Identifying Factors Affecting Software Development Cost

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Agenda

- Software Cost - An Introduction
- Related Work
- Factors Studied at the Swedish Bank
- Analysis & Results
- Academic Implications
- Industry Implications
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Software Cost

- Business processes change -> systems change
- Systems are interconnected
- Systems are complex
- New development?
Enterprise System Life cycle cost

Studies have shown that as much as 70 % of the total lifecycle cost for an enterprise system is spent on modifying it.

Why is “cost” important?

- Over 70 % of software budgets is spent on modifications [Harrison 1990]
- The change cost has been increasing from 40 % in the early 1970s up to 90 % in the early 1990s [Pigoski 1997]
- The cost of making changes, rather than dropping, is on the increase [Jarzabek 2007]
Why assess project cost?

- Type 1, successful projects
- Type 2, system taken into operation but ..
  - Defects in functionality
  - Not within time
  - Not within budget
- Type 3, project cancelled

Research Question

What factors have an effect on software development project costs?

Source: Standish group R30 applications
Study

- Data from 50 projects performed at one of the largest banks in Sweden
- In total 32 factors are studied.
- Using one-way ANOVA and bivariate regression analysis.

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Related Work

Factor based cost estimation methods and models

- Function Points
- COCOMO
- TEAMATE
- SEER-SEM
- PRICE-S
- ESTIMACS
- Checkpoint
- Softcost
- The Putnam Software Life Cycle Model (SLIM)
- The Jensen Model
- The Bailey-Basili Model

Function Points

- 1983
- Function point analysis is a way of measuring the size and extent of a software system by looking at which functions the system delivers to the user.
- Instead of e.g. number of lines of code.
- Used as factor in many models and methods for estimation.
COCOMO

The COnstructive COst Model

- Size attributes such as number of lines of source code or function points.
- Additional cost drivers required:
  1) Platform - software reliability, database size, required reusability, documentation match to life-cycle needs and product complexity.
  2) Product - execution time constraint, main storage constraint and platform volatility.
  3) Personnel - analyst capability, programmer capability, personnel continuity, applications experience, platform experience and language and tool experience.
  4) Project - project use of software tools, multisite development, required development schedule, precedencedness, development flexibility, architecture/risk resolution, team cohesion and process maturity.

TEAMATe

The Enterprise Architecture Modifiability Analysis Tool

- Change management process maturity.
- Documentation quality.
- Software system understandability, size, internal and external coupling, change size, change difficulty.
- Quality of tools for software system changes.
- Quality of infrastructure for software system changes.
- Project team expertise, project members time on project, number of project members.
- Software system change activity synchronization need.
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Factors Studied at the Swedish Bank

- No of function points \{Real numbers \geq 0\}
- Platform \{Type\}
- Interface \{Type\}
- Risk classification \{High / Medium / Low\}
- Existence of schedule \{Yes / No\}
- Existence of testing plan and conductor \{Yes / No\}
- Length and cost of pre-study \{Real numbers \geq 0\}
- Project type \{Development / Integration\}
- Project priority \{High / Low\}
- Personnel (Manager, Architect, ...) \{Name\}
- Revisions in deadline and budget \{Natural numbers\}
- etc...
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Analysis

• Factors belonging to nominal or ordinal scales are analyzed by using one-way between subjects analysis of variance (ANOVA).

• Factors belonging to interval or ratio scales are analyzed by using a bivariate regression analysis.
Results

- The one-way ANOVA assessment indicates that six factors have significant impact on project costs, given a boundary of $p < 0.05$ which is recommended.

- Four of the factors that could provide regression models for describing project costs show reasonably high fit of data ($R^2 \geq 0.4$), and can thus be used to describe the data.

Risk Classification

$(p = 0.00016)$

The costs were roughly four times greater for high risk projects than low risk projects.
Budget Revisions
(p = 0.0033)

Projects with many budget revisions seem to end up as more expensive than projects with few revisions.

Primary Platform
(p = 0.015)

The TDE-platform seems to involve the most expensive projects.
Project Priority
(p = 0.018)

A project which had a high priority received approximately three times more resources than a project with low priority.

Commissioning Body’s Unit
(p = 0.048)

Involved project costs varied a lot with the different commissioning body units.
Commissioning Body
$(p = 0.052)$

The commissioning body has a high correlation to project costs.

Consultants
$(R^2 = 0.40)$

Every additional consultant increased project costs with about $1\ 000\ 000$ SEK and displayed a sufficient amount of correlation.
Function points
(R² = 0.46)

The number of function points showed a reasonable correlation with project cost, with approximately 11 000 SEK for every added function point.

Duration
(R² = 0.48)

Correlation between project costs and number of workdays was good enough to support a model, every added workday provided about 27 000 SEK.
The number of project participants provided a reasonably good linear model describing project costs. Every added project participant resulted in an added cost of approximately 300 000 SEK.

<table>
<thead>
<tr>
<th>Factor</th>
<th>p</th>
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<tbody>
<tr>
<td>Cooperation</td>
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<tr>
<td>Architect</td>
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<td>Final deadline revisions</td>
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<tr>
<td>Secondary platform</td>
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<tr>
<td>Liable for delivery</td>
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<td>Competence performing assignment</td>
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<td>Existence of testing conductor</td>
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<td>Existence of overall schedule</td>
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<tr>
<td>Existence of overall testing plan</td>
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<tr>
<td>Performance of estimation- and prognosis efforts</td>
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<tr>
<td>Presentation interface</td>
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<tr>
<td>Integrations testing</td>
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<td>Project manager</td>
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<tr>
<td>Quality of delivery</td>
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<td>Conformance to requirements</td>
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<td>External parts</td>
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<td>Implementation efficiency</td>
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<td>Business manager</td>
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<td>Method for debit</td>
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<td>Area of delivery</td>
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<td>Project type</td>
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Non-Significant Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>$R^2$</th>
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<td>Length of pre-study</td>
<td>0.024</td>
</tr>
<tr>
<td>Cost of pre-study</td>
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</tr>
</tbody>
</table>

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  - Industry Implications
Academic Implications
- Significant Factors

Possible extension to existing models and methods.
- Risk classification
- Commissioning body and unit

Validation of factors already in existing models and methods.
- Platform
- Function points

- Budget revisions
- Duration
- Consultants
- Participants

Academic Implications
- Non-significant Factors

- Implementation efficiency
- Conformance to requirements
- Existence of overall schedule
- Project manager
- Cooperation
- Cost of pre-study
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Industry Implications

• Companies (the bank in this study) should pay some more attention to existing models and methods.
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Questions?