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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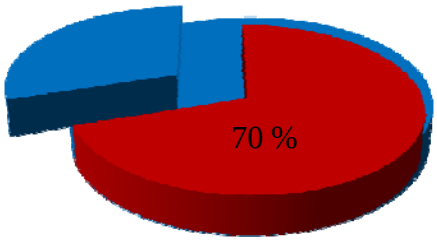
Software Cost

- Business processes change -> systems change
- Systems are interconnected
- Systems are complex

- New developement?

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.

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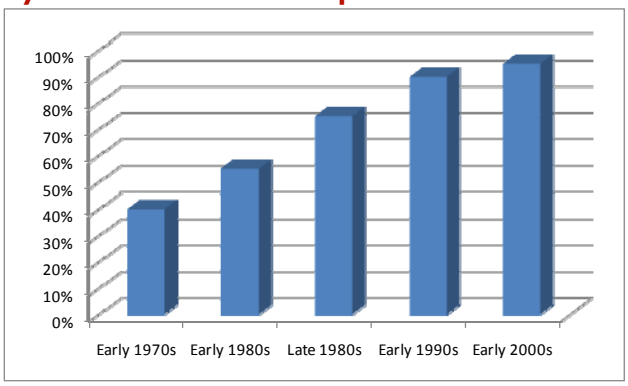
Why is ”cost” important?



- 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]

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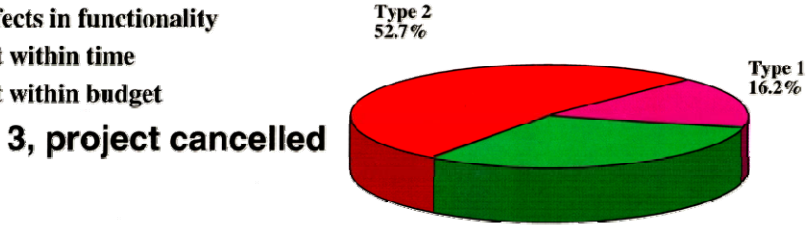
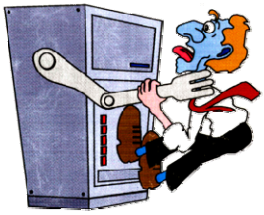
Why assess project cost?

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





Source: Standish group
8380 applications

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Research Question

What factors have an effect on software development project costs?

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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, data base 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, precedentedness, 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 ≥ 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 ≥ 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.

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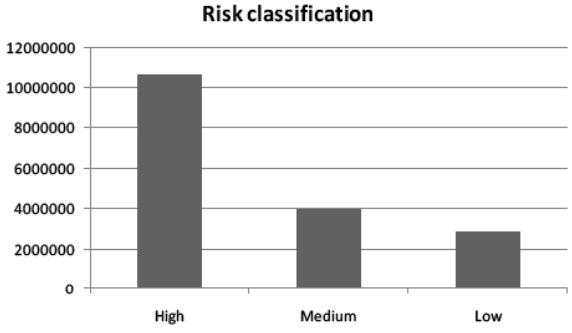
Risk Classification
(p = 0.00016)



The costs were roughly four times greater for high risk projects than low risk projects.

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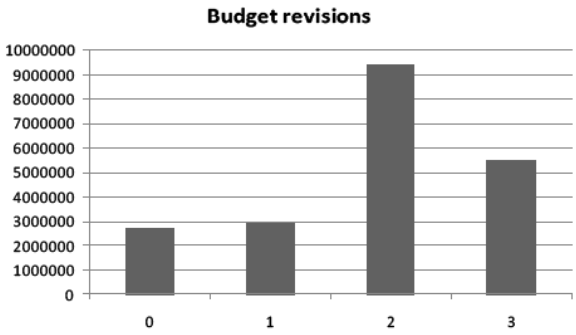
Budget Revisions
(p = 0.0033)



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

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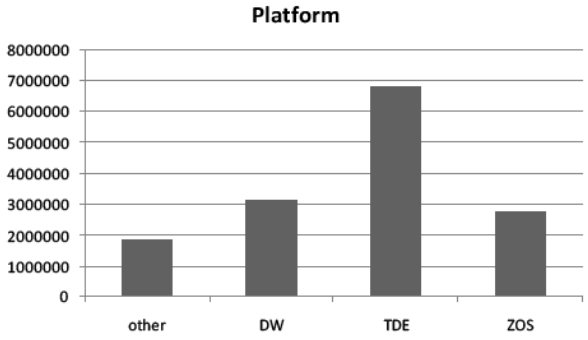
Primary Platform
(p = 0.015)



The TDE-platform seems to involve the most expensive projects.

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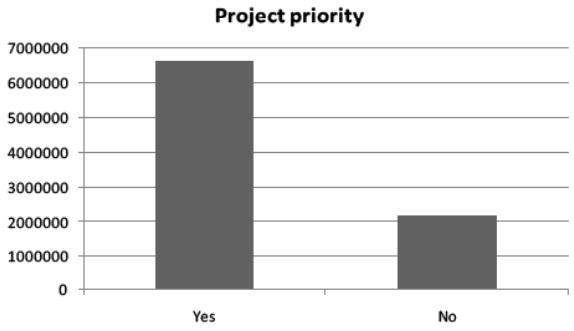
Project Priority
(p = 0.018)



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

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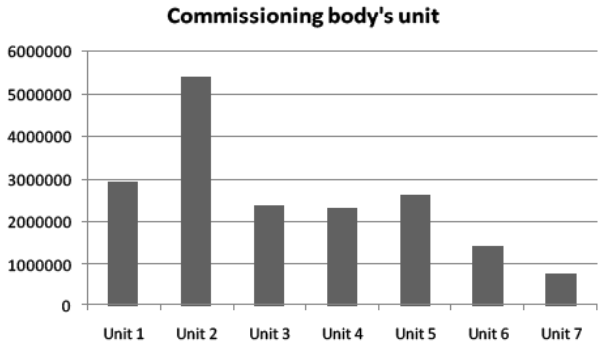
Commissioning Body's Unit
(p = 0.048)



Involved project costs varied a lot with the different commissioning body units.

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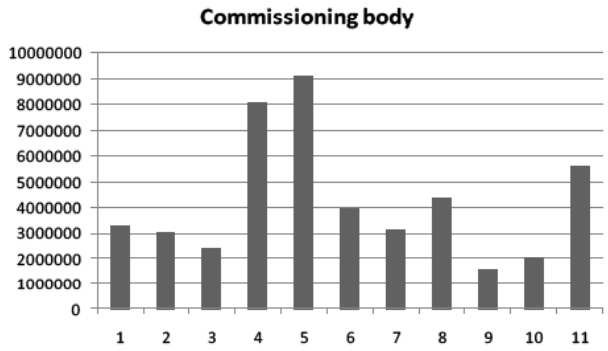
Commissioning Body
(p = 0.052)



The commissioning body has a high correlation to project costs.

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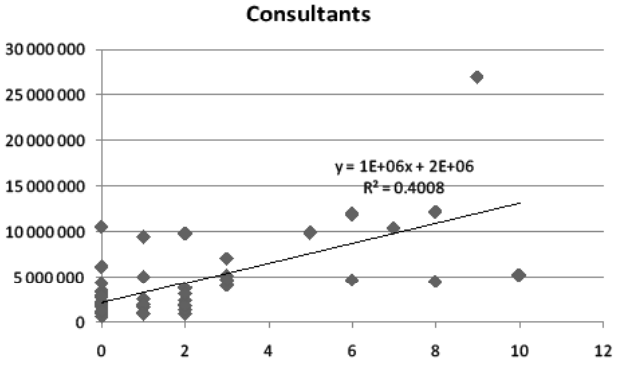
Consultants
(R^2 = 0.40)



Every additional consultant increased project costs with about 1 000 000 SEK and displayed a sufficient amount of correlation.

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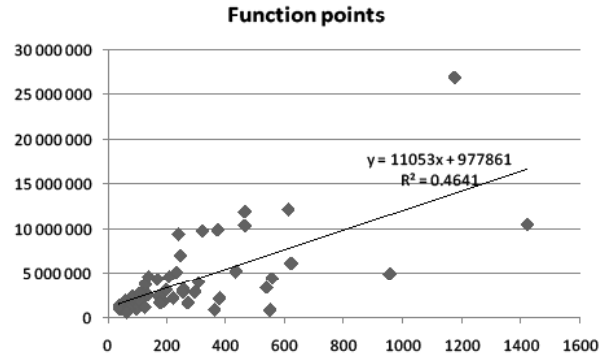
Function points
(R^2 = 0.46)



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

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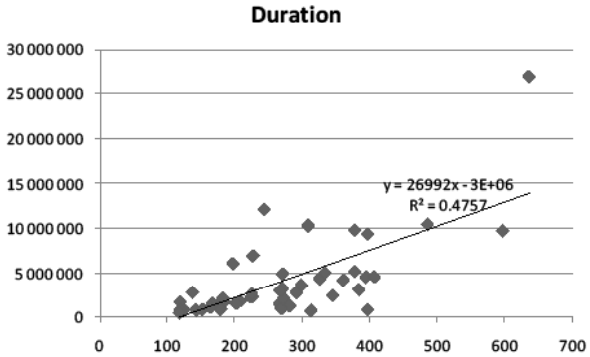
Duration
(R^2 = 0.48)



Correlation between project costs and number of workdays was good enough to support a model, every added workday provided about 27 000 SEK.

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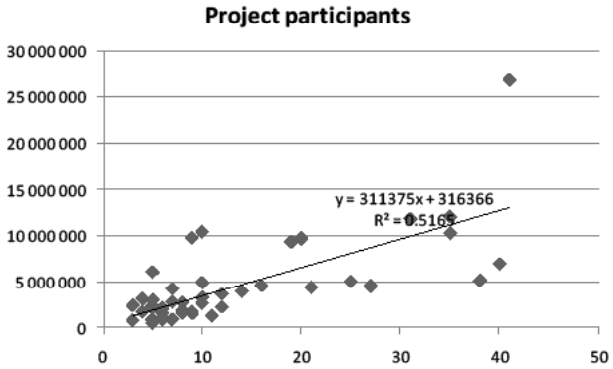
Project Participants
(R^2 = 0.52)



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.

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Non-Significant Factors

Factor	p
Cooperation	0.17
Architect	0.21
Final deadline revisions	0.22
Secondary platform	0.22
Liable for delivery	0.25
Competence performing assignment	0.26
Existence of testing conductor	0.28
Existence of overall schedule	0.29
Existence of overall testing plan	0.29
Performance of estimation- and prognosis efforts	0.30
Presentation interface	0.31
Integrations testing	0.34
Project manager	0.35
Quality of delivery	0.43
Conformance to requirements	0.50
External parts	0.62
Implementation efficiency	0.66
Business manager	0.76
Method for debet	0.83
Area of delivery	0.86
Project type	0.91

Non-Significant Factors

Factor	R^2
Length of pre-study	0.024
Cost of pre-study	0.023

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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

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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 attentation to existing models and methods.

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Questions?