%)
Post-release savings	\$522,195 (21%)
Delivery schedule savings	7 weeks (6.5%)

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Automatic Defect Detection

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- ▶ Efficiency
- End

Customer savings	\$41,024 (2.3%)
Pre-release savings	\$47,540 (1.7%)
Post-release savings	\$43,887 (1.7%)
Delivery schedule savings	>1 week (0.5%)

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Risk Assessment

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- ▶ Efficiency
- End

Customer savings	\$340,261 (19%)
Pre-release savings	\$327,585 (12%)
Post-release savings	\$313,317 (13%)
Delivery schedule savings	4 weeks (4%)

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Test First Development

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- ▶ Efficiency
- End

Customer savings	\$410,244 (23%)
Pre-release savings	\$475,403 (17%)
Post-release savings	\$438,864 (18%)
Delivery schedule savings	6 weeks (5.5%)

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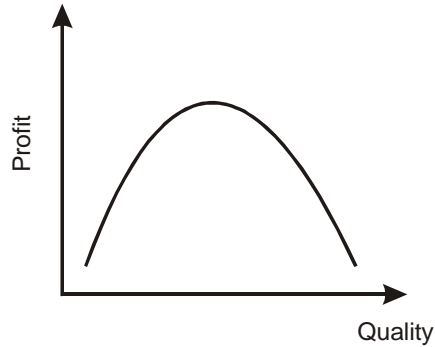
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Profits and Quality

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

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Profit = Revenue - (pre-release costs + post-release costs)

- There is an optimal quality level that maximizes profit
- Too little quality will impact revenue
- Too much quality would be too expensive to maintain

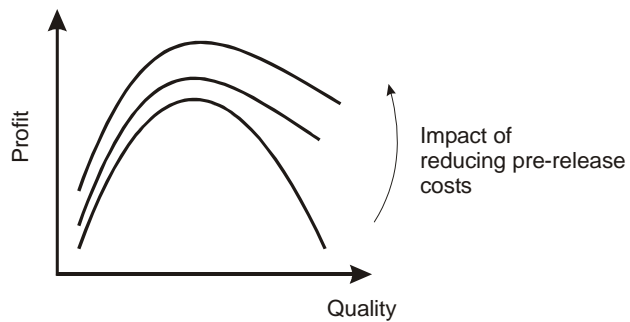
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Improving Pre-Release Efficiency

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

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- Maximizing pre-release efficiency is the optimal strategy for higher quality products
- For lower quality products the impact will be less pronounced

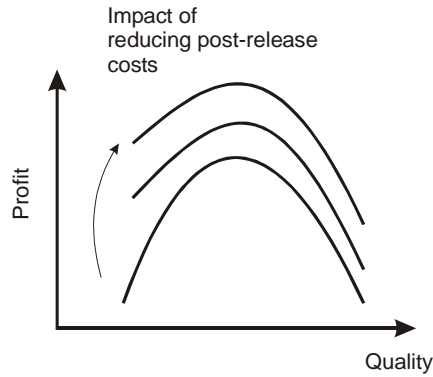
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Improving Post-Release Efficiency

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

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- Maximizing post-release efficiency is the optimal strategy for lower quality products
- For higher quality products the impact will be less pronounced

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Contact

Contents

- Benchmark
- Q Cost
- Improvement
- ROI
- Examples
- Efficiency
- End

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