Technomics
Better Decisions Faster

What Does Agile Software Development Need?

Predictable Cost or Predictable Outcomes?

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Presenters

Christina Kosmakos

Christina Kosmakos is a Lead Analyst at Technomics, Inc., where she has provided cost estimating and analysis for the Navy PEO IWS 2.0. Her three years of experience include cost support, program management support, proposal evaluations, and data analysis. She holds a B.A. in Mathematical Statistics from the University of Virginia.

Dave Brown

Dave Brown is a SME, with expertise in software and IT estimating. He has 30 years of experience providing cost estimating and analysis to NGA, DoD and DHS clients. Throughout his 11-year career at Technomics, Dave completed life cycle cost estimates, independent cost assessments, cost research, program management support, modeling and simulation, data analysis, and database development.

Agenda

- Introduction, Problem Statement, & Background
- Analytical Approach
- Results
- Looking Beyond Cost
- Conclusion
- Next Steps

Introduction

- The transition from waterfall to agile software development has challenged the Cost Estimating Community

- Extrapolation from current project actuals is a step towards solving the problem of reliably predicting future current project development costs

- This analysis aims to provide an answer to the question:
  - What does Agile software development need: Predictable Cost or Predictable software Outcomes?

Problem Statement

- Short-Term versus Long-Term thinking
  - Typical cost estimator: long term view, based on defined requirements
  - Typical agile developer: short term view, iteratively delivering capability and adjusting the plan to address evolving requirements and/or reprioritization of requirements in a given timeframe

- How is cost viewed?
  - Typical cost estimator: cost is uncertain, but predictable
    - There is always cost risk, which must be understood and managed
  - Typical agile developer: requirements are flexible, but budget is fixed
    - Therefore, there is no cost risk

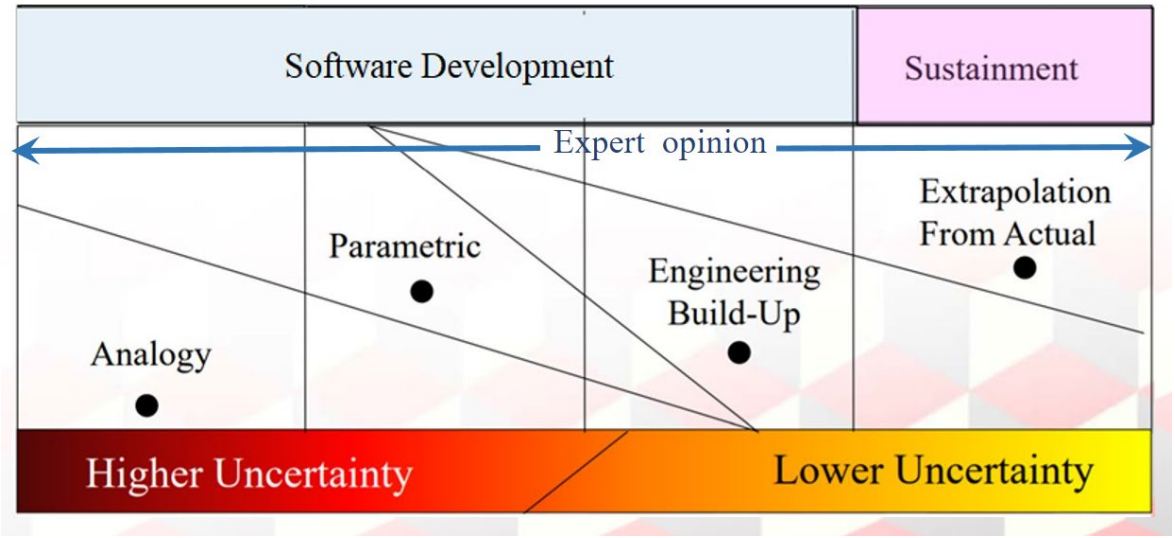
Agile Terminology

- ***Epic:*** body of work that can be broken down into specific tasks (called user stories) based on the needs of customers
- ***Sprint:*** short, time-boxed period when a team works to complete a set amount of work
- ***Story:*** smallest unit of work in an agile framework; it is an end goal expressed from the software user's perspective
- ***Story Points:*** metric used in Agile project management to understand the implementation difficulty of a certain user story; number that showcases how challenging a story is for the team based on complexity, risks and efforts

Story Points are the agile metric that best reflect work accomplished by a sprint team

Which Estimating Method is Best?

- The best approach to software development estimates depends on when the estimate is needed, and the **data available**



- Early-Cycle Estimates
  - When a sizing metric is not available, other methods such as *analogy* or *T-shirt sizing* can be leveraged
  - Suggested ICEAA 2022 presentation/paper: ***Uncertainty of Expert Judgment in Agile Software Sizing.*** *(Braxton)*
- Mid-Cycle Estimates
  - When a sizing metric can be obtained, the *parametric* method can be used
  - This requires a standard sizing metric such as function points
  - Suggested ICEAA 2022 presentation/paper: **Dynamic Software Effort Estimation: How SWEET It Is!** *(Gellatly / / Braxton / Brown)*
- Late-Cycle Estimates
  - Most defensible approach at this stage is *Extrapolation from Actuals*
  - This requires actual cost history
  - *Focus of this presentation*

Background

- Tasked with providing budget and execution planning for a software development effort that recently transitioned to agile with two sprint teams

- Data available:
  - Actual cost per month by team and by build
  - Agile data made available via Jira
    - Relevant Agile metrics chosen:
      - Number of Story Points completed per month by team and by build
      - Story Point status indicator (i.e. Open, Closed, External Review)
      - Planned story points (backlog)

Analytical Approach

- Utilized the Extrapolation from Actuals Cost Estimating Technique
  - Highest credibility and greatest accuracy when properly applied (CEBoK)
  - Assumes work completed is representative of work remaining
  - Especially beneficial for agile because it can be updated and revised frequently, as additional data is collected

- Three approaches of Extrapolation from Actuals were explored and evaluated
  - Approach 1: extrapolate based on average cost per month
  - Approach 2: extrapolate based on average cost per story point per month
  - Approach 3: extrapolate based on rolling average cost per story point per month

Exploration of 3 Potential Solutions

Approach 1: Cost per Month	Approach 2: Cost per Story Point per Month	Approach 3: Three Month Rolling Average Cost per Story Point per Month
▪ 2 months of cost data required ▪ Normalized for working days ▪ Average cost/day utilized for projection	▪ 2 months of cost, story point, and planned story point data required ▪ Average cost/story point utilized for projection	▪ 3 months of cost, story point, and planned story point data required ▪ Three month rolling average cost/story point utilized for projection

- ❑ These three approaches were selected for various reasons:
  - ❑ Approach 1: requires minimal data
  - ❑ Approach 2: considers both cost and work accomplished
  - ❑ Approach 3: accounts for work accomplished, i.e. story points started, but not considered closed or in external review until the following month

Approach 1: Cost Per Month

1. Data

Month	Working Days	Team 1 Cost	Team 2 Cost
January	19	$ 116,825	$ 151,018
February	19	$ 134,048	$ 112,597
March	23	$ 114,612	$ 125,180
April	22	$ 165,175	$ 151,293
May	20	$ 149,500	$ 122,772
June	21	$ 108,191	$ 119,113
July	21	$ 133,288	$ 139,438
August	22	$ 108,022	$ 35,684
September	21	$ 159,247	$ 46,688
October	20	$ 94,635	$ 18,693
November	20	$ 52,542	$ 5,675
December	21	$ 32,408	$ 2,289
January	20		

2. Analysis

1. Calculate ***Average Cost per Working Day*** utilizing all data available prior to the month you are projecting *(Note: calculations for Sprint Team 1 and Sprint Team 2 are done individually)*
2. Multiply the ***Average Cost per Working Day*** by the ***Working Days*** in the month you are projecting

3. Projections

Team 1 Projections	Team 2 Projections
$ 151,844	$ 159,556
$ 131,814	$ 140,221
$ 127,870	$ 130,142
$ 138,673	$ 135,146
$ 133,511	$ 132,431
$ 139,835	$ 139,800
$ 129,478	$ 120,353
$ 126,479	$ 106,785
$ 123,418	$ 98,315
$ 123,060	$ 94,698
$ 109,919	$ 82,766

Approach 2: Cost Per Story Point per Month

1. Data

Month	Team 1			Team 2		
	Cost	Executed Story Points	Planned Story Points	Cost	Executed Story Points	Planned Story Points
January	$ 116,825	119	107	$ 151,018	88	117
February	$ 134,048	61	83	$ 112,597	171	143
March	$ 114,612	140	86	$ 125,180	104	110
April	$ 165,175	114	98	$ 151,293	117	108
May	$ 149,500	118	113	$ 122,772	179	137
June	$ 108,191	132	122	$ 119,113	125	113
July	$ 133,288	156	140	$ 139,438	137	132
August	$ 108,022	83	98	$ 35,684	91	90
September	$ 159,247	120	116	$ 46,688	83	107
October	$ 94,635	117	128	$ 18,693	42	137
November	$ 52,542	98	83	$ 5,675	131	92
December	$ 32,408	78	65	$ 2,289	90	56
January			98			108

2. Analysis

1. Calculate the ***Average Cost per Executed Story Point*** utilizing all data available prior to the month you are projecting *(Note: calculations for Sprint Team 1 and Sprint Team 2 are done individually)*
2. Multiply the ***Average Cost per Executed Story Point*** by the ***Planned Story Points*** in the month you are projecting

3. Projections

Team 1 Projections	Team 2 Projections
$ 119,164	$ 111,559
$ 111,533	$ 115,914
$ 137,714	$ 153,828
$ 149,913	$ 113,374
$ 160,959	$ 131,953
$ 107,072	$ 90,187
$ 129,022	$ 100,896
$ 145,511	$ 125,387
$ 91,385	$ 82,447
$ 68,599	$ 45,100
$ 100,002	$ 82,116

Approach 3: Three Month Rolling Average Cost Per Story Point per Month

1. Data

Month	Team 1			Team 2		
	Cost	Executed Story Points	Planned Story Points	Cost	Executed Story Points	Planned Story Points
January	$ 116,825	119	107	$ 151,018	88	117
February	$ 134,048	61	83	$ 112,597	171	143
March	$ 114,612	140	86	$ 125,180	104	110
April	$ 165,175	114	98	$ 151,293	117	108
May	$ 149,500	118	113	$ 122,772	179	137
June	$ 108,191	132	122	$ 119,113	125	113
July	$ 133,288	156	140	$ 139,438	137	132
August	$ 108,022	83	98	$ 35,684	91	90
September	$ 159,247	120	116	$ 46,688	83	107
October	$ 94,635	117	128	$ 18,693	42	137
November	$ 52,542	98	83	$ 5,675	131	92
December	$ 32,408	78	65	$ 2,289	90	56
January			98			108

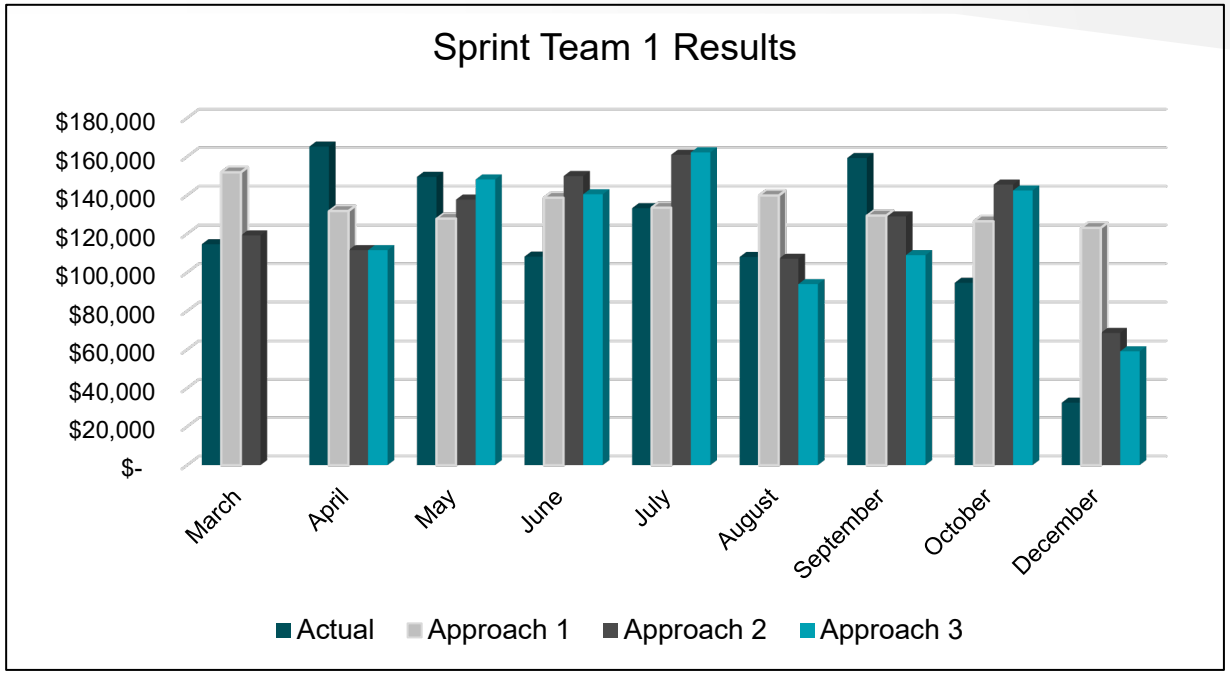
2. Analysis

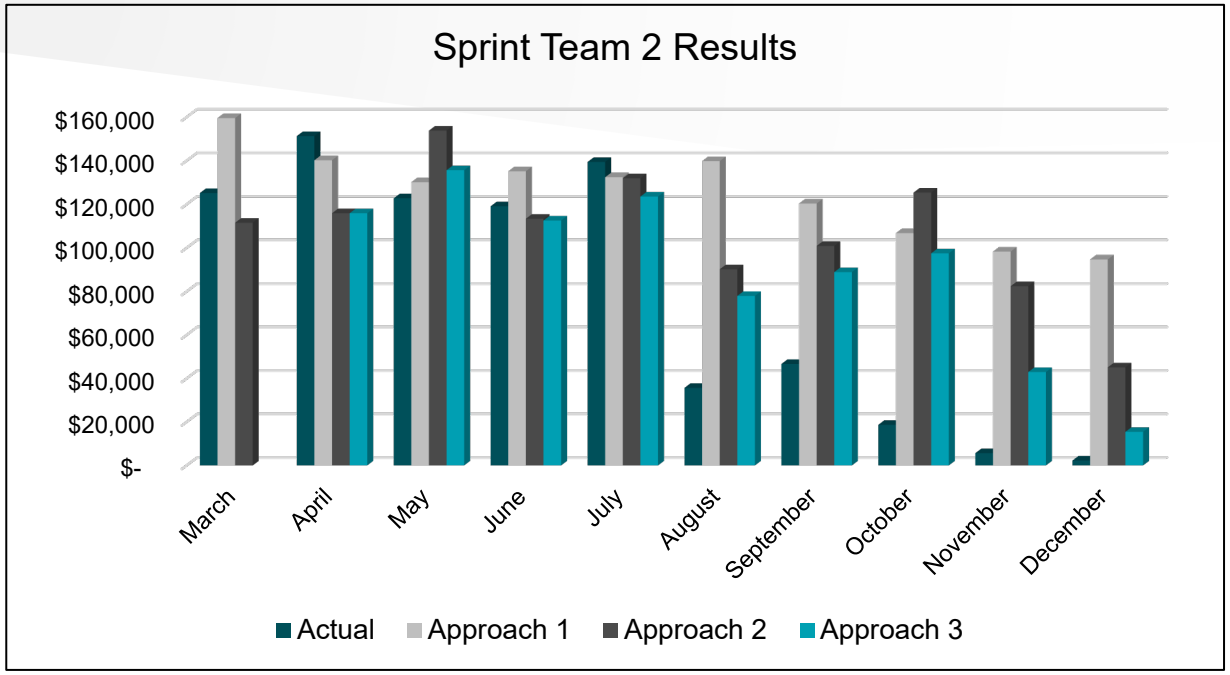
1. Calculate the ***Average Cost per Executed Story Point*** utilizing only the 3 months of data prior to the month you are projecting *(Note: calculations for Sprint Team 1 and Sprint Team 2 are done individually)*
2. Multiply the ***Average Cost per Executed Story Point*** by the ***Planned Story Points*** in the month you are projecting

3. Projections

Team 1 Projections	Team 2 Projections
$ 111,533	$ 115,914
$ 148,151	$ 135,653
$ 140,494	$ 112,569
$ 162,171	$ 123,570
$ 93,951	$ 77,953
$ 108,954	$ 88,896
$ 142,457	$ 97,511
$ 93,449	$ 42,961
$ 59,086	$ 15,465
$ 59,861	$ 10,967

Results (1 of 3)





- Due to the collection of data each month, we are able to compare the Actual cost to the projected costs for each Approach
- For both Sprint Team 1 and Sprint Team 2, the projected costs from Approach 3 are closer to the Actual cost for the majority of months

Results (2 of 3)

Approach	Sprint Team 1		Sprint Team 2		Total	
	CV	Correlation	CV	Correlation	CV	Correlation
1	0.37	31%	0.60	78%	0.48	54%
2	0.31	61%	0.59	68%	0.45	65%
3	0.34	57%	0.49	84%	0.42	71%

- Lowest CV and highest Correlation when projecting cost:
  - Approach 2 for Sprint Team 1
  - Approach 3 for Sprint Team 2
  - Approach 3 for both Sprint Team 1 and 2

- Approach 3: Three Month Rolling Average Cost per Story Point per Month is the recommended approach for projecting future costs

Results (3 of 3)

Planned Story Points	CV
Sprint Team 1	0.17
Sprint Team 2	0.34

- Sprint Team 2 plans future story points with less accuracy
- Approach 3 is considerably better than Approach 1 and 2 at projecting costs for Sprint Team 2
  - There is no clear variable that indicates how well a team will plan future story points
  - Approach 3 handles the inaccuracy of planned future story points more effectively

Looking Beyond Cost

- The Cost/Story Point CV for Sprint Team 1 and 2 indicates that efficiency is relatively variable
  - This suggests significant risk and uncertainty relative to how much work is accomplished
    - Deferred work can easily go unnoticed

Cost/Story Point	CV
Sprint Team 1	0.45
Sprint Team 2	0.68

- In this data set, cost is relatively variable as well
  - Note that risk and uncertainty still exist in a fixed cost environment
- Analysis and results indicate Approach 3 projects cost with the most accuracy, which challenges the agile community viewpoint that cost is not a risk that needs to be managed

Application

- Understand where the program is in the life-cycle and what data is available before deciding to move forward with this methodology
  - Late-cycle methodology that requires 2 or 3 months of relevant historical data
- Depending on the amount of months and the type of relevant historical data, Approach 1, 2, and/or 3 can be leveraged to support budget and execution planning
- Recommend risk adjusting estimates based on the CV results

Conclusion

- Extrapolation from actuals is a viable method for estimating agile software development costs

- Analysis indicates best results are achieved when a combination of cost and work accomplished is considered

- So, which does agile software development need, predictable cost or predictable software outcomes?
  - Ultimately, it needs both
  - Indicates requirement of close collaboration between the agile developer and cost estimator
    - Estimator has the ability to smartly leverage historical project metrics for extrapolation and the developer has the ability to track and collect these metrics

Next Steps

- Collect more data and build cost estimating relationships
  - Require performing activities to provide agile productivity and cost data
  - Include duration as a necessary data field
    - How much time is spent on each story point?
- Encourage agile developers to improve future story point plans
- Continue to use extrapolation from actuals for analysis
- Relate cost & productivity metrics of on-going software development projects to functionality and capability requirements, in an effort to build reliable cost estimating methodology for new start Agile development projects

Back Up

Dataset

Starting Data

Month	Team 1		Team 2	
	Cost	Story Points	Cost	Story Points
January	$ 116,825	119	$ 151,018	88
February	$ 134,048	61	$ 112,597	171
March	$ 114,612	140	$ 125,180	104
April	$ 165,175	114	$ 151,293	117
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