Project Risk Management: A New Approach

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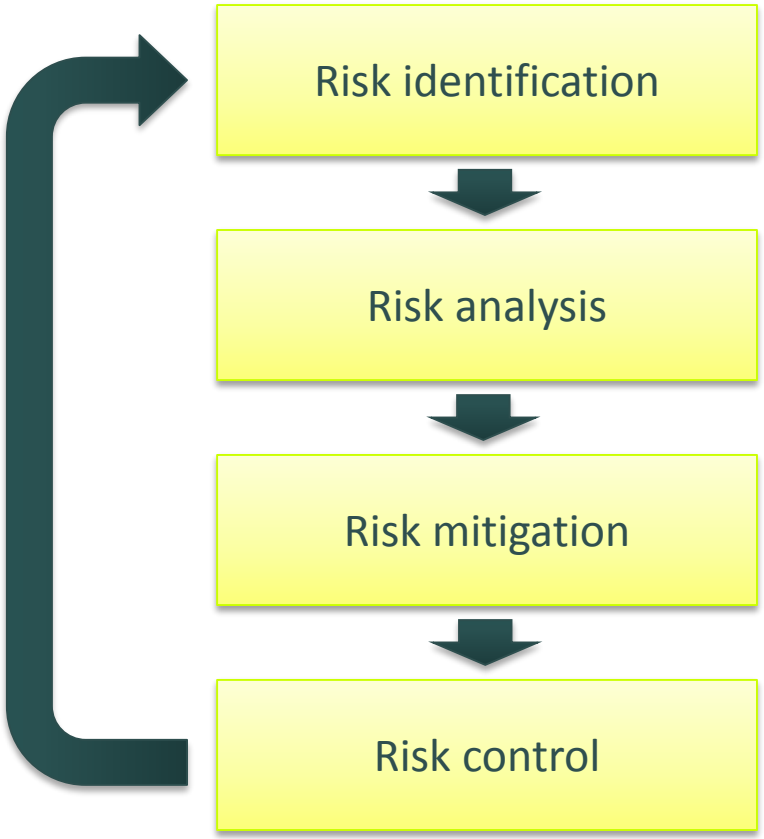
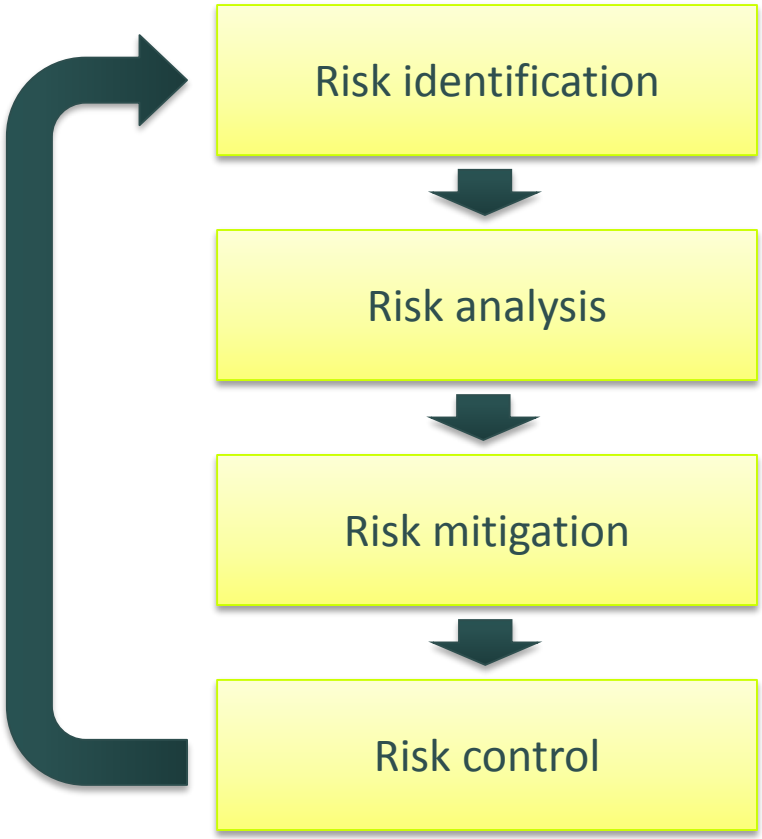
Risk management 101

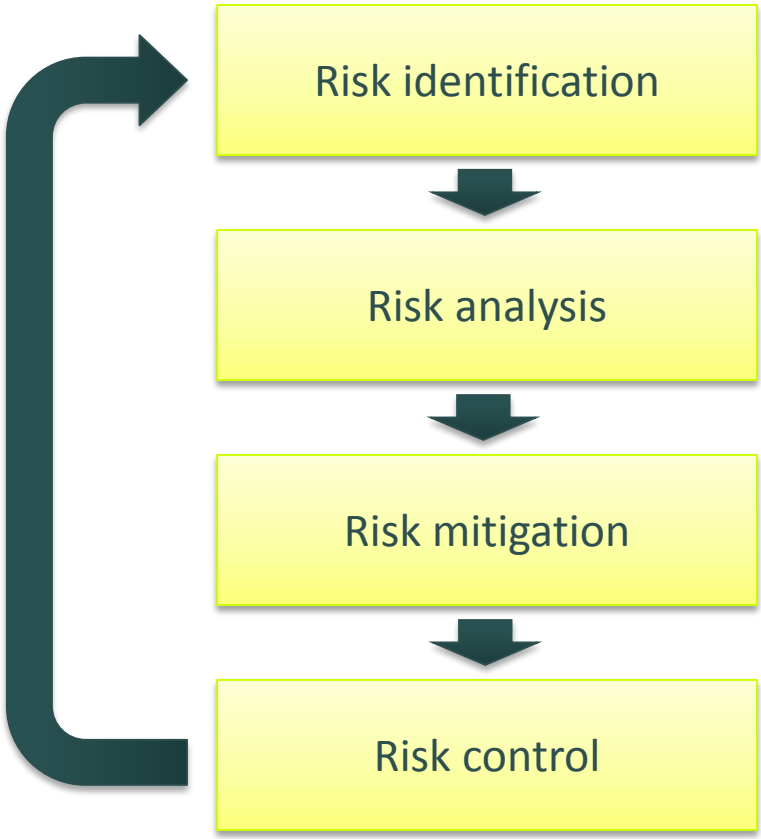


RISK MANAGEMENT 101



- Quantify probabilities and impacts of risks
- Assess the impact on project objectives
- Calculate the project objectives

RISK MANAGEMENT 101



- Quantify probabilities and impacts of risks
- Assess the impact on project objectives
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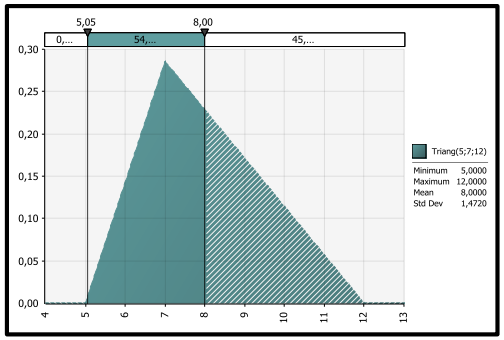
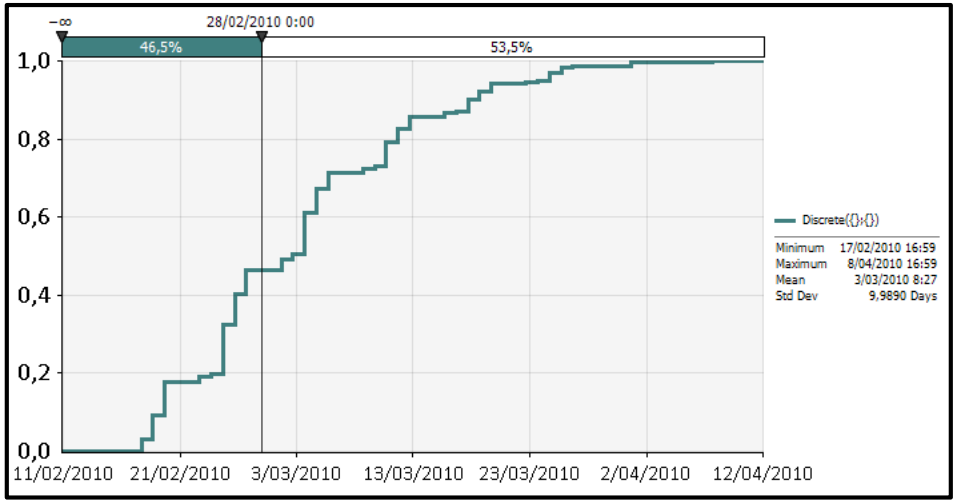
Where to start?

PROJECT RISK MANAGEMENT: CURRENT APPROACH

- Model uncertainty in activity durations
  - Normal distribution
  - Triangular distribution
  - Beta distribution



- Apply Monte Carlo Simulation to simulate project objectives
  - Probability that project finished before a certain date



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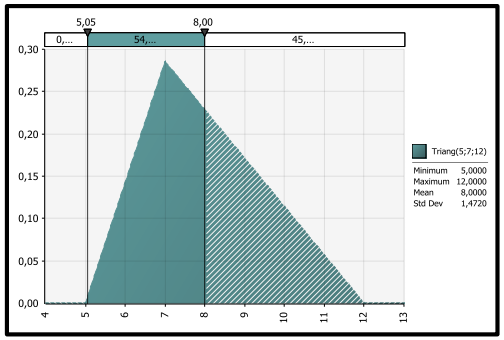

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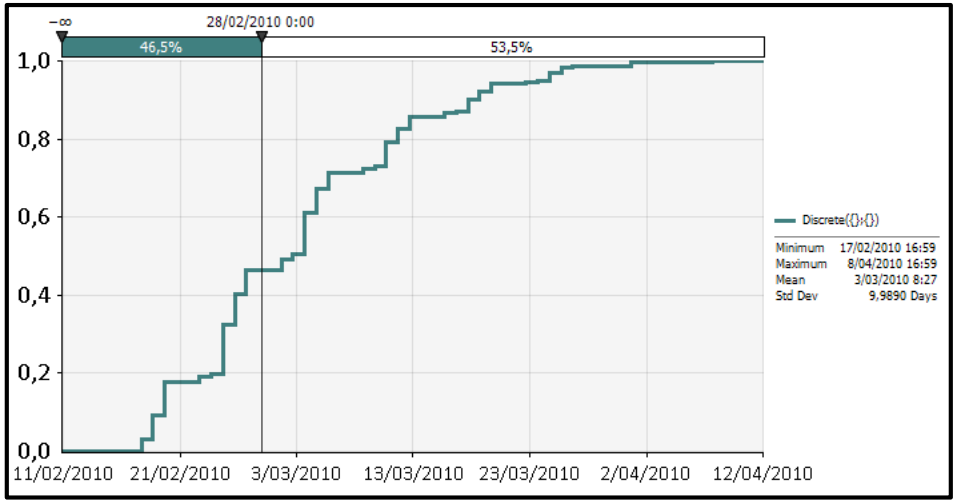
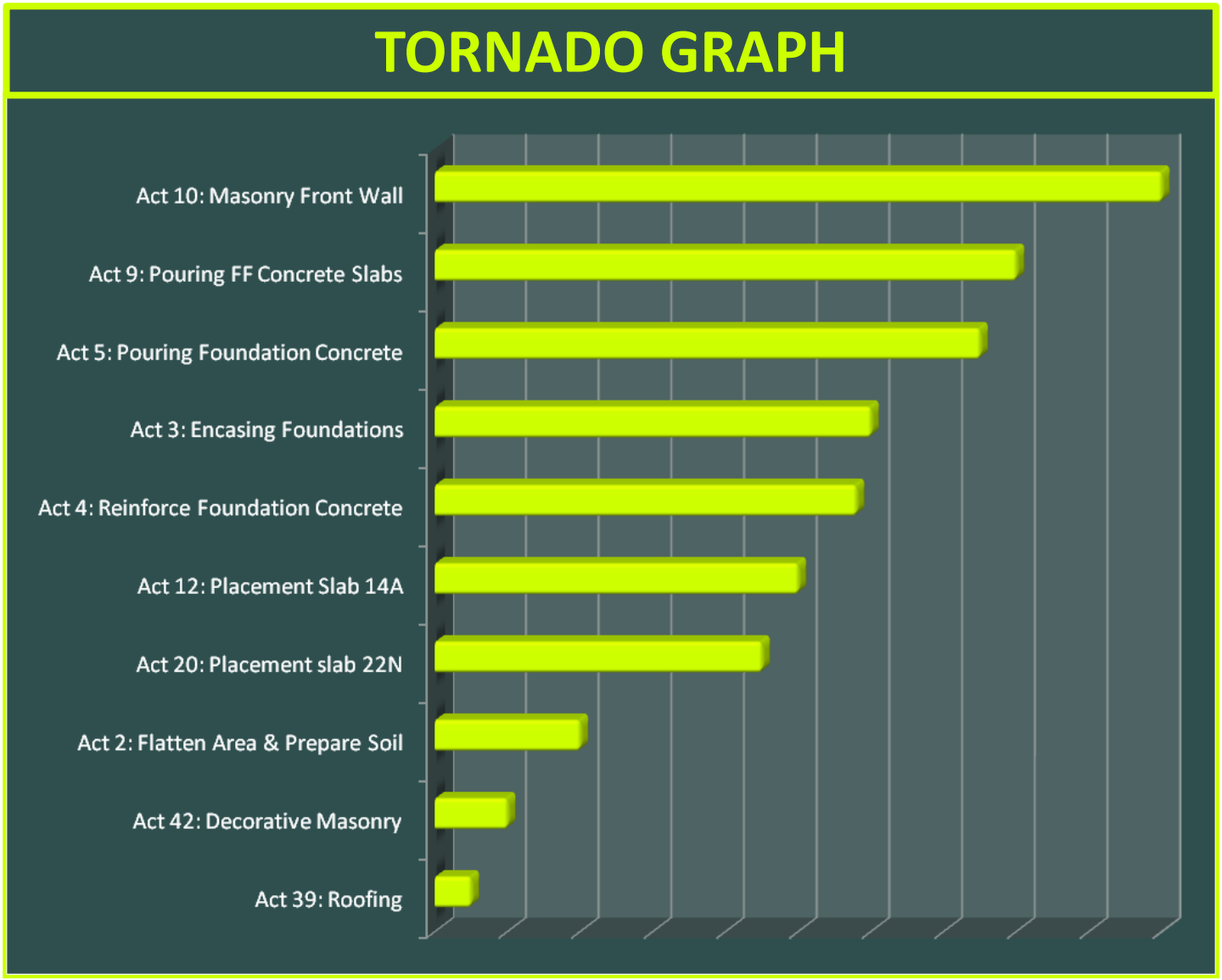
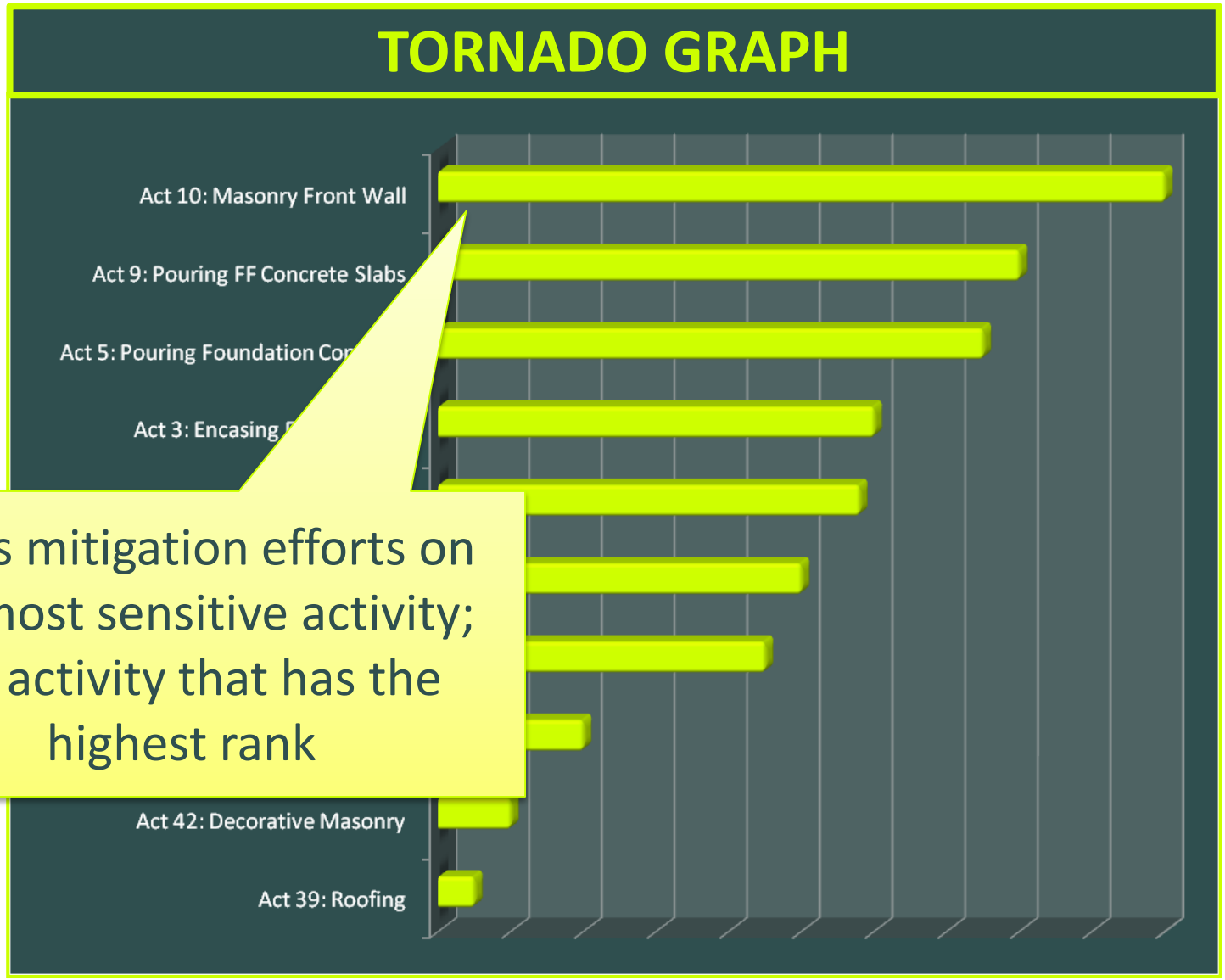


Analysis needs to
be followed by action
=>
Risk mitigation is required

RISK MITIGATION: RANKING OF MOST SENSITIVE ACTIVITIES



RISK MITIGATION: RANKING OF MOST SENSITIVE ACTIVITIES



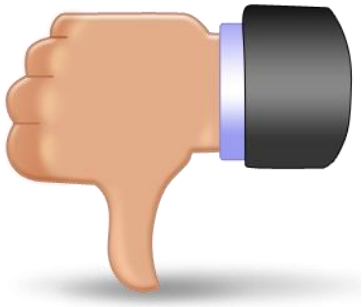
Focus mitigation efforts on the most sensitive activity; the activity that has the highest rank

CURRENT RANKING MEASURES

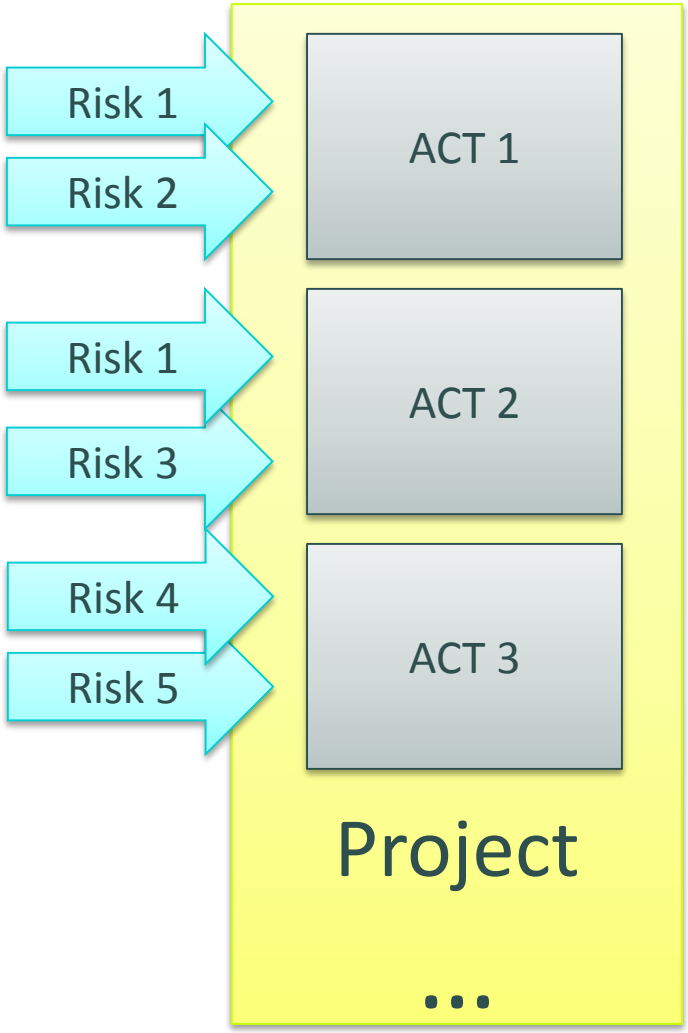
- Criticality Index $CI_i = P(ES_i = LS_i)$
- Significance Index $SI_i = \mathrm{E}\left[\frac{\mathrm{d_i}}{\mathrm{d_i} + \mathrm{TF_i}} \times \frac{\mathrm{C}}{\mathrm{E}(\mathbf{C})}\right]$
- Cruciality Index $CRI_i = corr(\boldsymbol{d}_i, C)$
- Schedule Sensitivity Index $SSI_i = \sqrt{\frac{Var(\boldsymbol{d}_i)}{Var(\boldsymbol{C})}}.CI$
- …

Problems with current approach

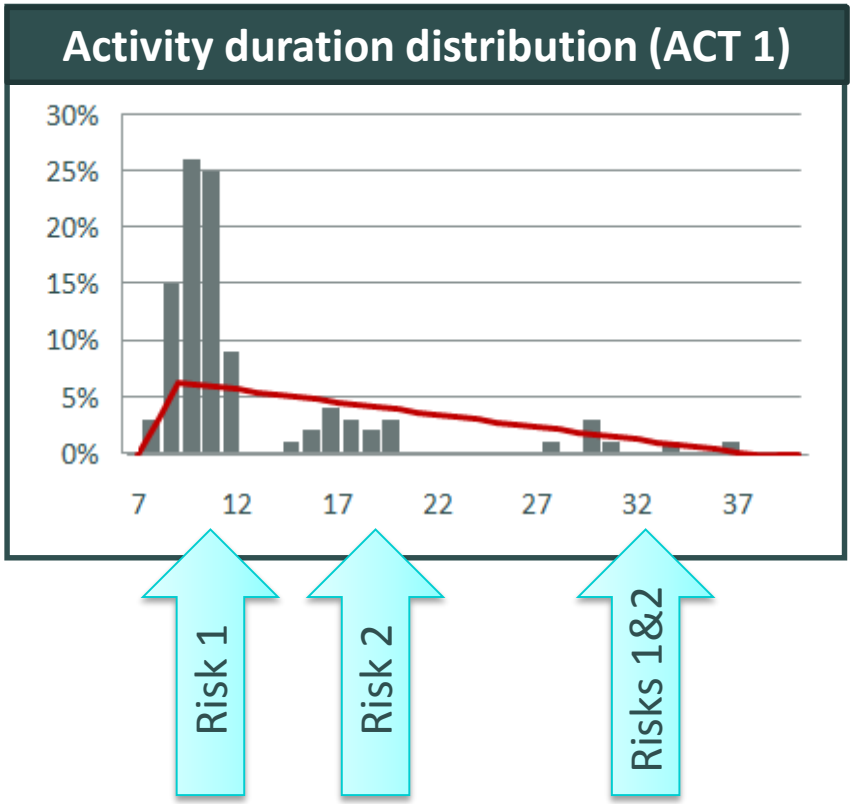
- Project managers have a very hard time to model uncertainty
- All of the previous ranking measures have been criticized
- It is not clear where the uncertainty originates from
- It is unclear how to mitigate uncertainty



New approach: Risk-driven (instead of activity-based)



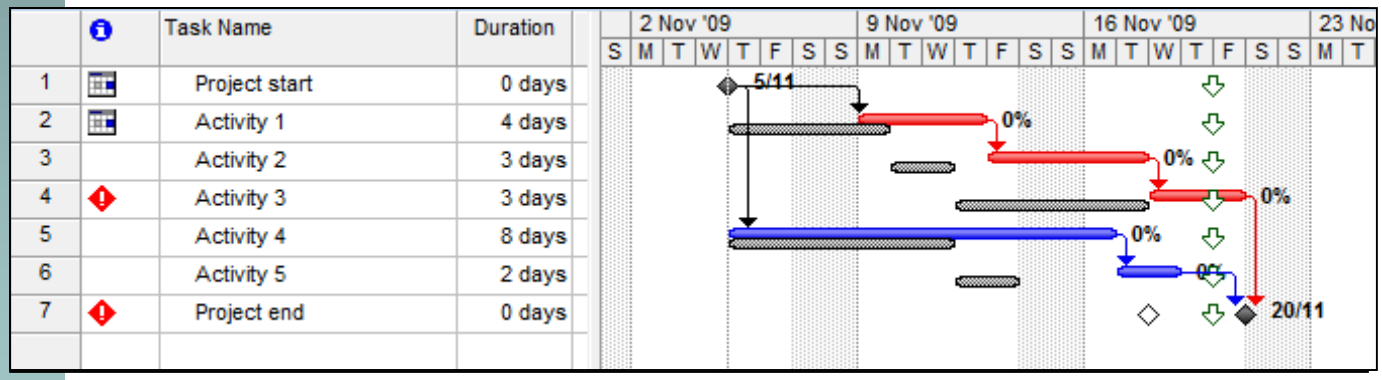
$$\boldsymbol{d}_i = f(d_i, \boldsymbol{r}_{ij})$$



PROPOSED RANKING MEASURES

- Cruciality Index (literature) $CRI_j = corr(\boldsymbol{r}_j, C)$

- Critical delay contribution $CDC_{ij} = E\left[\frac{\boldsymbol{r}_{ij} \cdot y_{ij}}{\sum_i \sum_j \boldsymbol{r}_{ij} \cdot y_{ij}} \cdot (\boldsymbol{C} - \delta)\right]$



	Delay	CDC
Act 1	+3	0.75
Act 2	+2	0.50
Act 3	-1	-0.25
Act 4	+3	0
Act 5	0	0
TOT	**C – E(C) = 4**	**C - δ = 1**

PROPOSED RANKING MEASURES

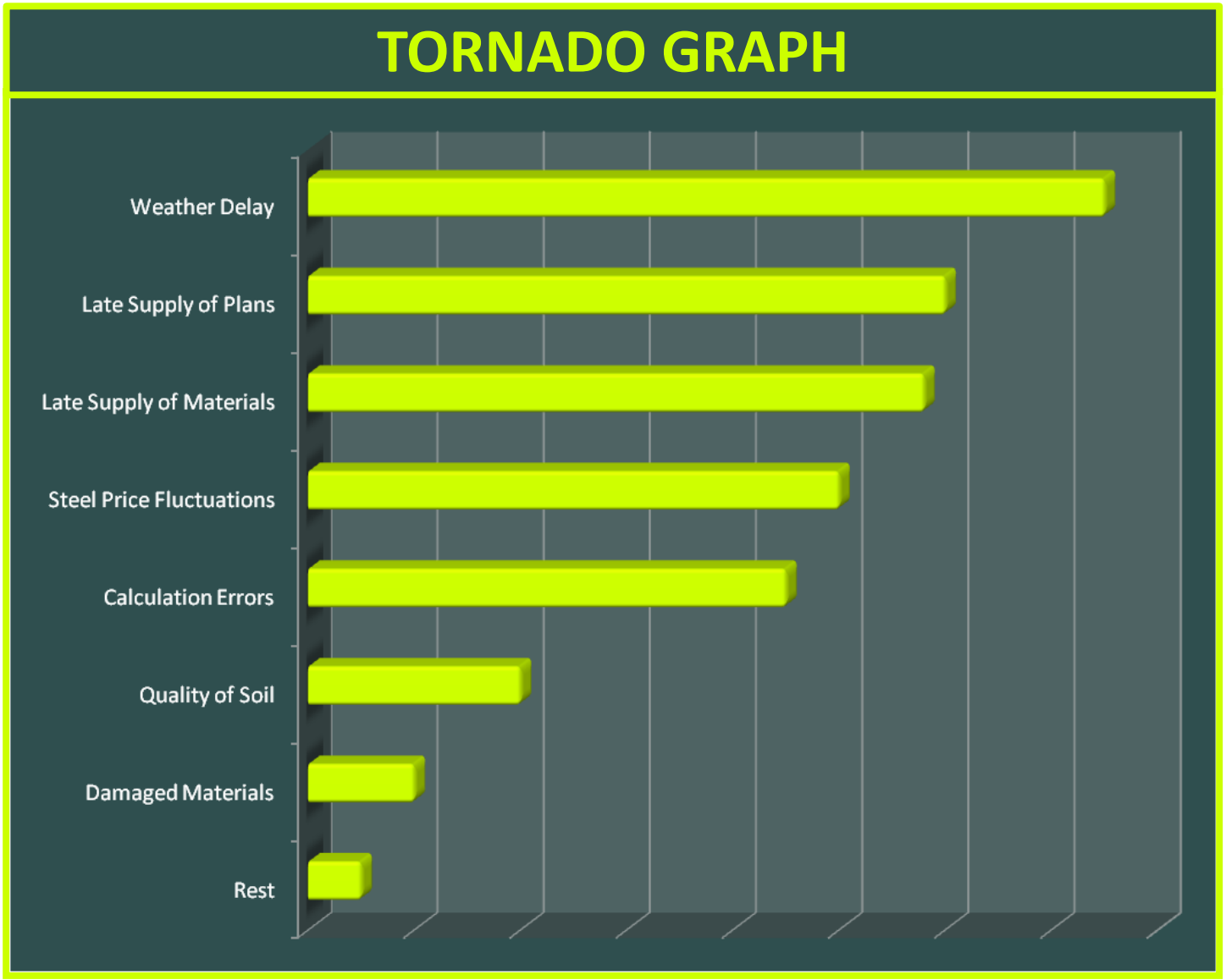
- Cruciality Index (literature) $CRI_j = corr(\boldsymbol{r}_j, C)$

- Critical delay contribution $CDC_{ij} = E\left[\frac{\boldsymbol{r}_{ij} \cdot y_{ij}}{\sum_i \sum_j \boldsymbol{r}_{ij} \cdot y_{ij}} . (\boldsymbol{C} - \delta)\right]$

ADVANTAGES OF THE NEW APPROACH

- Risks are much easier to predict than uncertainty
- CDC is calculated on risk per activity basis and can be aggregated on the level of risks and activities
- Risks **root** causes are ranked

TORNADO GRAPH USING RISK-DRIVEN RANKING MEASURES



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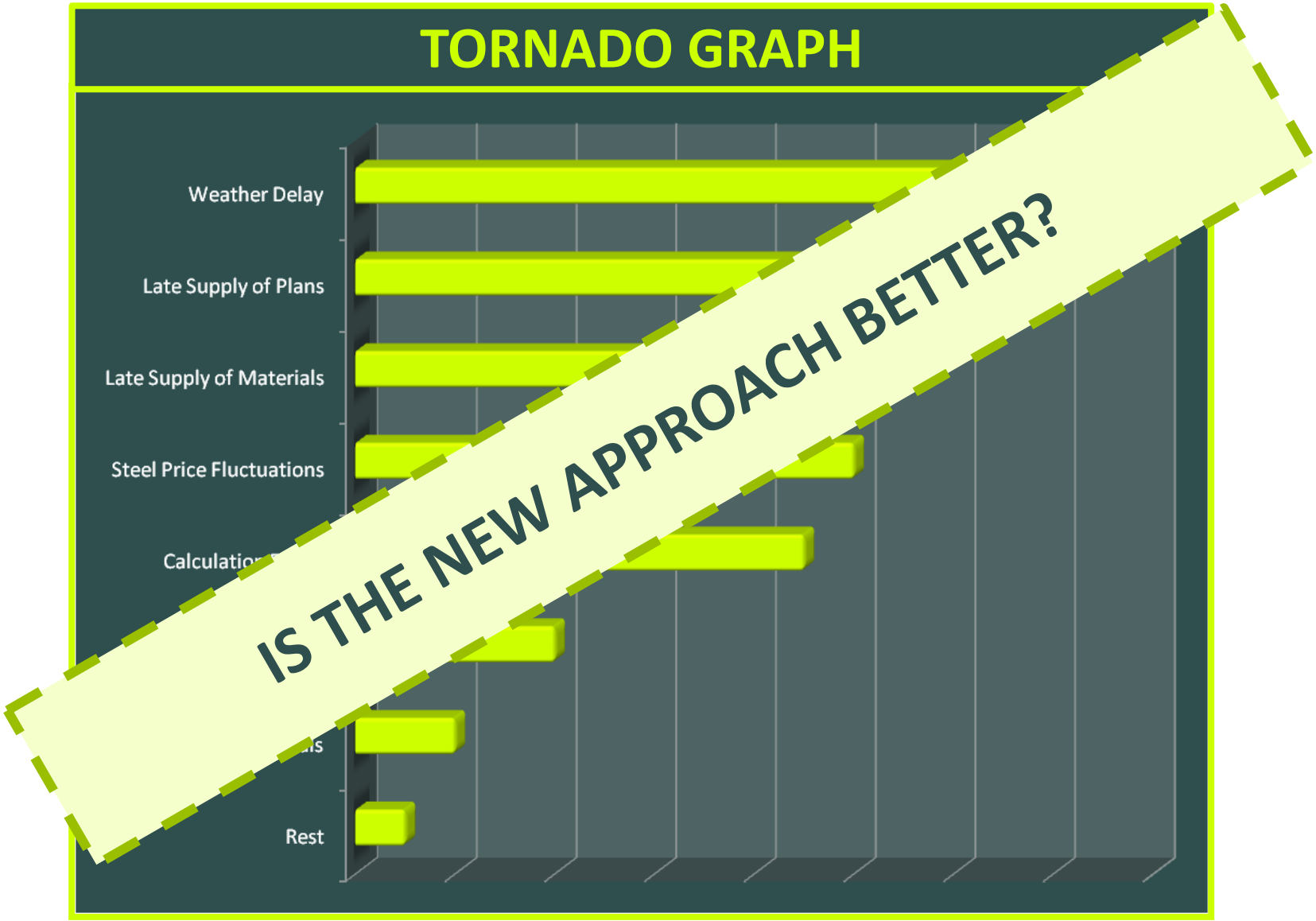


Evaluating the new approach: computational experiment

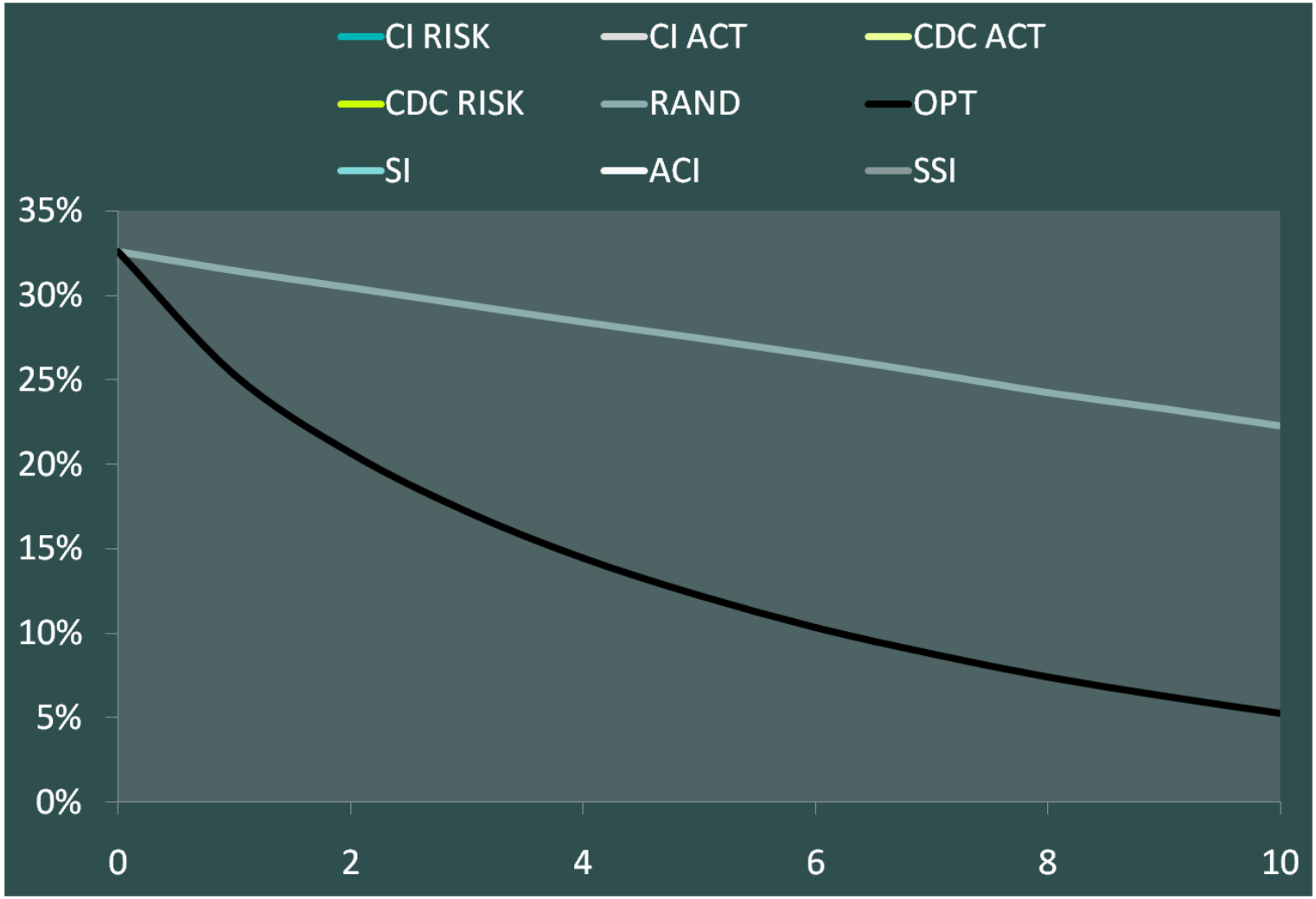
- For a large set of projects (600 projects of PSPLIB 120):
  - Model uncertainty (i.e. define risks, impacts, probabilities…)
  - Simulate the project execution
  - For each ranking measure:
    - Calculate the highest-ranked risk according to the measure
    - Eliminate the highest-ranked risk (i.e. focus our mitigation efforts on this risk)

How good do the measures
perform when mitigating 10 risks?

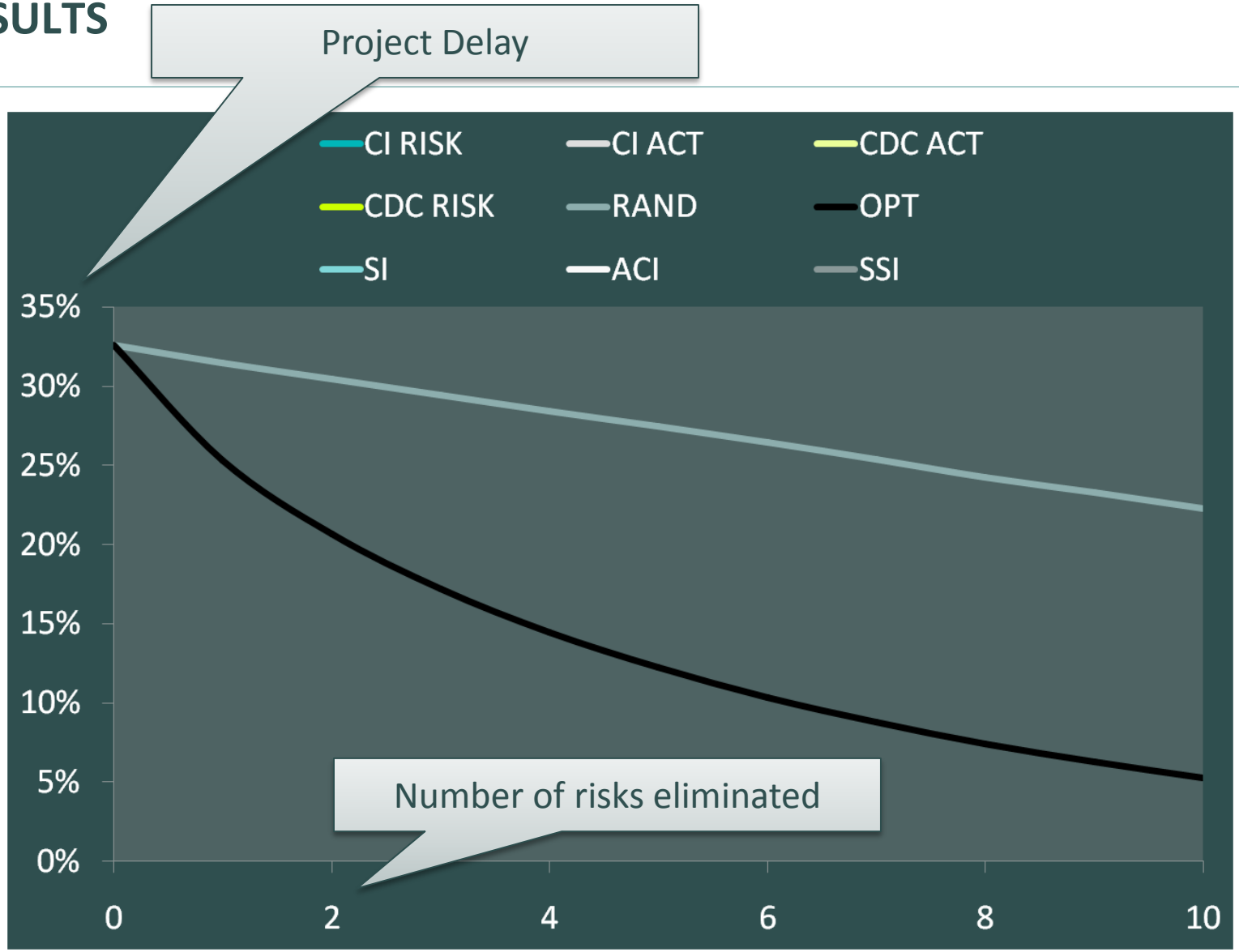
COMPUTATIONAL EXPERIMENT: RANKING MEASURES

ACTIVITY-BASED => SELECT THE LARGEST RISK THAT IMPACTS THE HIGHEST-RANKED ACTIVITY	RISK-DRIVEN => SELECT THE LARGEST RISK
CDC ACT	CDC RISK
CI ACT	CI RISK
SSI	
SI	
ACI	

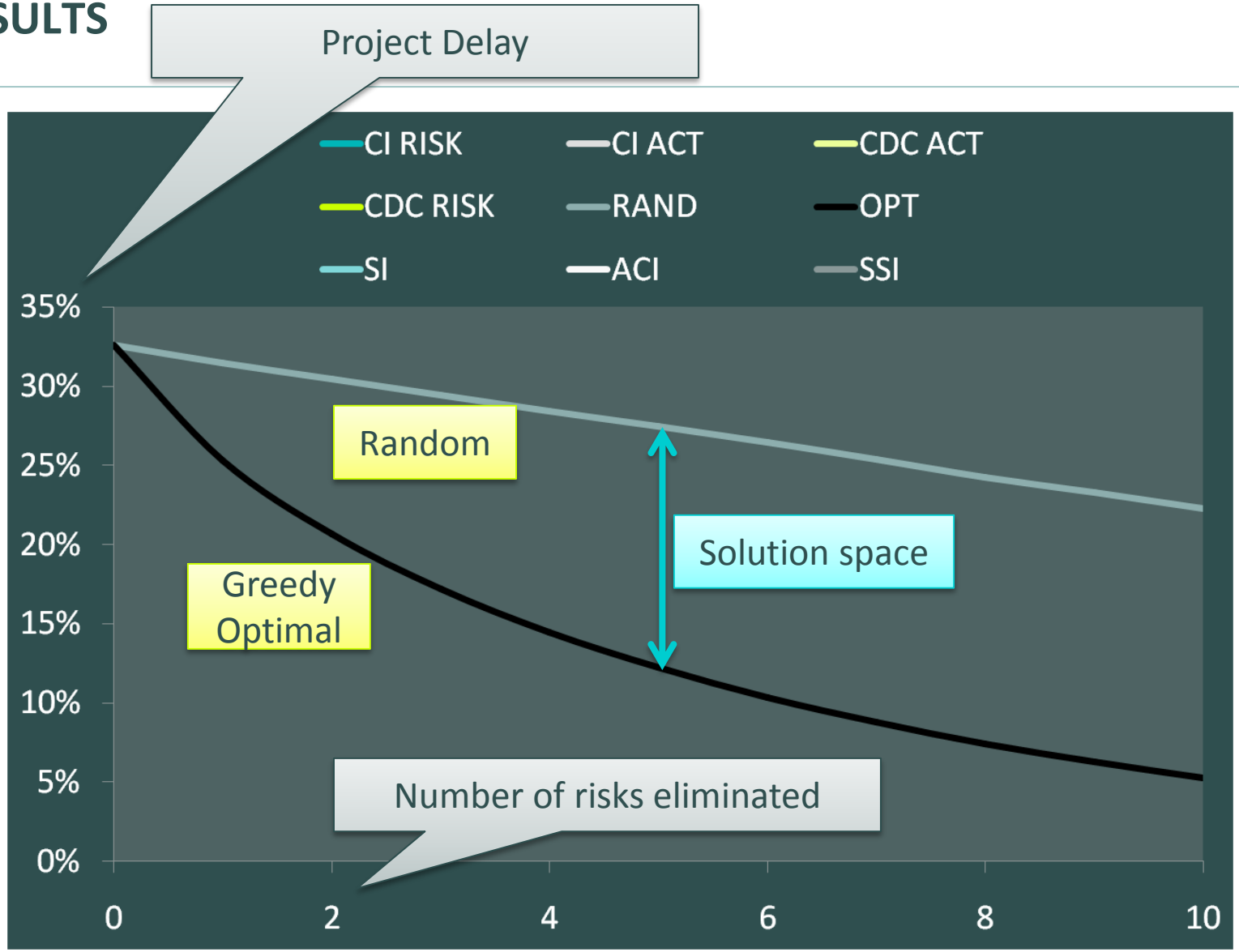
RESULTS


CI RISK
CI ACT
CDC ACT
CDC RISK
RAND
OPT
SI
ACI
SSI
35%
30%
25%
20%
15%
10%
5%
0%
0
2
4
6
8
10

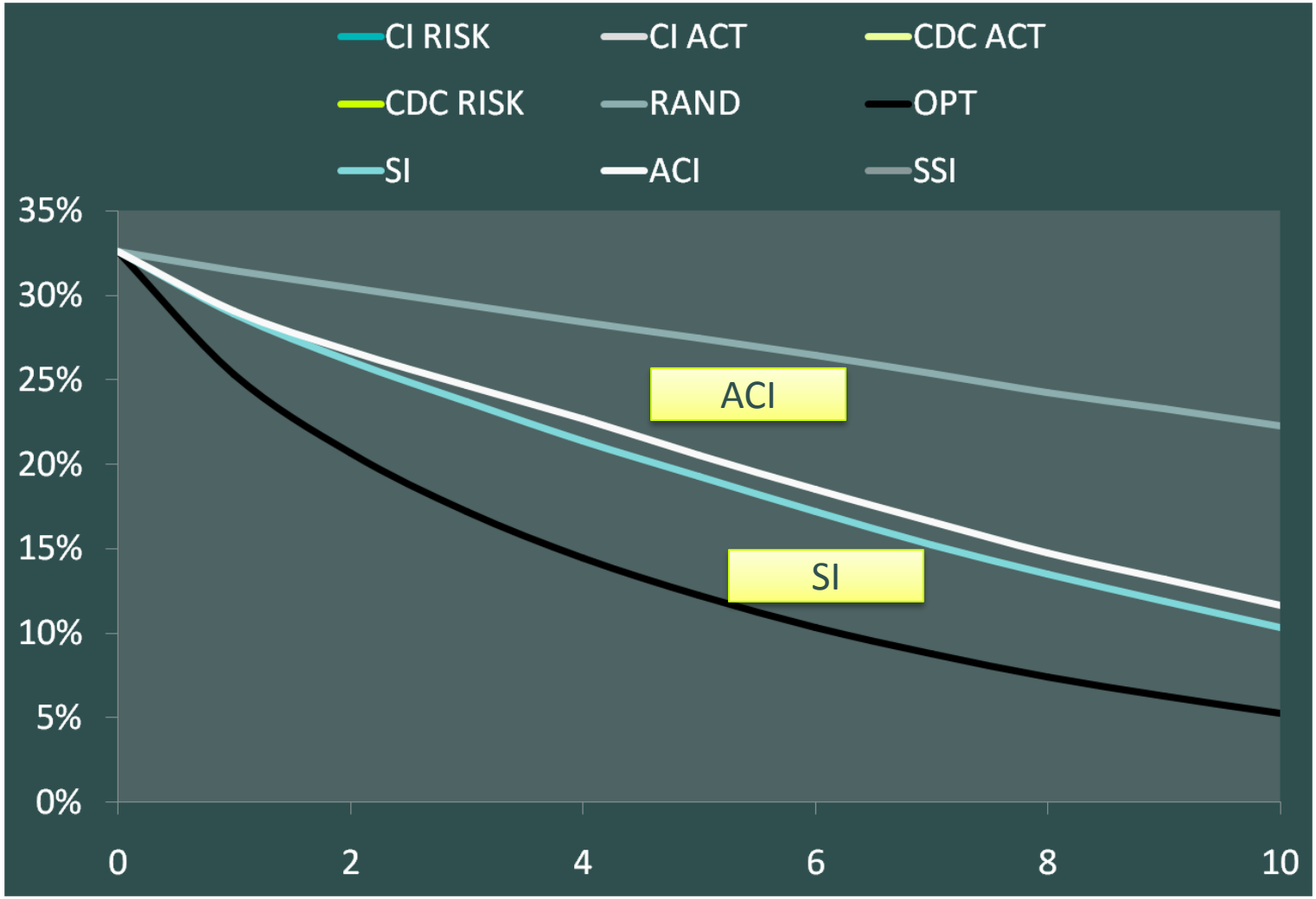
RESULTS


Project Delay
CI RISK
CI ACT
CDC ACT
CDC RISK
RAND
OPT
SI
ACI
SSI
35%
30%
25%
20%
15%
10%
5%
0%
0
2
4
6
8
10
Number of risks eliminated

RESULTS


Project Delay
CI RISK
CI ACT
CDC ACT
CDC RISK
RAND
OPT
SI
ACI
SSI
35%
30%
25%
20%
15%
10%
5%
0%
Random
Solution space
Greedy
Optimal
Number of risks eliminated
0
2
4
6
8
10

RESULTS


CI RISK
CI ACT
CDC ACT
CDC RISK
RAND
OPT
SI
ACI
SSI
35%
30%
25%
20%
15%
10%
5%
0%
0
2
4
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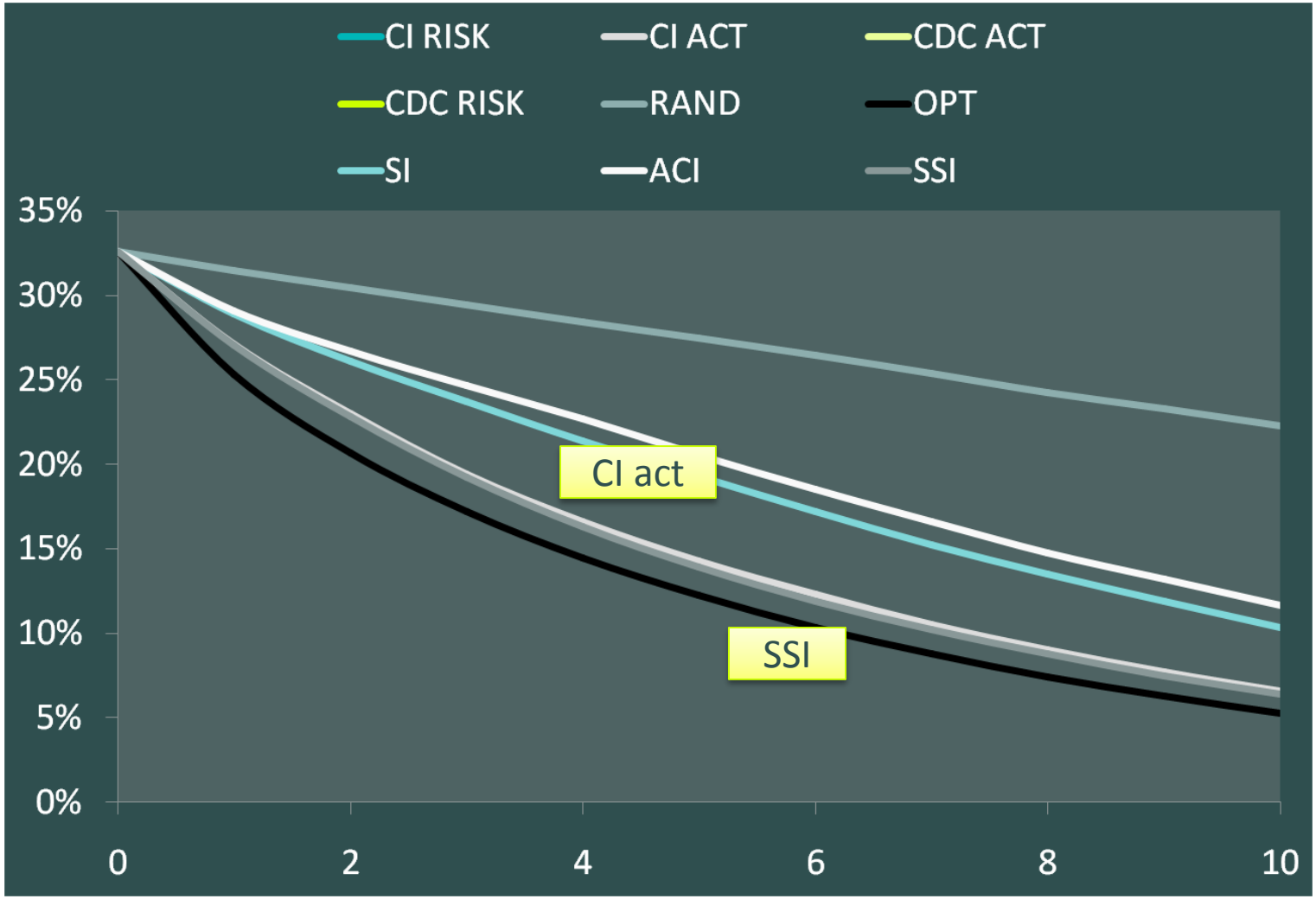
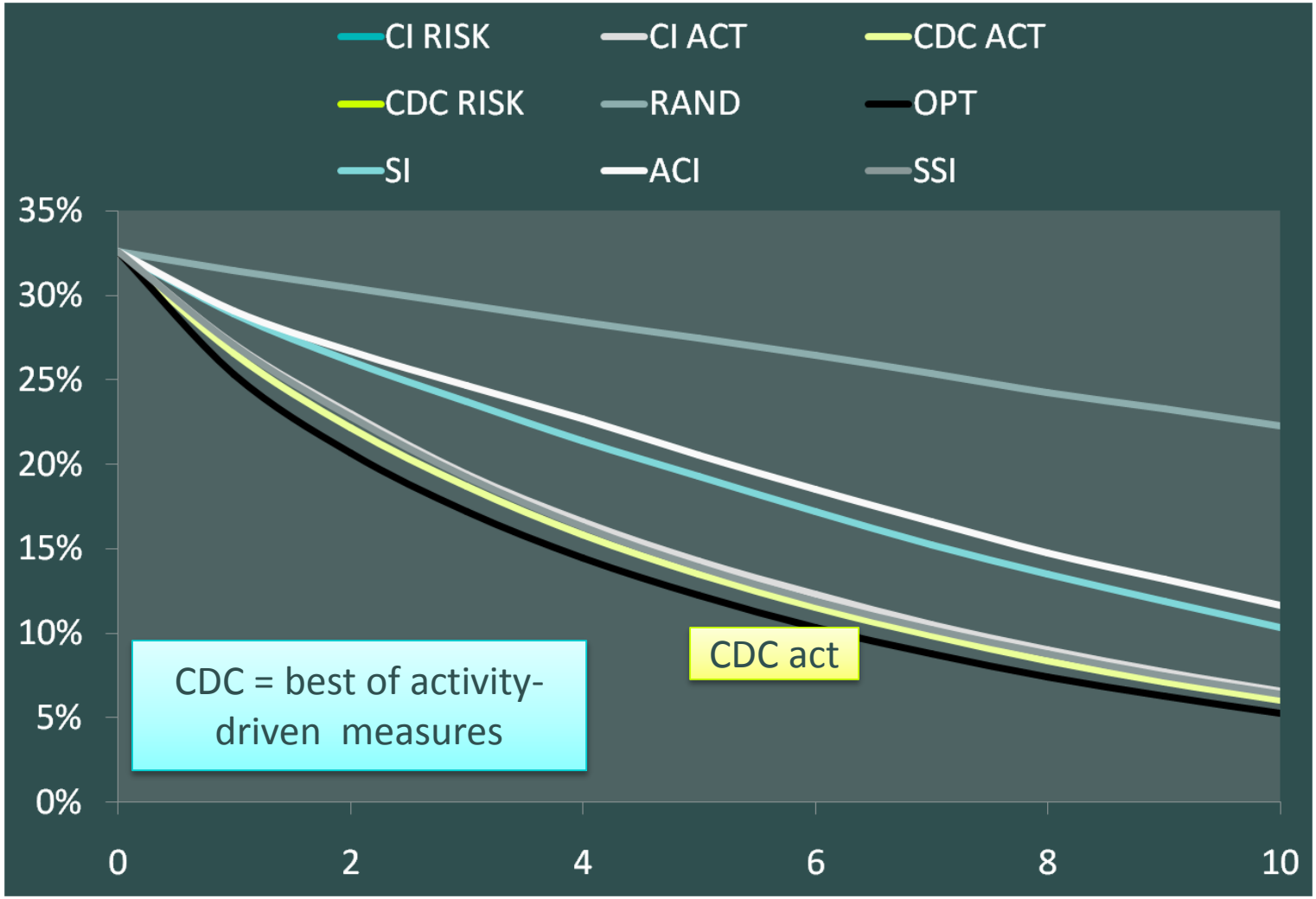
8
10
ACI
SI

RESULTS


CI RISK
CI ACT
CDC ACT
CDC RISK
RAND
OPT
SI
ACI
SSI
35%
30%
25%
20%
15%
10%
5%
0%
0
2
4
6
8
10
CI act
SSI

RESULTS


CI RISK
CI ACT
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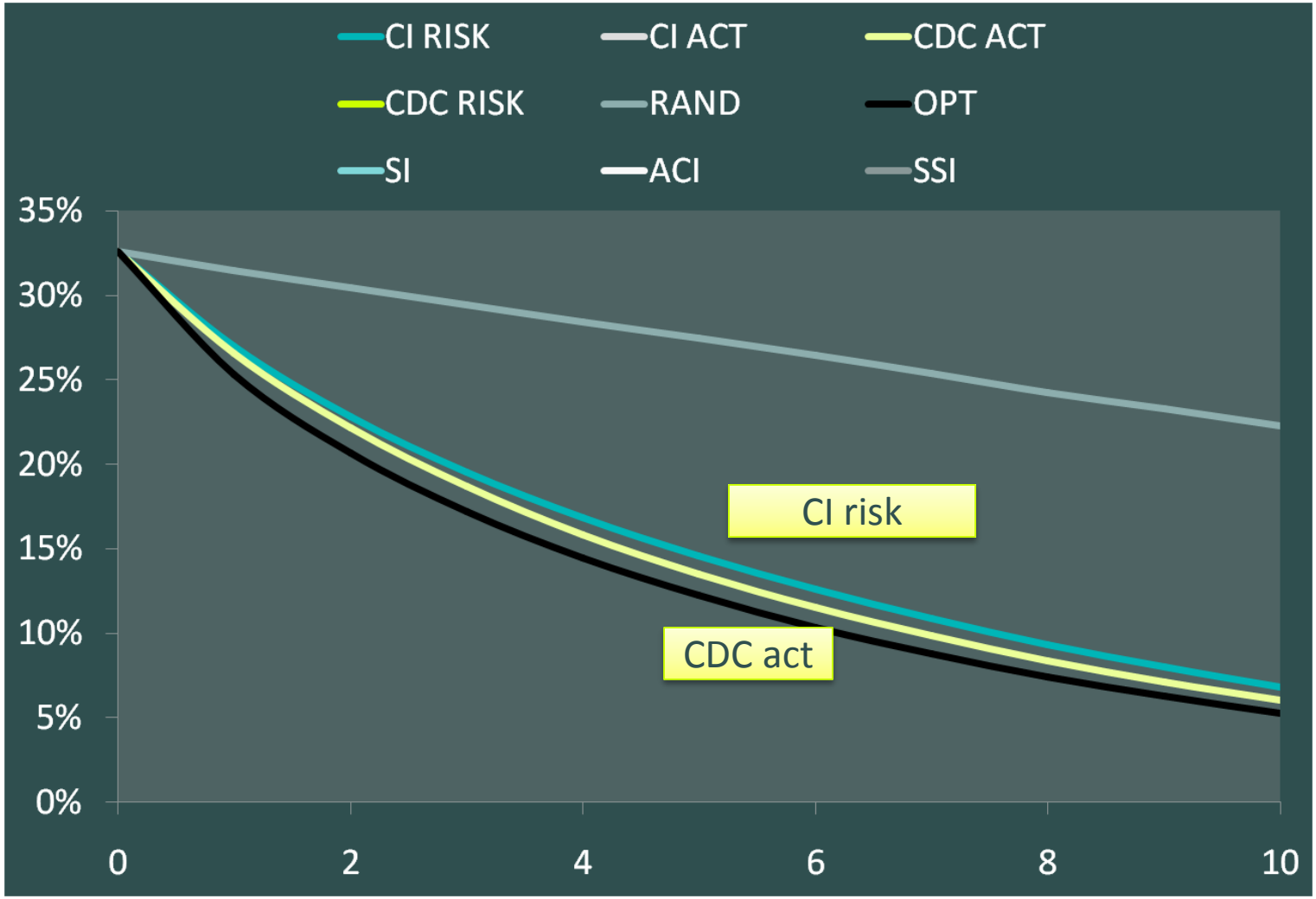
CDC RISK
RAND
OPT
SI
ACI
SSI
35%
30%
25%
20%
15%
10%
5%
0%
0
2
4
6
8
10
CDC = best of activity-driven measures
CDC act

RESULTS


CI RISK
CI ACT
CDC ACT
CDC RISK
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ACI
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35%
30%
25%
20%
15%
10%
5%
0%
0
2
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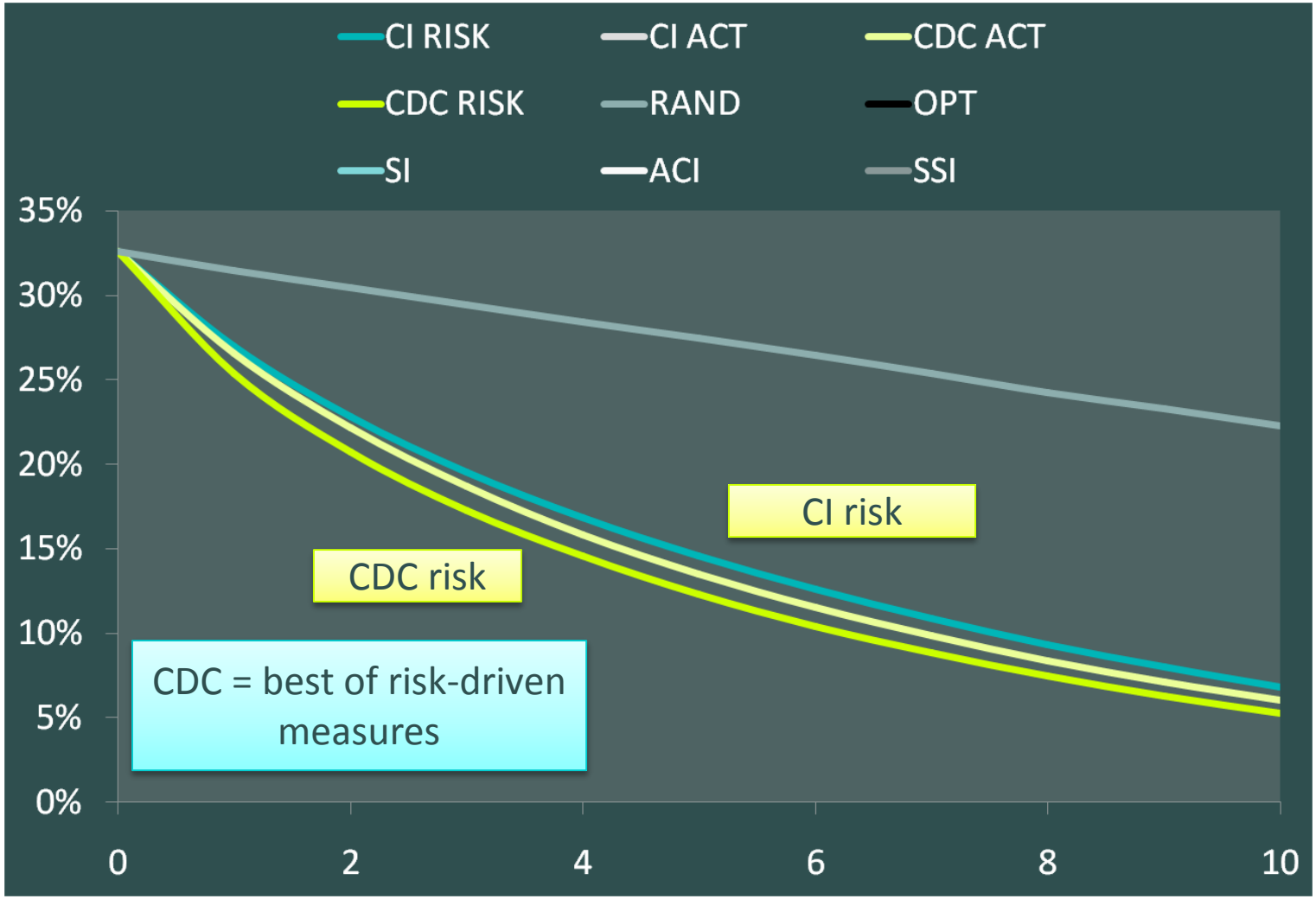
CI risk
CDC act

RESULTS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10%
5%
0%
0
2
4
6
8
10
CI risk
CDC risk
CDC = best of risk-driven measures

Conclusions

- A risk-driven approach to project risk analysis is preferred
- CDC is able to outperform current best practice measures (activity-based AND risk-driven)
- CDC is very close to greedy optimal
- Recommendations are insensitive to parameter settings:
  - Different settings of risk probabilities and impacts
  - Risk occurrences correlated or not?
- Future research: Optimal approach is future research

QUESTIONS?