Software Cost Estimating
Body of Knowledge

Benchmarking

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Outline

- Benchmarking introduction:
  - What, goals, relevance to software cost estimation
- When benchmarking?
- Software services
- How to benchmark
  - Reality check
  - ROM landing zone
  - Landing zone determination
- Reference materials
Objectives

• To understand the concept of benchmarking in the context of software cost estimation

• To learn about the ways historical data can be used to assess the likely proposals of supplier bids

• To understand the importance of estimating software projects in the most accurate ways, as both optimistic and pessimistic estimates will actually result in extra cost!
Benchmarking defined

• Benchmarking is the process of comparing your companies processes against industry leaders or industry best practices. To understand the way the best performers do things, it becomes possible to:
  • Understand the competitive position of the organization
  • Understand the possibilities for process or product improvement
  • Create a point of reference, a target to aim for.

• Benchmarking gives insight into industry best practices with the aim to understand if and how should improve in order to stay or become successful.
Benchmarking and cost estimation

• Benchmarking is often used to understand the organizations capabilities against the industry leader(s).

• In this module, the main focus is on benchmarking the cost (or effort) estimate. So, how does an estimate relate to possible peers in the industry,

• This is usually very relevant for customer organizations outsourcing their AD projects and for outsourcing supplier organizations wanting to win the bid for these contracts.
Relevance to cost engineering

• In a tender, a benchmark is often carried out by the customer organization (or a third party) to determine the landing zone in which the price offers of the bidding organizations should fall.
  • To be able to compare, the definitions of the units of measure should be identical: e.g. a square foot in the US should be the same unit of measure as a square foot in other countries.

• The landing zone typically contains a low, likely and high price, based on the actual prices in the market for similar services.
4 types of benchmarking

• In general there are 4 types of benchmarking:

   1. Internal benchmarking – A comparison inside of the company. For instance the comparison between 2 business units.

   2. Competition benchmarking – A systematic comparison of the company against competitors. This is sometimes hard to do because of the confidentiality and the difficulty to obtain the data necessary.

   3. Functional benchmarking – A comparison of the company against other non-competing companies that carry out similar activities.

In the context of estimation

• Benchmarking in the context of software cost estimation can apply to different types:
  • To benchmark the estimation process. For instance assess the estimation process in terms of maturity level (Galorath).
  • To benchmark the outcome of the estimate.
  • To benchmark the competitiveness of an offer
Estimation process maturity

95% of the industry

Majority of software projects are not mitigated for bias, resulting in optimistic estimates.

Estimation Bias Mitigation Begins at Level 2, Solid at Level 3
Project Estimate: BoE baseline

• Baseline the project estimate: Basis of Estimate for Software Services.

• Recommended Practice (AACEi and Nesma)
  • Baseline of the Estimate.
  • Scope, assumptions, data used, decisions made.

• An estimate described in the BoE baseline can be easily benchmarked:
  • Compare apples to apples
  • Possible need for normalization of peers,
    • E.g. correct for schedule compression
## Basis of Estimate

<table>
<thead>
<tr>
<th>RECOMMENDED PRACTICE</th>
<th>Estimation purpose</th>
<th>Engagement</th>
<th>Estimating methodology (FP, expert, etc.)</th>
<th>Estimate Classification (1,2,3,4,5)</th>
<th>Level of detail Stage, Deal size/type, fixed price/TM</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Scope Description</td>
<td></td>
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<tr>
<td></td>
<td>Design Basis (Components lists, units, etc.)</td>
<td>Assumptions internal, external</td>
<td>Effort Basis delivery constraints, service levels</td>
<td>Planning Basis Working time standby</td>
<td>Cost Basis methods and sources, units</td>
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<td></td>
<td></td>
<td>Sizing Basis Requirements Functional technical</td>
<td>Exclusions No costs included for...</td>
<td>Exceptions anomalies or variances on standard</td>
<td>Risks and Opportunities assumptions</td>
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<td></td>
<td>Allowances Not in the Basis</td>
<td>Contingencies Uncertainty, unforeseeable elements</td>
<td>Management Reserve changes in scope, effort</td>
<td>Reconciliation Changes to previous estimation</td>
<td>Benchmarking Comparisons to similar engagements</td>
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<td>Attachments</td>
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**Containments**
- cost elements for mitigation

**Allowances**
- Not in the Basis

**Assumptions**
- internal, external

**Sizing Basis**
- Requirements
  - Functional
  - technical

**Effort Basis**
- delivery constraints, service levels

**Planning Basis**
- Working time
  - standby

**Estimation methodology**
- (FP, expert, etc.)

**Estimate Classification**
- (1,2,3,4,5)

**Estimate Quality Assurance**
- Reviews

**Attachments**
- Reviews

**Benchmarking**
- Comparisons to similar engagements

**Reconciliation**
- Changes to previous estimation
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Outsourcing

• In outsourcing, benchmarking is usually an activity carried out by one (or more) of the bidding suppliers.

• Especially when outsourcing organizations tender a large part of their IT portfolio (Application Development and/or Maintenance & Support) to a single supplier.

• These are often multimillion USD contracts for multiple years.

• Bidding suppliers use external benchmarking companies to benchmark the market conform price for all services in scope of the tender in order to understand the competitiveness of their offer.
International Software Benchmarking Standards Group (ISBSG)

• Independent and not-for-profit

• Full Members are non-profit organizations, like Nesma, IFPUG, FiSMA, China SPI, GUFPI-ISMA, Swiss-ICT

• Grows and exploits two repositories of software data:
  • New development projects and enhancements (> 8000 projects)
  • Maintenance and support (> 1100 applications)

• Everybody can submit project data
  • DCQ’s on the site, online or Excel data files.
  • Anonymous
  • Free benchmark report in return
Mission: “To improve the management of IT resources by both business and government, through the provision and exploitation of public repositories of software engineering knowledge that are standardized, verified, recent and representative of current technologies”.

All ISBSG data is

- validated and rated in accordance with its quality guidelines
- current
- representative of the industry
- independent and trusted
- captured from a range of organization sizes and industries
Benchmark the proposal

• The ISBSG can be used to calculate a landing zone:
  • The minimum price of the offer of suppliers
  • The likely price of the offer of suppliers
  • The maximum process of the offer of suppliers
• This is helpful in determining the business case
• Why not just selecting the cheapest proposal?
  • If the proposal is too cheap, there is a chance that the supplier underestimated the work (intentionally or unintentionally)
  • This will come back at some point as the supplier will try other ways to make a profit.
Optimistic estimates are likely to fail

- Many projects are not estimated in a professional way
  - Only expert estimates, no use of estimation models / historical data

- Underestimation results in bad planning
  - Development team too small
  - Duration too short
  - Unrealistic milestones
  - Project management with no grip on the project
  - Extra management attention, more meetings
  - Stress in the team $\rightarrow$ bad quality $\rightarrow$ more effort
  - Bad software, low maintainability
The impact of optimism

• If your estimate is optimistic, the project may be in danger already at the start and may become much more expensive compared to a situation of a likely or high estimate.

• Optimistic estimates result in non-linear extra cost, pessimism in linear extra costs (Parkinson’s law).
Realistic Estimates

• **Use multiple estimation methods:**
  - Expert estimates (bottom up)
  - Parametric estimates (bottom up)
  - Challenge / Comparison

• **All estimates should be expressed in ranges!**
  - Low: 20000 hours / Likely 30000 hours / Max: 45000 hours

• **Reality check the estimates (own history / ISBSG)**
  - Hours per 1000 slocs
  - Hours per function point

• **Document/Baseline the Estimate**
  - Basis of Estimate (BoE)
  - AACE recommended practice 74R-13
In the IT industry, estimates are often low

**IT industry – estimates are too optimistic**
- Business/customer: pressure to lower price;
- Business/customer: pressure shorter time-to-market;
- Business/customer: incomplete requirements
- Business/customer: early fixed price/date quote

**IT supplier**
- Unclear what customer wants;
- Immature estimation techniques (only expert estimates);
- No idea about own performance and capabilities;
- Not defendable $\rightarrow$ easy to push back

**Optimistic estimates are more rule than exception**
The D&E repository of ISBSG provides the detailed data of over 8000 projects in Excel. You can easily filter and analyze the most relevant dataset.
Example benchmark

• Selection:
  • Data Quality: A or B
  • Year of Project > 2012
  • Project Type: Enhancement
  • Primary Programming language: Java
  • Count approach: Nesma or IFPUG

• The landing zone may be in this case:
  • Low: 6.8 h/FP
  • Likely: 7.8 h/FP
  • Max: 9.4 h/FP

• Further refinement may be possible, for instance:
  • Size category
  • Development methodology
  • Industry
  • Application type
  • ...

<table>
<thead>
<tr>
<th></th>
<th>PDR (hours/FP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of projects</td>
<td>166</td>
</tr>
<tr>
<td>Minimum</td>
<td>4,2</td>
</tr>
<tr>
<td>Percentile 10%</td>
<td>5,3</td>
</tr>
<tr>
<td>Percentile 25%</td>
<td>6,8</td>
</tr>
<tr>
<td>Median</td>
<td>7,8</td>
</tr>
<tr>
<td>Percentile 75%</td>
<td>9,4</td>
</tr>
<tr>
<td>Percentile 90%</td>
<td>10,2</td>
</tr>
<tr>
<td>Maximum</td>
<td>15,3</td>
</tr>
<tr>
<td>Average</td>
<td>7,9</td>
</tr>
</tbody>
</table>

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### Further analysis

#### Median PDR by Team Size - All Platforms

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<tr>
<th></th>
<th>N</th>
<th>Min</th>
<th>P10</th>
<th>P25</th>
<th>Median</th>
<th>P75</th>
<th>P90</th>
<th>Max</th>
<th>Mean</th>
<th>Std Dev</th>
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<tr>
<td>ABAP</td>
<td>23</td>
<td>4.2</td>
<td>7.0</td>
<td>7.9</td>
<td>11.3</td>
<td>15.6</td>
<td>21.4</td>
<td>34.3</td>
<td>13.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Access</td>
<td>10</td>
<td>1.6</td>
<td>2.4</td>
<td>2.7</td>
<td>7.1</td>
<td>8.7</td>
<td>13.0</td>
<td>14.5</td>
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<td>4.5</td>
</tr>
<tr>
<td>ASP</td>
<td>22</td>
<td>1.8</td>
<td>2.6</td>
<td>3.6</td>
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<td>15.6</td>
<td>30.6</td>
<td>8.6</td>
<td>7.0</td>
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<tr>
<td>Assembler</td>
<td>12</td>
<td>3.8</td>
<td>4.6</td>
<td>8.2</td>
<td>15.7</td>
<td>23.0</td>
<td>34.8</td>
<td>45.8</td>
<td>17.9</td>
<td>13.2</td>
</tr>
<tr>
<td>C</td>
<td>103</td>
<td>1.8</td>
<td>3.6</td>
<td>8.3</td>
<td>13.6</td>
<td>24.4</td>
<td>41.0</td>
<td>76.5</td>
<td>18.8</td>
<td>16.3</td>
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<tr>
<td>C++</td>
<td>80</td>
<td>1.0</td>
<td>4.9</td>
<td>8.2</td>
<td>14.8</td>
<td>31.3</td>
<td>54.2</td>
<td>78.7</td>
<td>23.1</td>
<td>20.0</td>
</tr>
</tbody>
</table>
Benchmarks is also useful for suppliers

- Senior management of a software company wondered how competitive they were when it comes to productivity.
- Many bids for projects were lost and they wished to improve, especially their Microsoft.Net department.
- Analysis of the bids by department showed the following:

<table>
<thead>
<tr>
<th>Nr. of bids</th>
<th>23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average PDR in bid</td>
<td>16,3 h/FP</td>
</tr>
<tr>
<td>Average Size (FP)</td>
<td>230 FP</td>
</tr>
<tr>
<td>Average teamsize</td>
<td>6 fte</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<td>N</td>
<td>35</td>
</tr>
</tbody>
</table>
Result

• This analysis data indicated that the bids were well outside best industry performance – between the 75% and 90% percentiles

• This caused a review of the bid phase which showed a number of issues:
  • Estimates were extremely pessimistic due to severe penalties in case of overruns;
  • In a number of stages, risk surcharges were added;
  • They wished to work in fixed team of 6 fte, but ISBSG data shows that the project size was usually too small for this teams size to be efficient;

• As a result the bid process was redesigned, making the company more successful!
12 criteria for benchmark success

1. Benefit the executives who fund it
2. Benefit the managers and staff who use it
3. Generate positive ROI within 12 months
4. Meet normal corporate ROI criteria
5. Be as accurate as financial data
6. Explain why projects vary
7. Explain how much projects vary
8. Link assessments and quantitative results
9. Support multiple metrics
10. Support multiple kinds of software
11. Support multiple activities and deliverables
12. Lead to improvement in software results
The benchmark data should not:

1. Conceal the names of projects and units
2. Show only overall data without any details
3. Omit non-coding activities
4. Omit "soft factors" that explain variances
5. Support only one metric such as LOC
6. Omit quality and show only productivity
7. Be used to set ambiguous or abstract targets:
   • 10 to 1 productivity improvement
   • 10 to 1 quality improvement
   • 30% schedule improvement
Software benchmarks

- Size Data
  - Source Code
  - Function Points
- “Soft” Attribute data
  - Environment
  - Tools, Processes
  - Audit trails
- “Hard” Data
  - Staffing
  - Schedules
  - Effort
  - Costs
  - Defects
- Normalized Data
  - Productivity
  - Quality

SIZING

ASSESSING

PLANNING & ESTIMATING

BENCHMARKS

MEASURES & TRACKING
Benchmarks and process improvement

- **BENCHMARKS**
  - Quantitative Data:
    - Size
    - Effort
    - Schedule
    - Documentation
    - Defects
  - Qualitative Data:
    - Personnel
    - Processes
    - Technology
    - Environment

- **ASSESSING**
  - Where You Are:
    - Productivity
    - Rates
    - Quality Levels
  - Why You Are:
    - Project Profiles
    - Department Models

- **IMPROVING**
  - How You Should Be:
    - Best Case Models

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ISO/IEC 29155-2:2013

- Systems and software engineering – Information technology project performance benchmarking framework

ISO/IEC 29155-2:2013 provides general requirements for processes of "the information technology (IT) project performance benchmarking framework" by prescribing:

- the requirements for the processes for individual activities within the benchmarking framework (e.g. conduct benchmarking, maintain repository, submit data),

- the tasks necessary to successfully execute activities and equip them with components, both of which are defined in ISO/IEC 29155-1.

- ISO/IEC 29155-2:2013 is intended for use by any stakeholder(s) of IT project performance benchmarking (e.g. benchmarking user, benchmark provider, benchmarking service provider, and IT project team).
To use the standard

The following are examples of how ISO/IEC 29155-2:2013 can be used:

• by a systems and software supplier to implement a benchmarking process to estimate and/or evaluate performance of an IT project,

• by a systems and software acquirer (or a third-party agent) for evaluating the performance of the supplier’s IT project,

• by a benchmark provider to implement processes to collect and analyse IT project data and provide benchmarks,

• by a benchmarking service provider to implement various services (e.g. providing instruments for benchmarking, or conducting an instance of benchmarking for a benchmarking user).

• ISO/IEC 29155-2:2013 does not prescribe how to utilize benchmarking results, nor does it prescribe the name, format, or explicit content of the documentation that results from the benchmarking processes.
Conclusions

• Benchmarking is the process of comparing processes against industry leaders.

• In the context of cost estimation, benchmarking is about comparing the estimate against relevant historical projects carried out by that relevant peers.

• Industry estimation maturity is low, most often resulting in optimistic estimates (human bias not mitigated).

• Benchmarking the estimate by creating a landing zone results in an understanding of the reality value of an estimate.

• The ISBSG is the international not-for-profit organization that collects relevant and current industry data, which is provided in an easy to analyze Excel sheet.
Thanks for attending this workshop

Benchmarking

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Questions

(Module name)

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