Icebergs or Shifting Sands: What’s the Key to Software Estimation?

Carol Dekkers, P.Eng., CSM, CFPS(Fellow), PMP
Quality Plus Technologies, inc.
WHO AM I?

Carol Dekkers, PMP, CFPS (Fellow), P.Eng.

CEO, Quality Plus Technologies, Inc.
Lead author of ICEAA Software Cost Estimating Body of Knowledge (SCEBoK)

IFPUG Past President
ISO project editor
Consultant. Author. Speaker. Instructor
Estimating software-intensive systems

Status quo

The difference with software

Overcoming uncertainty

SCEBoK
Status Quo: Standish Group CHAOS reports (since 1996)

Standish Group CHAOS Report defines project outcomes:

SUCCESS: On-time, on-budget, with all features

CHALLENGED: Delivered, but...
late, and/or over-budget, and/or missing features

FAILED: Not delivered or cancelled
Status Quo

PROJECT SUCCESS RATES
AGILE VS WATERFALL

<table>
<thead>
<tr>
<th>METHOD</th>
<th>SUCCESSFUL</th>
<th>CHALLENGED</th>
<th>FAILED</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGILE</td>
<td>42%</td>
<td>50%</td>
<td>8%</td>
</tr>
<tr>
<td>WATERFALL</td>
<td>26%</td>
<td>53%</td>
<td>21%</td>
</tr>
</tbody>
</table>

Standish Group CHAOS report (c)2015

Project Management Institute Study 2017

© Carol Dekkers/Quality Plus Technologies, Inc. 2021
Status Quo: "Cost & Schedule Growth - a Legacy of Disaster"

<table>
<thead>
<tr>
<th></th>
<th>Olympics</th>
<th>Software/IT</th>
<th>DAMS</th>
<th>NASA/DoD</th>
<th>Rail</th>
<th>Bridges/Tunnels</th>
<th>Roads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Cost Growth</td>
<td>156%</td>
<td>43-56%</td>
<td>24-96%</td>
<td>52%</td>
<td>45%</td>
<td>34%</td>
<td>20%</td>
</tr>
<tr>
<td>Frequency of Occurrence</td>
<td>10/10</td>
<td>8/10</td>
<td>8/10</td>
<td>8/10</td>
<td>9/10</td>
<td>9/10</td>
<td>9/10</td>
</tr>
<tr>
<td>Frequency of Doubling</td>
<td>1 in 2</td>
<td>1 in 4</td>
<td>1 in 5</td>
<td>1 in 6</td>
<td>1 in 12</td>
<td>1 in 12</td>
<td>1 in 50</td>
</tr>
<tr>
<td>Average Schedule Delay</td>
<td>0%</td>
<td>63-84%</td>
<td>27-44%</td>
<td>27-52%</td>
<td>45%</td>
<td>23%</td>
<td>38%</td>
</tr>
<tr>
<td>Frequency of Schedule Delay</td>
<td>0/10</td>
<td>9/10</td>
<td>7/10</td>
<td>9/10</td>
<td>8/10</td>
<td>7/10</td>
<td>7/10</td>
</tr>
</tbody>
</table>

1. COMMON
   Multiple Industries Experience Significant Cost and Schedule Growth - Has Been a Problem for a Long Time

2. FREQUENT
   70-80% of Projects Experience Cost and Schedule Growth

3. HIGH
   Cost: 50% or More on Average (Mean)
   Schedule: 30% or More on Average (Mean)

4. EXTREME (FOR COST)
   Cost Growth in Excess of 100% Is a Common Occurrence in Most Projects (1 in 6)

Source: Christian B. Smart, *Solving for Risk Management: Understanding the Critical Role of Uncertainty in Project Management*
Status Quo: High Profile Software Projects

**Phoenix federal pay system (COTS solution)**
- $310M CDN budget 2009-2016
- May 2018: 600K pay backlog
- 2019: $2.6B CDN to stabilize data (pre-replacement)

**Denver airport baggage system**
- $560M USD & over budget, 16 month delay, system finally scrapped (poor project communication and scope creep)

**Healthcare.gov (Agile)**
- $860M USD spent, $150M overrun failed agile project
- 36 states, 10x users, abandoned

**Miller Coors (ERP package)**
- Merger results in 7 instances of SAP software
- Failed integration → $100 M USD lawsuit/counter suit
- Finally settled out of court
## Status Quo: Reasons for Software Project Failure

<table>
<thead>
<tr>
<th>Cause</th>
<th>Customer</th>
<th>Supplier</th>
<th>Comment / Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor user input</td>
<td>X</td>
<td>X</td>
<td>Training, time</td>
</tr>
<tr>
<td>Stakeholder conflicts</td>
<td>X</td>
<td>?</td>
<td>Project Management</td>
</tr>
<tr>
<td>Vague requirements</td>
<td>?</td>
<td>?</td>
<td>Terminology</td>
</tr>
<tr>
<td><strong>Poor cost and schedule estimation</strong></td>
<td>?</td>
<td>X</td>
<td>Overly-optimistic, risk (avoidance)</td>
</tr>
<tr>
<td>Skills that do not match the job</td>
<td>X</td>
<td>X</td>
<td>Training</td>
</tr>
<tr>
<td><strong>Hidden costs of going “Lean and Mean”</strong></td>
<td>X</td>
<td>X</td>
<td>Unrealistic goals, Resources</td>
</tr>
<tr>
<td>Failure to plan</td>
<td>?</td>
<td>?</td>
<td>Structure, PM</td>
</tr>
<tr>
<td>Communication breakdowns</td>
<td>X</td>
<td>X</td>
<td>Blame (He said, she said)</td>
</tr>
<tr>
<td>Poor architecture</td>
<td>X</td>
<td>X</td>
<td>Planning</td>
</tr>
<tr>
<td>Late “failure” warning signals</td>
<td></td>
<td>X</td>
<td>Measurement</td>
</tr>
</tbody>
</table>

What is the Impact of Unrealistic* Estimates?

Standish Group on U.S. government / business:
~ $81 B USD = canceled software projects
~ $59 B USD = budget overruns

* Unrealistic estimates → Overly-optimistic (Cost unreasonably low, and duration too short) and Overlook (avoid) risks
Using Data to Create Realistic Estimates (and Better Results)

Cost estimating best practices CAN BE TAILORED to software:

- Estimating Maturity Model (formal methods)
- Cone of uncertainty
- Foundation of solid historical data
- Data analysis and normalization
- Planning for cost and schedule growth
- Cross checks, sensitivity analysis, risk and uncertainty
Many companies do not follow formal estimating practices (Level 1)

Source: Adapted from Estimation Maturity Model by Dan Galorath and Esteban Sanchez, Galorath.com

© Carol Dekkers/Quality Plus Technologies, Inc. 2021
Software-specific Cone of Uncertainty

What is Uncertain?
• Software Size
• Software Complexity
• Team capability
• Schedule constraints
• Team size
• Productivity
• Relationships between:
  – Size and effort
  – Size and productivity
• Historical data (quality)

Estimates should always be expressed as a range, not an absolute.

Estimate with historical data statistics and strive to mitigate the underestimation risk
Underestimate (Hofstadter’s Law)
“Parkinson Squeeze” the current underestimate

@ http://blog.karmoa.com
Status quo: Causes of Cost & Schedule Growth

OPTIMISM
Innate bias - Planning Fallacy
Project managers are risk-seeking

COST, SCHEDULE, TECHNICAL MISALIGNMENT
Like a three-legged stool, all need to be consistent in order for a project to balance

MOORE’S LAW
Exponential growth in technology Paired with projects that take a decade or longer to complete means that either there is a continual requirements update process or the product is obsolete on delivery

BLACK SWANS
Unpredictable, rare, unprecedented events that have a huge impact

LAKE WOBEGON
Project managers and staff are not like the children of Garrison Keillor’s fictional town – they are not all above average

Numerous Reasons, Both Internal and External

Source: Christian B. Smart, *Solving for Risk Management: Understanding the Critical Role of Uncertainty in Project Management*
Realistic estimates build on KK + KU + historical data relationships (CER, SER)
Data-based estimates (DoD CADE, ISBSG, your own data)

- Data analysis is important (data must be similar, relevant, comparable)
- Data normalization is critical (units of measure, scope, who, what, OT)
- Realistic, actuals of effort and schedule data tell a story (CER, SER)
ICEAA Software Cost Estimation Body of Knowledge: SCEBoK

SOFTWARE PROJECT DEFINITION: SCOPE, ACTIVITIES, ORGANIZATIONS, PARADIGMS

COST DRIVERS: SOFTWARE SIZE, COMPLEXITY, TEAM CAPABILITY, SCHEDULE CONSTRAINTS...

ESTIMATING TECHNIQUES BASED ON RELEVANT HISTORICAL DATA (NORMALIZED AND ANALYZED)

SOFTWARE GROWTH, REUSE AND ADAPTED CODE

PROCURED AND PACKAGED SOFTWARE, SOFTWARE ESTIMATING TOOLS

SOFTWARE SUSTAINMENT AND MAINTENANCE

Presented for the ICEAA 2021 Online Workshop - www.iceaaonline.com

© Carol Dekkers/Quality Plus Technologies, Inc. 2021
ICEAA SCEBoK Techniques

- Parametric - published Cost Estimating Relationship: CER
- Parametric - derived CER
- Analogy
- Commercial Models
- Expert Opinion
- Rules of Thumb and Benchmarks Cross-checks
ICEAA SCEBOK

5-Step Estimating process

Based on GAO and DoD best practice guides, supplemented with commercial estimation practices, with a global outlook:

• Step 1: Definition & Planning (Estimating Scope, Purpose, Ground Rules/Assumptions)
• Step 2: Historical Data Collection, Normalization, and Analysis
• Step 3: Selecting an Estimating Technique and Preparing a Point Estimate (Size $\rightarrow$ Effort $\rightarrow$ Cost, and Duration)
• Step 4: Sensitivity, Risk & Uncertainty Analysis
• Step 5: Documentation & Presentation
• Update estimate and collect data during project
Why ICEAA SCEBoK?

• Software provides a **number of unique challenges** for the estimator to get a Realistic / Close estimate
• **Understanding software cost estimation is critical** because software is increasingly part of almost every program estimate
• **Paradigms, software growth, packaged solutions, cost drivers, and correct usage of historical data** are pre-requisites to realistic estimates
• **Status quo is not good enough → need formal estimating process, historical data, and repeatable practice**
A Final Note...

Capers Jones:
‘The software industry has the worst metrics and measurement practices of any industry in human history’

Me:
“SCEBoK will help create realistic data-based estimates. Over time, this will lead to more, successful projects, and (hopefully) better metrics.”

Carol Dekkers, March 2021

1. Source: Capers Jones, *Quantifying Software – Global and Industry Perspectives*, 2018
Increasing Predictability
(Known Knowns with Icebergs)

Iceberger

Draw an iceberg and see how it will float.
(Inspired by a tweet by @GlacialMeg)

Icebergs are less dense than water, so they always float with about 10% of their mass above the water. But which way up? An iceberg wouldn’t float exactly like on this page in reality. Its three-dimensional distribution of mass and its relative density compared to the water are both significant factors that are only approximated here.

https://joshdata.me/iceberger
Thank you...

- Carol Dekkers
- 813-816-1329
- caroldekkers@gmail.com
- www.qualityplustech.com

- SCEBoK: www.iceaaonline.com