Concept Symposium 2018
Governing Megaprojects – Why, What and How

Inaccurate Cost Forecasts: Development of Costs over Time

Governments worldwide are faced with the risk of significant cost overruns with the delivery of infrastructure projects. Despite the development of better project management tools and techniques to forecast costs and research efforts to identify the causes of cost overruns, still many projects fail.

Contract changes are often said to be an important contributor to cost overruns in infrastructure projects. However, the failure to deliver projects within budget is mainly due to problems before the contract stage, i.e. in the front-end of projects, the decision-making and planning phase, where risks and uncertainty are often not adequately addressed.

This research aims to improve our understanding of how cost overruns come about by investigating how costs develop from the first project plans to the opening of the project. We contribute to the literature on Early Warning (EW) signs, by identifying when in the project development process projects are most vulnerable to changes. This stage may reveal a possible sign of project failure, and knowledge of these EW signs can help prevent project failure or deviation from the main goals.

Moreover, we investigate the extent to which projects follow similar patterns regarding the development of their costs over time. Based on the classification of past projects, the cost development of future projects can be assessed improving their predictability and potentially their performance.

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The Concept Symposia on Project Governance

The Norwegian Ministry of Finance and the Concept Research Program hosts every second year a symposium on project Governance. Project governance, in brief, is concerned about investments and their outcome and long-term effects. In view of the problem at hand, the aim is to ensure that the best conceptual solution is chosen, that resources are used efficiently and anticipated effects realized. Resource persons from ministries, governmental agencies, academia, international organizations, and industry are invited. In order to facilitate professional exchange and direct communication between participants, the number of individuals is restricted. The aim is to initiate further international cooperation and research on important issues related to project governance.

Cost Estimates As Early Warning Signs For Project Cost Performance

An Exploratory Study of Dutch Projects

Concept Symposium 2018 on Project Governance
Governing Megaprojects – Why, What and How

Chantal C. Cantarelli

Cost Performance Status

- "HS2 civil works £1bn above target cost" (New Civil Engineer)

- Projected baseline cost of California High Speed Rail is "now $77 billion – up 20 percent from two years ago" (CHSR Authority, 2018)

- "The track record in delivering government projects successfully has been poor" (NAO, 2016)

- "A third of UK.gov big projects will fail in next five years" (NAO, 2016)

Explanations Poor Cost Performance

- The three main **explanations** for cost overruns (e.g. Flyvbjerg et al., 2003):
  - technical challenges
  - over-optimism
  - strategic misrepresentations

- Main problem with cost overruns lies in **front-end stages** (e.g. Samset and Volden, 2015, Cantarelli et al., 2012)

Front-end Phase Of Project Development

- **Front-end phase** includes ”the entire set of activities from decision on the initial concept to the final decision for financing the project” (Williams and Samset, 2010)
- **Cost estimation paradox:** the focus is on the final cost estimate (the budget) while early cost estimates are overlooked (Samset and Volden, 2016)
  - In the early phases, a realistic cost estimate for comparison with benefits is necessary.
  - Initial cost underestimation can have large implications for project selection
  - Initial cost underestimation is “probably a far more severe problem than cost overrun in the implementation phase”.
  - Need to ”do the right project” is just as important as to “do the project right”
- *“More research is necessary to determine the extent of the problem of early cost estimation and its implications.”* (Samset and Volden, 2016)

Early Warning Signs

"An early warning is an observation, a sign, a message or some other item that is or can be seen as an expression, an indication, a proof, or a sign of the existence of some future or incipient positive or negative issue. It is a sign, omen, or **indication of future developments**" (Nikander, 2002).

EW sources: risk analyses, stakeholder analyses, earned value management performance measurements (Nikander, 2002; Jaafari, 2007; Klagegg et al., 2010; Miller and Lessard, 2000; Kim et al., 2003; Cleland, 1986)

EWS vs Risk Analysis

EW can give advance notice of arising risk but they do not provide information about the probability of occurrence of these risks

Early Warning Signs

- **Purpose** EW signs: aid project manager in taking timely actions in response to indicators of poor performance
- *"Very little literature to date deals explicitly with early warning in projects and project management"* (Samset and Volden, 2015)
- Some research into *identification* of early warning signs and *potential barriers*, little research on *how early warning signs can influence overall performance of projects* (Haji-Kazemi et al., 2012)

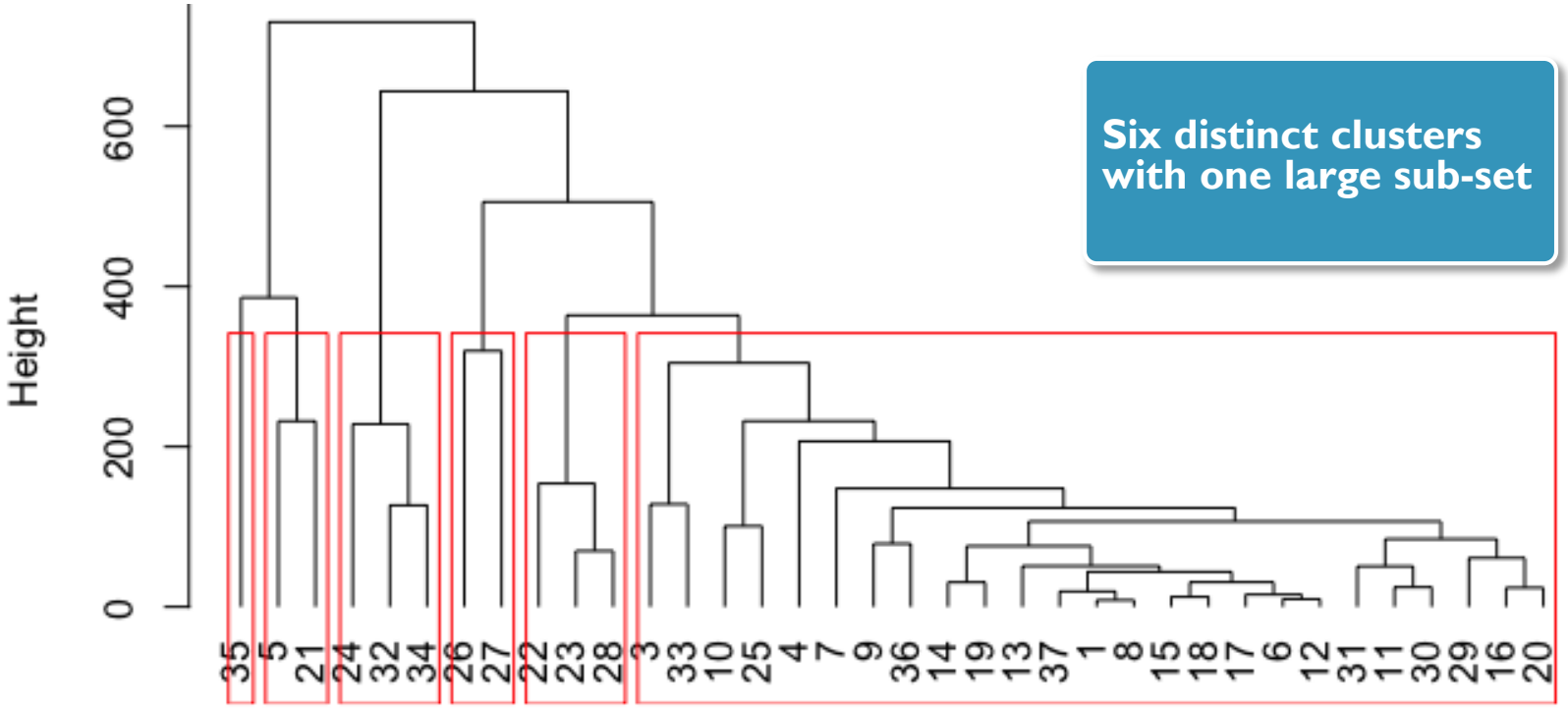
Research Objectives

- Improve our understanding of how cost overruns come about by investigating **how costs develop** from the first project plans to the opening of the project.
- Identify any groupings of projects based on **similar cost development patterns**
- Investigate how cost estimates can **act as early warning signs** to help prevent project failure or deviation from the main project goals.

Method

- **Cluster analysis:** organises data into representative groups based upon similar characteristics. Each member of the cluster has more in common with other members of the same cluster than with members of the other groups.
- Experiments varied by:
  - Algorithms: hierarchical and partitional clustering
  - Distance measures: average and Ward
  - Data: I. six cost estimates from initial planning to opening and II. cost estimates up to green light decision and cost overrun at project opening
- 'Best' cluster size and solution selected on strength of the cluster structure (using internal validity indices)

Cluster Dendogram Road Projects*



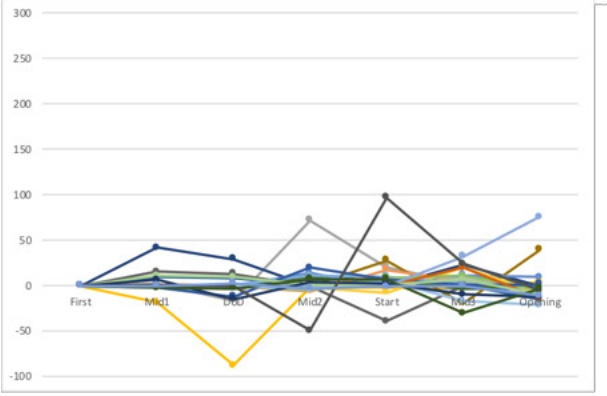
Six distinct clusters with one large sub-set

* Hierarchical clustering, dynamic time wrapping basic (dtw) 6 cluster solution

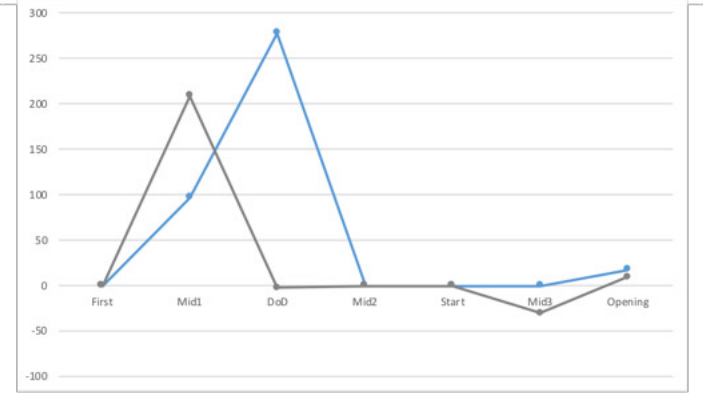
Cluster Series Road Projects*

Large sub-set

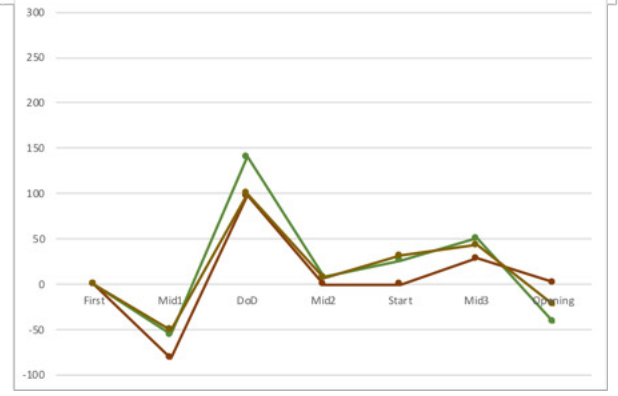
Cluster 1



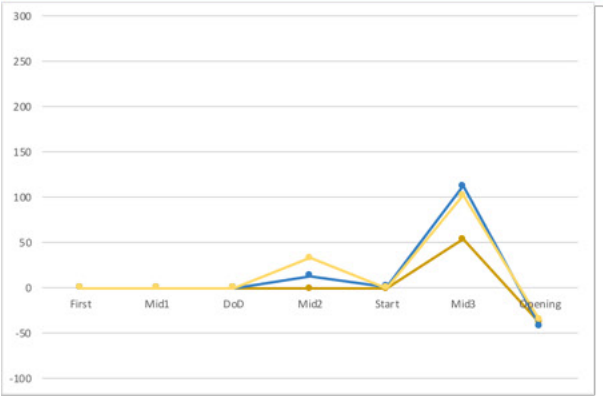
Cluster 2



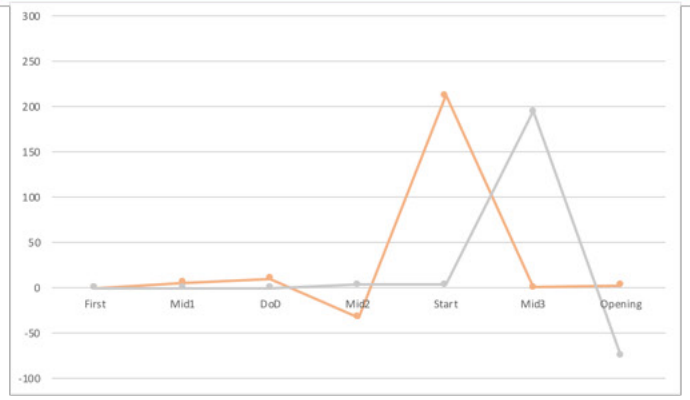
Cluster 3



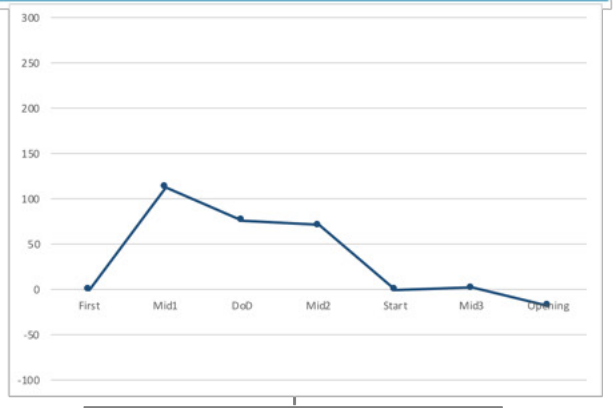
Cluster 4



Cluster 5



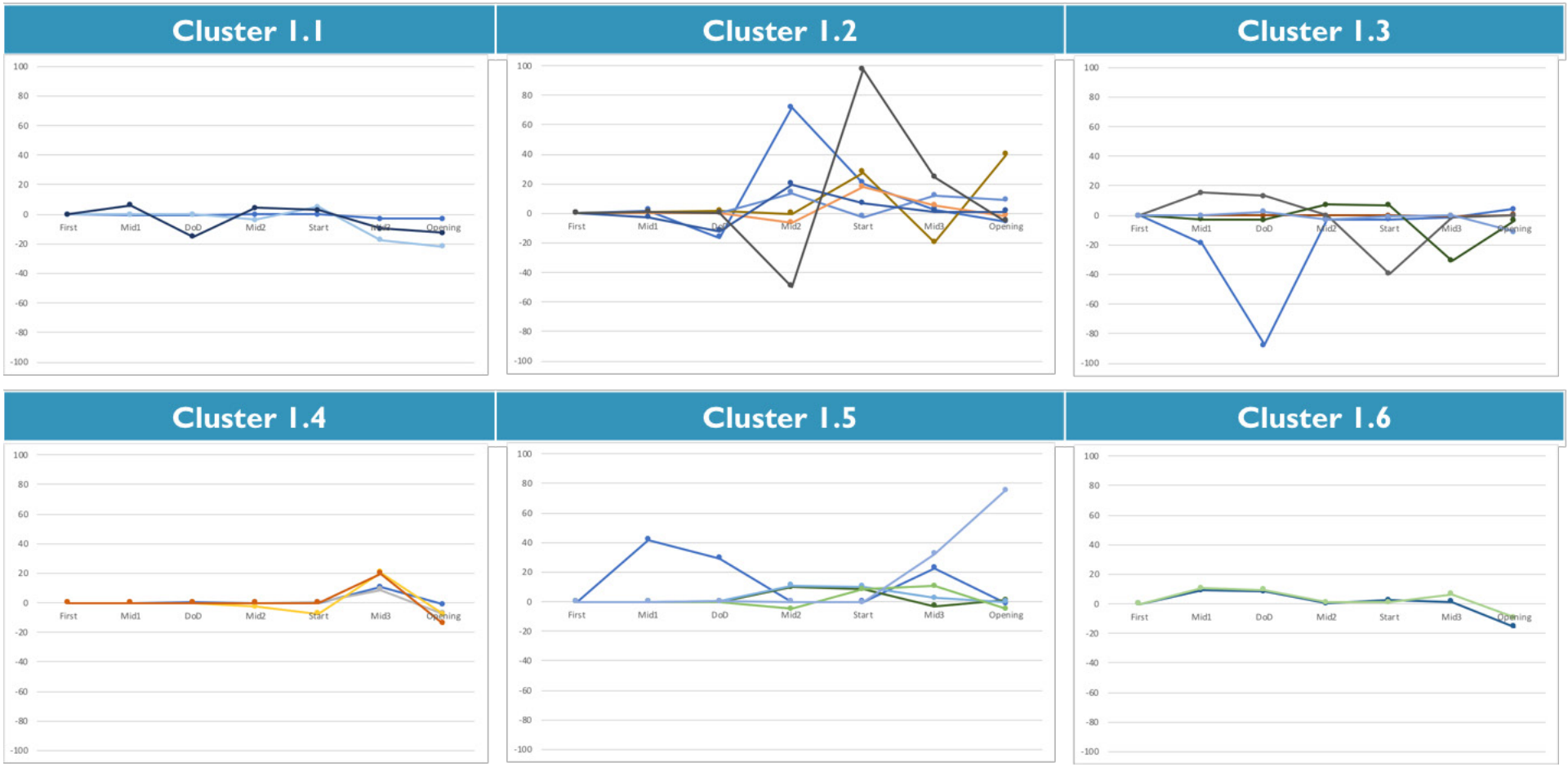
Cluster 6



Potential 'outlier'

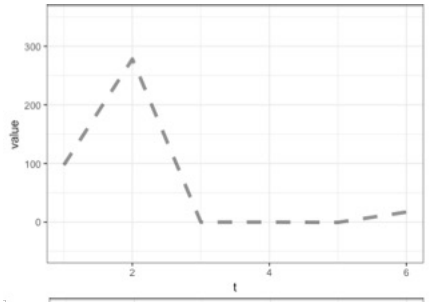
* Hierarchical clustering, dynamic time wrapping (dtw), Ward distance method, 6 cluster solution (same scales)

Cluster Series Road Projects - Subset*



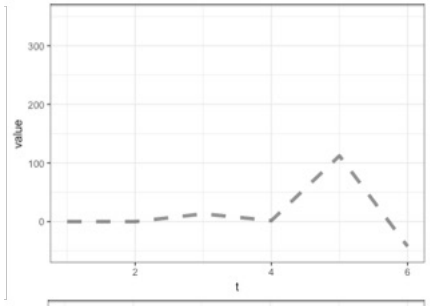
* Hierarchical clustering, shape based distribution, average distance method, 6 cluster solution (same scales)

Patterns of Cost Development



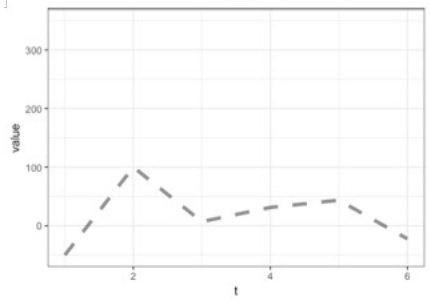
- Critical phase: before DoD
- Pattern: major increases early years, then stable

- Environmental req, e.g. ground works (poor EAA)
- Poor design, procedures not met
- Very short period decision to start, very long construction
- Major projects



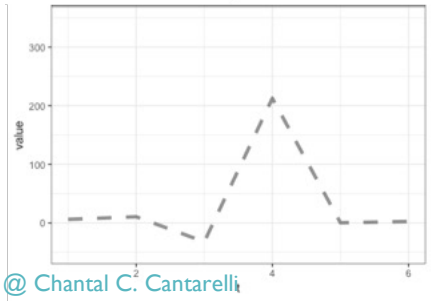
- Critical phase: First half of construction start
- Pattern: stable until Start then large increase and some correction

- Some regulatory changes at start /second half construction
- Scope additions, construction methods downgraded
- Long project duration, particularly front-end phase
- Very large projects



- Critical phase: before DoD
- Pattern: drop then large increase, considerable increase around construction phase

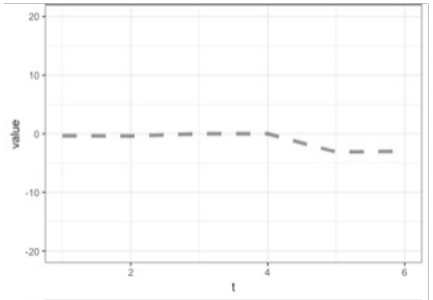
- Delay in project delivery (ground works/procedures, construction changes)
- Inaccurate estimates (after start)
- Short period to DoD but phase until start relatively long
- Large projects (1.5/2x average size)



- Critical point: around construction start
- Pattern: sharp increase before start, then stable

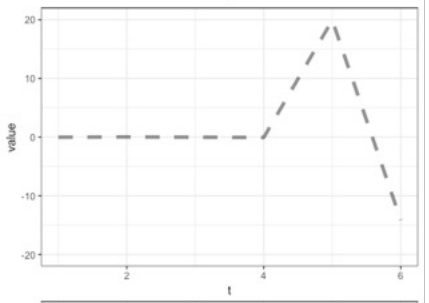
- Delays (planning procedures, related project(s))
- Increase contingencies (at start)
- Relatively older projects
- Average duration except shorter construction phase
- Slightly smaller/medium sized projects

Patterns of Cost Development



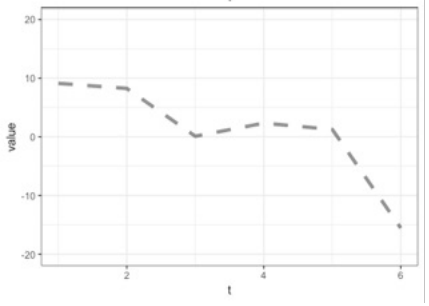
- Pattern: Stable cost development, slight reduction once construction started

- No major adjustments reported
- Average front-end period, shorter construction period
- Small projects (average cost underrun)



- Pattern: Stable cost development, marginal upward/downward adjustment after construction

- No major adjustments reported
- Short initiation and period between decision and start, relative long construction phase
- Small projects (app. on budget)



- Pattern: Marginal increase before DoD, marginal decrease second half construction

- No major adjustments reported
- Some delays (complexity, procedures, scope changes)
- About average duration (slightly longer construction)
- About average project size (app. On budget)

Conclusions: Cost Development Patterns

Cost development over time and groupings of projects with similar patterns:

- Seven main patterns of cost development using six key project stages
- Project typically experience one critical phase
- Different patterns depending on project size
- Critical phases often in front-end stage but also around start of construction

Conclusions: Early Cost Estimates As EWS

Early cost estimates have potential to be used as early warning signs in front-end stage (here *before* decision to build)

- Sharp *increase* of cost estimates: may result in project failure if this is combined with short decision-making phase (could point to optimism bias)
- Sharp *decrease* of costs estimates: may result in project failure as it is often followed by large increase of cost in subsequent phase (could point to strategic misrepresentation of cost estimates)
- Cost estimates as early warning signs is most effective for *large and major* projects

Conclusions: Early Cost Estimates As EWS

Effectiveness of early cost estimates as early warning signs for project failure or deviation from project goals:

- Depends on the *root cause* of the cost change
  - Optimism bias: low initial costs that are adjusted upwards over time
  - Strategic misrepresentation: cost estimates are adjusted downward over time
- Limitations: exploratory study
  - Considerable part of projects have unique cost development pattern hence effectiveness of early warning signs will be low
  - Additional projects/variables to increase representativeness

Thank You For Your Attention!

Any Questions?