Colin H Cropley

A Global Review of Project Cost & Schedule Contingency Methods

Colin H Cropley BE (Chem), PMP, Cert PRINCE2 Practitioner

Risk Integration Management Pty Ltd, Melbourne, Victoria

www.riskinteg.com

Outline of Presentation

- Purpose of this presentation
- The problem of serious overruns in large projects
- Australian Contingency Guideline
- 2017 AACEI Annual Meeting DRM Conference track on Methodologies for Assessing Contingency
- Summary of Methodologies Conference track Papers
- Joint Confidence Level
- Lessons & Questions from Conference track
- Conclusions

Purpose of Presentation

- Assessment of appropriate time and cost contingencies for large and complex projects is a global challenge
- Australia is not particularly good at it
- Understanding the problem and finding effective ways to produce better outcomes is important for all project stakeholders, including taxpayers
- Significant progress has been made internationally
- This presentation is intended to make that progress known in Australia so that future major projects here:
  - may have more realistic time and cost contingencies set; and
  - achieve higher levels of time and cost compliance vs. budgets

The problem of serious overruns in large and complex projects

- Oil & Gas and Resource Megaprojects in Australia have poor records for meeting time and cost goals
- In October 2016, the Grattan Institute released a report on Cost overruns in transport infrastructure
  - Author Marion Terrill will discuss the report tomorrow
  - But estimates have been poor predictors of the outcomes of such projects over the last 15 years:
    - 10-25% were expected to overrun, but 34% actually did
  - State & C'wealth guides to infrastructure estimating are inconsistent and underplay the importance of basing estimates on past performance: i.e., using Reference Class Forecasting

Australian Contingency Guideline

- In 2016, RES/EA published "Contingency Guideline", to provide "a reference document for … sizing, allocating and managing" time and cost contingencies
- This drew on the knowledge and experience of Australian practitioners, but not international experience, for what is a global challenge: the assessment of realistic levels of time and cost contingencies
- The document is a valuable contribution, but it has serious gaps. There is no recognition of the importance of:
    - Past project performance as a predictor of future performance
    - Systemic risk, especially relating to flawed project delivery
- This presentation is partly a response to those gaps

2017 AACEI Annual Meeting Conference track on Contingency Methodologies

- In August 2016, AACE International invited submissions for a special track of presentations and a panel discussion on the theme "Project Cost and Schedule Risk Quantification: Alternative Methods"
- Accepted papers were presented at the 61st Annual Meeting of AACEI in Orlando Florida in June 2017
- Referencing Recommended Practice RP 40R-08, the papers were to show how the leading methods addressed the various attributes
- A closing panel discussed the updating of RP40R-08 and the attributes of the various methods but did not rank or directly compare them

AACEI RP 40R-08: Contingency Estimating – General Principles

- Purpose: To help guide practitioners in <u>developing or selecting</u> appropriate methods
- RP Attributes of methods to quantify risk impact:
  - Meet client objectives, expectations and requirements
  - Part of and facilitates an effective decision or risk management process (e.g., TCM)
  - Fit-for-use
  - Starts with identifying risk drivers with input from all appropriate parties
  - Methods clearly link risk drivers and cost/schedule outcomes
  - Avoids iatrogenic (self-inflicted) risks
  - Employs empiricism
  - Employs experience/competency
  - Provides probabilistic estimating results in a way the supports effective decision making and risk management

Methods recognised by RP 40R-08

- RP 40R-08 recognises that the definition of contingency and how to estimate it are among the most controversial topics in cost engineering
- Following methods listed as compliant with the General Principles:
  - Expert Judgment
  - Predetermined Guidelines (with varying degrees of judgment and empiricism used)
  - Simulation Analysis (primarily expert judgment incorporated in a simulation)
  - Range Estimating (focusing on a few critical items, as described in RP 41R-08)
  - Expected Value (RP 44R-08)
  - Parametric Modeling (empirically-based algorithm, usually derived through regression analysis, with varying degrees of judgment used) (RP 42R-08)

Summary of Methodologies Papers (1 of 3)

RISK Ref No	Title	Presenter(s)	Type Advocated	Comments on Paper
2700	Quantitative Cost Risk Analysis at Bid Stage	Didier Lagrange (Total, Paris)	CRA	Useful exposition of tender evaluation using CRA
2445	Risk and Uncertainty Practices in GAO's Best Practice Guides	Karen Richey, Jason T Lee (Washington DC)	CRA & SRA	Development & features of GAO's "*Cost Estimating and Assessment Guide*" & "*Schedule Assessment Guide*"
2555	Contingency Cage Match: Simultaneous Contingency Assessment Methods, A Case Study	Matthew Schoenhardt, Vachel Pardais (Alberta Canada)	Parametric + Expected Value using MCS	Comparison between ICSRA & Parametric + Expected Value using MCS by a P+EV Evangelist. Provided the parametric data is available, it is the best & most cost-effective method to assess contingency. Rates methods against 40R-08
2515	Realistic and Practical Risk Quantification (without CPM)	John K Hollmann (Virginia)	Parametric + EV using MCS	Describes hybrid parametric method plus EV using MCS. Emphasises importance of basing on past project performance and addressing bias. Features JCL. Rates method against 40R-08

Summary of Methodologies Papers (2 of 3)

RISK Ref No	Title	Presenter(s)	Type Advocated	Comments on Paper
2441	Integrated Cost-Schedule Risk Analysis Using Monte Carlo Simulation	Dr David Hulett (California)	ICSRA (JCL) using Risk Drivers for systemic risks	Describes Risk Drivers approach to ICSRA and uses the JCL approach to choosing combined limits, based on a time/cost scatter plot of entire plan results. (Used Polaris)
2470	From Activity Based Ranging to Risk Driver Approach	Craig Veteto (Texas)	ICSRA using Risk Drivers	Describes transition from activity and cost ranging to assigning risk drivers from risk register & risk optimisation benefits (Safran Risk, refers to JCL)
2510	Modelling Realistic Outcomes using Integrated Cost and Schedule Risk Analysis	Colin Cropley (Australia)	ICSRA & IRRA using macros + parametric	ISCRA incl macros + Hollmann parametric model for systemic risk; adds revenue & opex extension for modelling asset profitability with project. Rates method against 40R-08 (Used PRA, refers to JCL)
2592	Integrated Cost/Schedule Risk Analysis for Pre-Concept Alternatives Analysis / Technology Selection	Samuel Steiman PE, Molly Donovan (Virginia)	ICSRA for Select phase using Risk Drivers	Describes effective use of ICSRA at project concept stage to choose between alternative project options. Used RP 57R-09, JCL & prob. cash flows to select between options. (Used Polaris)

Summary of Methodologies Papers (3 of 3)

RISK Ref No	Title	Presenter(s)	Type Advocated	Comments on Paper
2511	Role of Project Novelty, Execution and Bias in Risk Quantification	Dr Yuri Raydugin (Calgary Alberta)	SRA2CRA	Review of methodologies and effects of biases. Makes use of "distance to reality" to justify preference for SRA2CRA and likelihood of unifying the various risk-based methodologies.
2505	Fully Integrated Cost Schedule Model – A Stochastic Alternative	Liwen Ren, Gustavo Vinueza (Ontario)	SRA2CRA	10 year Program refurbishing 4 Nuclear Reactor Power Units. Tools in use MS Project, @Risk for Project/@Risk. Large scale, highly procedural.
2701	Risk Dependency Analysis in Complex Projects	Paolo Cavanna, Franco Caron, Filippo Fratoni (ENI, Milan)	Risk Dependency & ICSRA	Innovative paper focused on revealing the significance of risk event inter-dependencies. Uses empiricism by using past project risk registers & outcomes. Blind tests against past projects.
2570	An Engineering Approach to Schedule Risk Assessment	Angela Tuffley & Adrian Pitman (Australia), Dr Elizabeth Clark (USA)	Parametric + SRA	Proven defence oriented methodology that relies on parametric modelling of software technical debt and true progress + SRA for rest of scope.

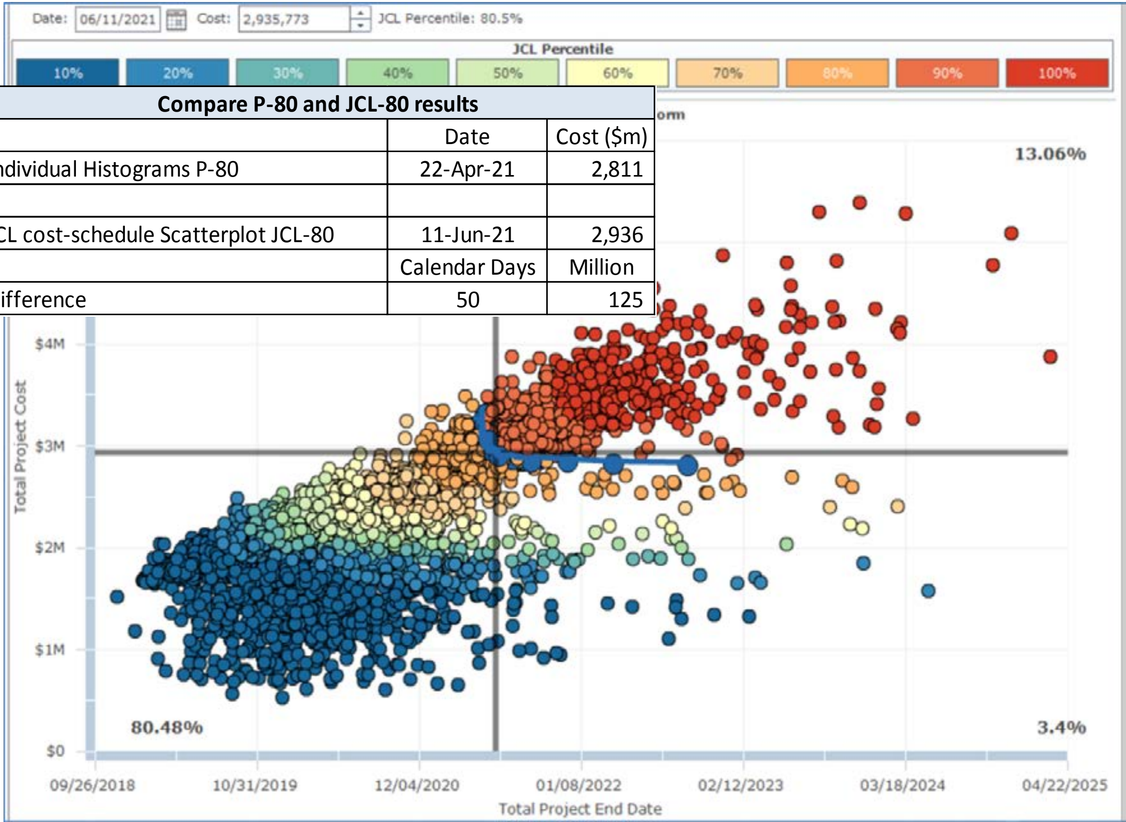
Special Role of Joint Confidence Level (JCL)

- Five of the 12 papers featured or referenced JCL, a technique described by David Hulett (in a personal communication) as follows:
  - "JCL is the term NASA uses for integrated cost-schedule risk analysis. It recognizes that targeting some percentile of confidence from simulations of cost and time separately will not produce a probability of achieving the same percentile for BOTH time and cost. Higher cost and later dates are needed to achieve both objectives with the same target percentile."
- Since 2009, NASA has mandated the use of a methodology it calls Joint Confidence Level, based specifically on Probabilistic Cost-Loaded Schedules to assess cost & schedule contingencies for its projects.*
  - JCL70 requires that all programs and any projects with life-cycle cost >$250m "use a rigorous process that combines its cost, schedule, and risk into a single model" that can generate a combined P70 cost-schedule goal. This exceeds P-levels for individual cost and schedule goals.
- Adopting JCL reduced NASA's cost overruns# from substantial (85% of projects > 50% in 10 years prior to implementing JCL) to close to 0%: for the 10 projects completed from 2009 to 2015, aggregated actual capex was less than aggregated announced capex

*NASA's Cost Estimating Handbook Version 4.0 Appendix J (Feb 2015); #NASA Office of the Inspector General, JCL Audit (Sep 2015)

Significance of JCL (based on paper by Dr D. Hulett)*

- Cost & Schedule histograms from an ICSRA focus on cost and schedule outputs individually
- When a scatterplot of single time and cost iterations is examined, it is clear that for a single cost limit (horizontal) or time limit (vertical), there are many outcomes that give < or > the 80th percentile result shown.
- To satisfy both limits at once, if time and cost are <100% correlated (73% here), higher separate limits are required, as shown in the table (one outcome from blue "necklace" of JCL-80 points).



Compare P-80 and JCL-80 results		
	Date	Cost ($m)
Individual Histograms P-80	22-Apr-21	2,811
JCL cost-schedule Scatterplot JCL-80	11-Jun-21	2,936
	Calendar Days	Million
Difference	50	125

*RISK-2441, ©AACE; Dr D.T. Hulett, by permission

Lessons & Questions from Methodologies Conference Track (1 of 3)

- Parametric modelling using representative past project data is the most reliable way to produce realistic forecasts of time & cost contingencies, taking account of bias and systemic risk.
- Project delivery systemic risk – the certain uncertainty that large project delivery will be less than optimal – leading to increases in project duration and cost – is the elephant in the room in most major projects. This is due to “Project proponent exceptionalism” (poor delivery will not happen to our project).
- Parametric modelling can be combined with Expected Value where there is no schedule, to cover both systemic and project-specific risks.

Lessons & Questions from Methodologies Conference Track (2 of 3)

- Parametric modelling can also be combined with CPM-based models (ICSRA or perhaps SRA2CRA) where good project schedules are available (or able to be built as adequately detailed summaries), to optimise schedule risk and model project specific risks
- Parametric modelling is based on previous project performance and is stated to include all sources of risk except significant project-specific risk events. This is a problem with CPM models, as:
  - Ranging of costs and durations, whether directly, or though risk drivers, is “double dipping” if parametric modelling is present.
  - A major benefit of CPM-based MCS modelling – schedule risk optimisation – would thus be precluded, unless Parametric modelling can be focused on Project Delivery systemic risk alone.

Lessons & Questions from Methodologies Conference Track (3 of 3)

- But how can Project Delivery systemic risk be separated from the rest of the risk which has produced the project outcomes data on which Multi-Linear Regression parametric modelling is based?
- Is it possible to isolate project delivery systemic risk from other sources of risk and uncertainty in previous project outcomes, even if a project delivery organisation were to set out to capture and record it?

- Other lessons include the following:
  - GAO's Best Practice Guides to Estimating & Scheduling Assessment are useful publicly available documents for use in projects
  - Risk event inter-dependencies can be important magnifiers of risk in major projects, but revealing them requires good systematic project closeout practices and compilation of reliable records of past projects, including risk registers

Conclusions (by the author)

- AACEI RP 40R-08 is expected to be revised based on the 2017 Methodologies Conference Track, to include guidance on which methods are now recommended by AACE and in which stages of project development they hold particular advantages
- Risk-based methods are likely to be given higher priority
- ICSRA methods are becoming more favoured over SRA2CRA as the ability to optimise schedule drivers of cost with cost drivers is more widely recognised, but poor schedule quality remains a perceived barrier, albeit soluble
- The problem of project delivery systemic risk needs to be recognised, rated and openly addressed at the highest levels of project delivery organisations
- Parametric modelling of systemic risk, especially relating to project delivery, is likely to be increasingly recognised and lead to better project delivery
- Systemic risk can be modelled by risk factors/drivers in CPM-based ICSRA models, but applicable empirical data is needed, usually provided by parametric models

Questions?

- See the author afterwards if you would like more information about the papers presented at the AACEI Annual Meeting
- Contact information:
  colin.cropley@riskinteg.com
  www.riskinteg.com

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