

Project Control and EVM Analysis with Risks and Uncertainties

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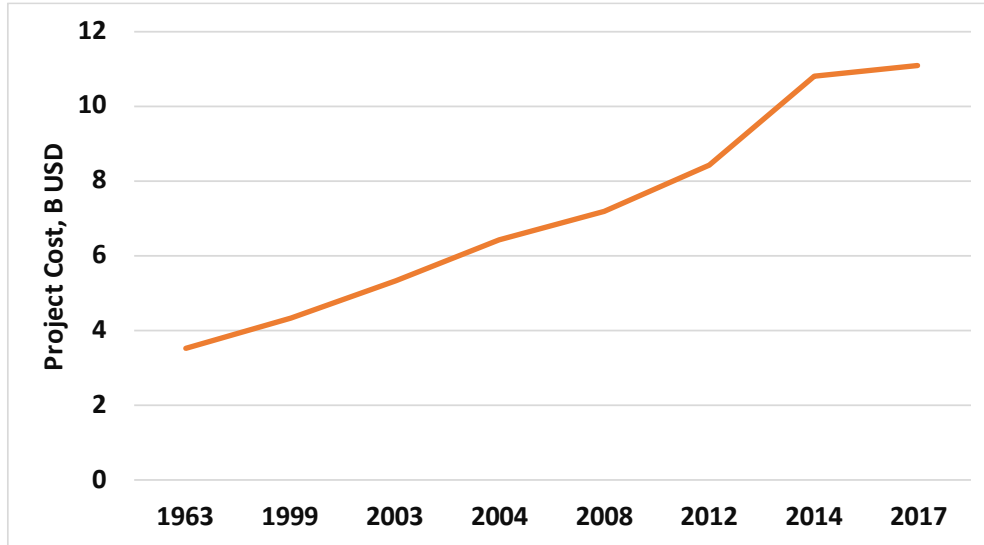


Why Project Control with Risk Analysis?



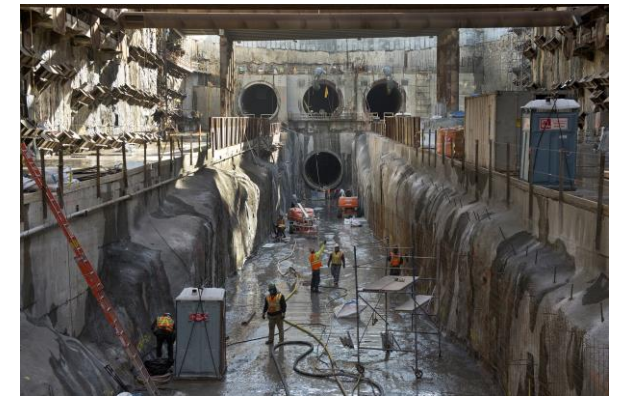
New York East Side Access Project

Extension the Long Island Railroad (LIRR) from Queens into a new station under Grand Central Terminal on Manhattan's East Side.



East Side Access cost estimates over time from USD \$5.3B in 2002 to USD \$11.2B in 2021

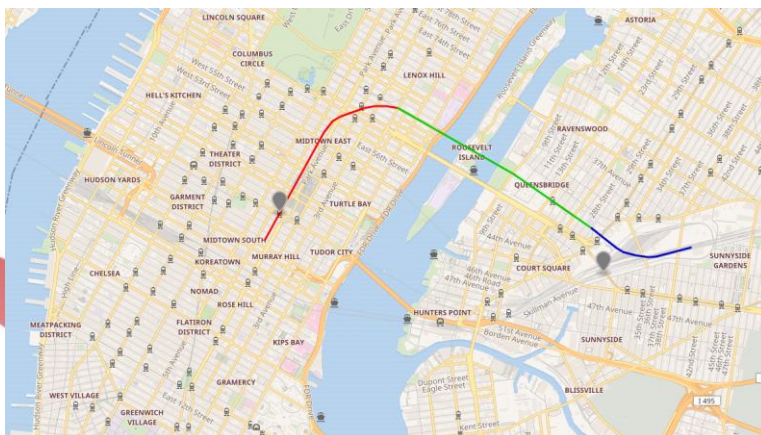
East Side Access: Queens



East Side Access: Manhattan



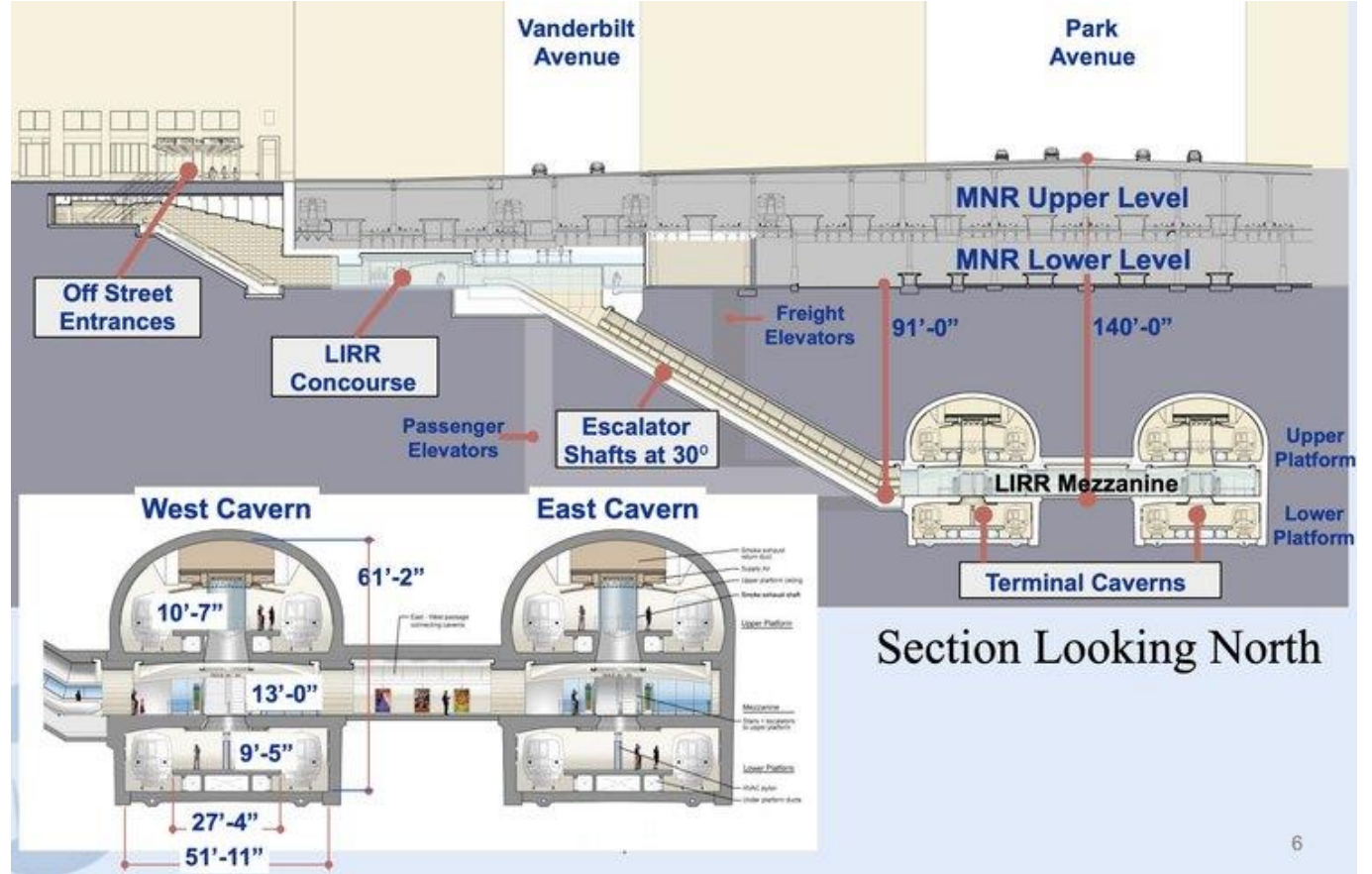
Map of the project: Line Length is 2 miles



East Side Access is considered to be one of the most expensive tunneling projects in history per mile.

New York East Side Access Project

Manhattan's East Side terminal design and actual station in Summer 2022



New York East Side Access Project

Main reasons behind significant cost overrun:

Mismanagement
Lack of oversight
Fraud

Common reasons behind cost overrun in many projects

Actual problems with the project:

- High payments to contractors, issues with bidding process
- Politically connected unions
- High profit of design and construction companies
- Design mistakes and design changes
- Problems related to cooperation with other agencies (e.g. Sunnyside Yard)
- 15-25% contingency due to bureaucracy



Manhattan's East Side terminal design

Moynihan Train Hall, New York

Expansion of Pennsylvania Station (the main intercity and commuter rail station in New York) into the city's former main post office building:



Total Construction Cost \$1.6B



- First phase: an expansion of a concourse under the Farley Building, started in 2010 and was completed in June 2017.
- Second phase: a train hall commenced in 2017 and was opened January 1, 2021.

Cost estimate in December 2002 was \$315 million

California High Speed Rail



Project Cost Escalation

2012 - \$68.4B
2018 - \$77B in year-of-expenditure dollars,
assuming a 2033 completion year
3% inflation

Comparing per kilometer cost in US and other regions

California High Speed Rail (2014): \$56 million
China per kilometer cost: \$17–21 million
Europe per kilometer cost \$25–39 million



Comparing Two Projects: Toronto vs. Addis Ababa LRT

Toronto Eglinton Crosstown LRT



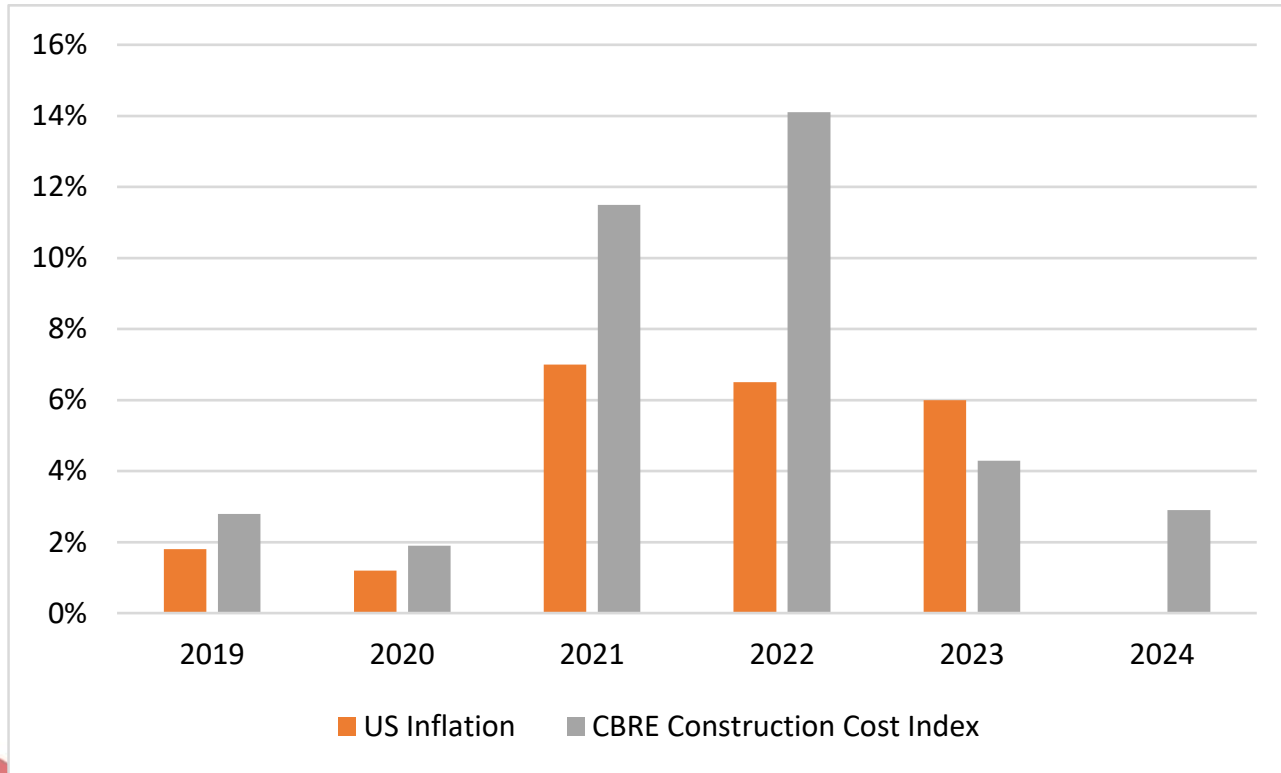
- 19 kilometres
- 25 stations
- 2019 Cost: 12.6B
- 12 years to build
- Average construction worker salary: ~CAD \$45,000

Addis Ababa LRT



- 17.4 kilometres (10.8 mi)
- 39 stations
- 2015 Cost: CAD ~0.6B, **21 times more expensive**
- 3 years to build
- Average construction worker salary ~CAD \$3,000

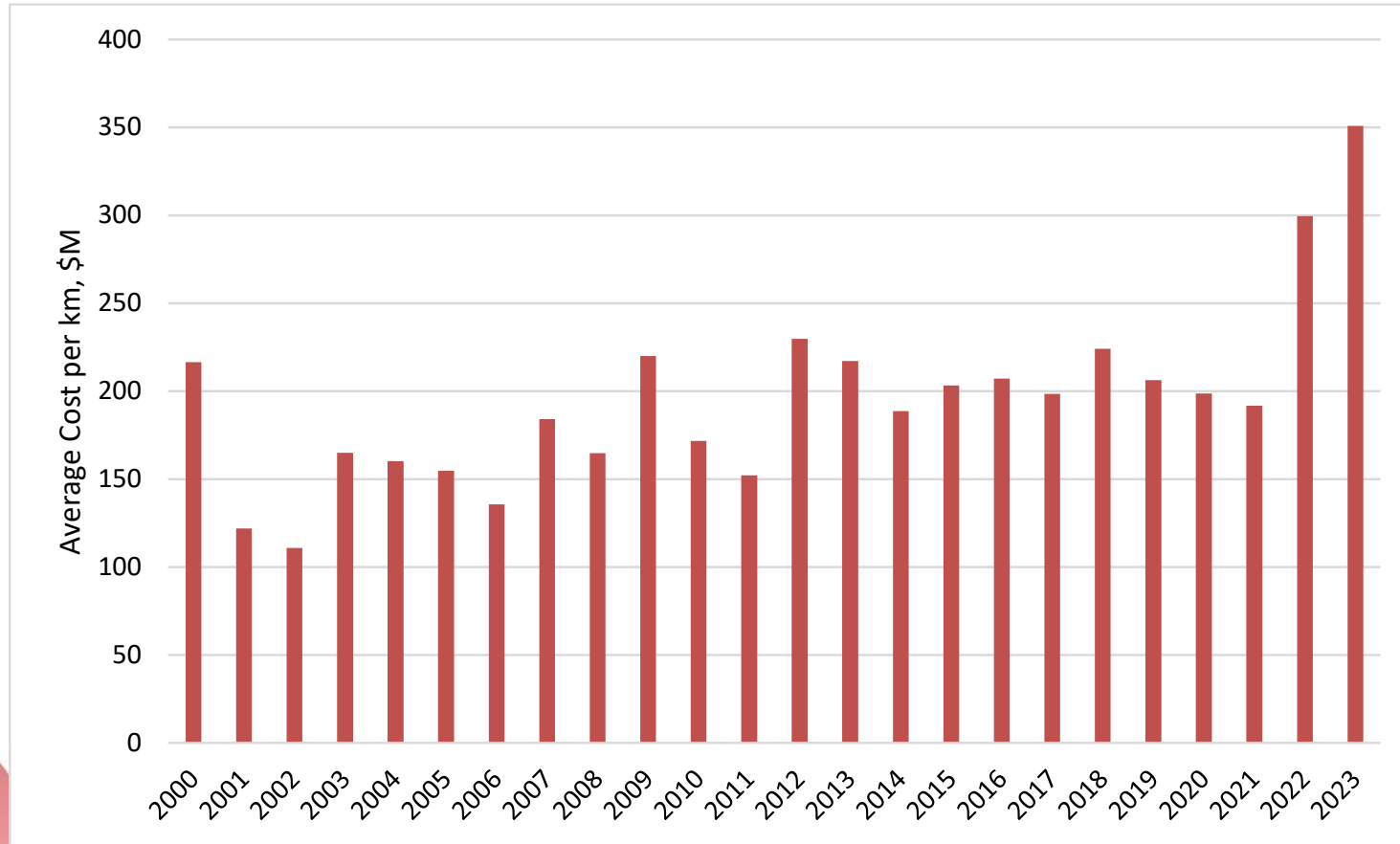
Construction Cost Growth Faster Than Inflation



Global Commercial Real Estate Services (CBRE):

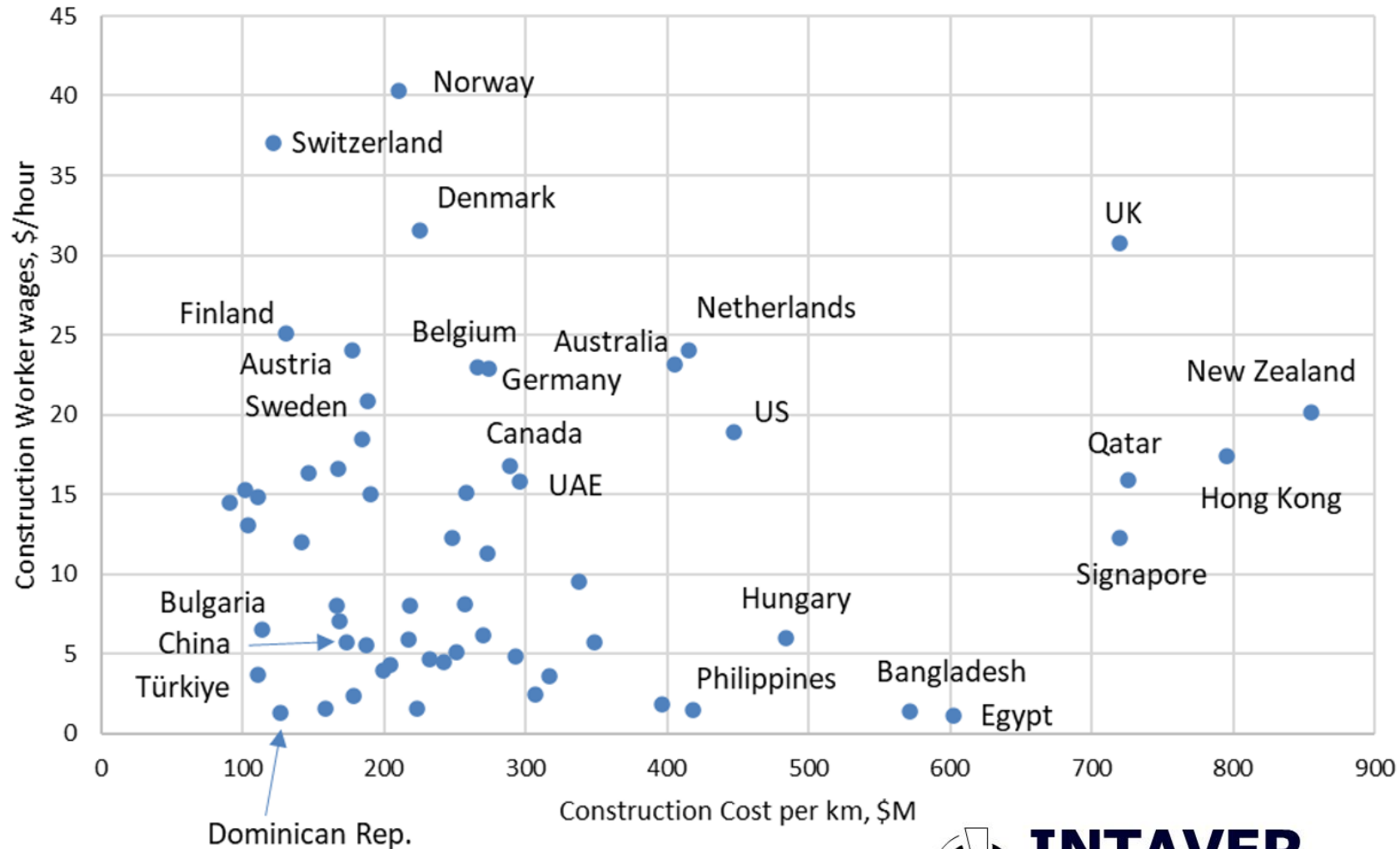
- For June 2022 new Construction Cost Index forecasts a 14.1% year-over-year increase in construction costs by year-end 2022 due to labor and material costs continuing to grow. However, the year 2022 is unusual due to high inflation.
- In 2023 and 2024 the cost Construction Cost Index should stabilize to 2%-4% and become close to the historical average.
- The average U.S. inflation in 2020-2021 was 4.1%.

Average Cost of Transit Projects per km in 2000-2025



- Cost growth of transit projects are around 4.8% on average until 2023 and 4.3% until 2021.
- The average world inflation rate from 2000-2021 was 3.35%

Correlation Between Construction Worker Wages and Construction Cost



Solution:

Integrated EVM and Risk Analysis



Three Components of EVM

Project schedule

Includes necessary tracking information, such as percent completed for each task

Value of Planned Work Indicators

Includes indicator as Planned Value (PV) or Budgeted Cost of Work Scheduled (BCWS)

Indicators How Much Work Was Performed

Includes Earned Value (EV) or Budgeted Cost of Work Performed (BCWP)

Most Used EVM Metrics for Risk Analysis

The Schedule Performance Index (SPI) =
$$\frac{\text{earned value (EV)}}{\text{planned value (PV)}}$$

The Cost Performance Index (SPI) =
$$\frac{\text{earned value (EV)}}{\text{actual cost (PV)}}$$

Creating the baseline spend plan (BCWS/PV)

Risk Register

Project Schedule (Resource and Cost Loaded)

Risk Name	Oper	Risk/Issu	Threat/C	Risk Assigned To
1 Cost information is not available	Open	Risk	Threat	Assigned to 2 tasks/resource
2 Delay in Financing	Open	Risk	Threat	Task 55:
3 Delay in getting level advice	Open	Risk	Threat	Task 29:
4 Delay in patent and trademark search	Open	Risk	Threat	Task 28:
5 Lack of knowledge of the specific area	Open	Risk	Threat	All resou
6 Not enough data to analyze demand level	Open	Risk	Threat	Task 21:
7 Not enough data to plan management of demanc	Open	Risk	Threat	Task 23:
8 Not enough information about competitors	Open	Risk	Threat	Assigne to 3 tasks/resource
9 Other risks, related to the project	Open	Risk	Threat	All tasks (global)
10 Problem with hiring	Open	Risk	Threat	Task 58: Hiring of key employ
11 Resource Risks	Open	Risk	Threat	
12 Risks affecting whole company/division	Open	Risk	Threat	All tasks (global)
13 Selected name is taken	Open	Risk	Threat	Task 28: Establish Name and
14 Staff turnover	Open	Risk	Threat	All resources (global)

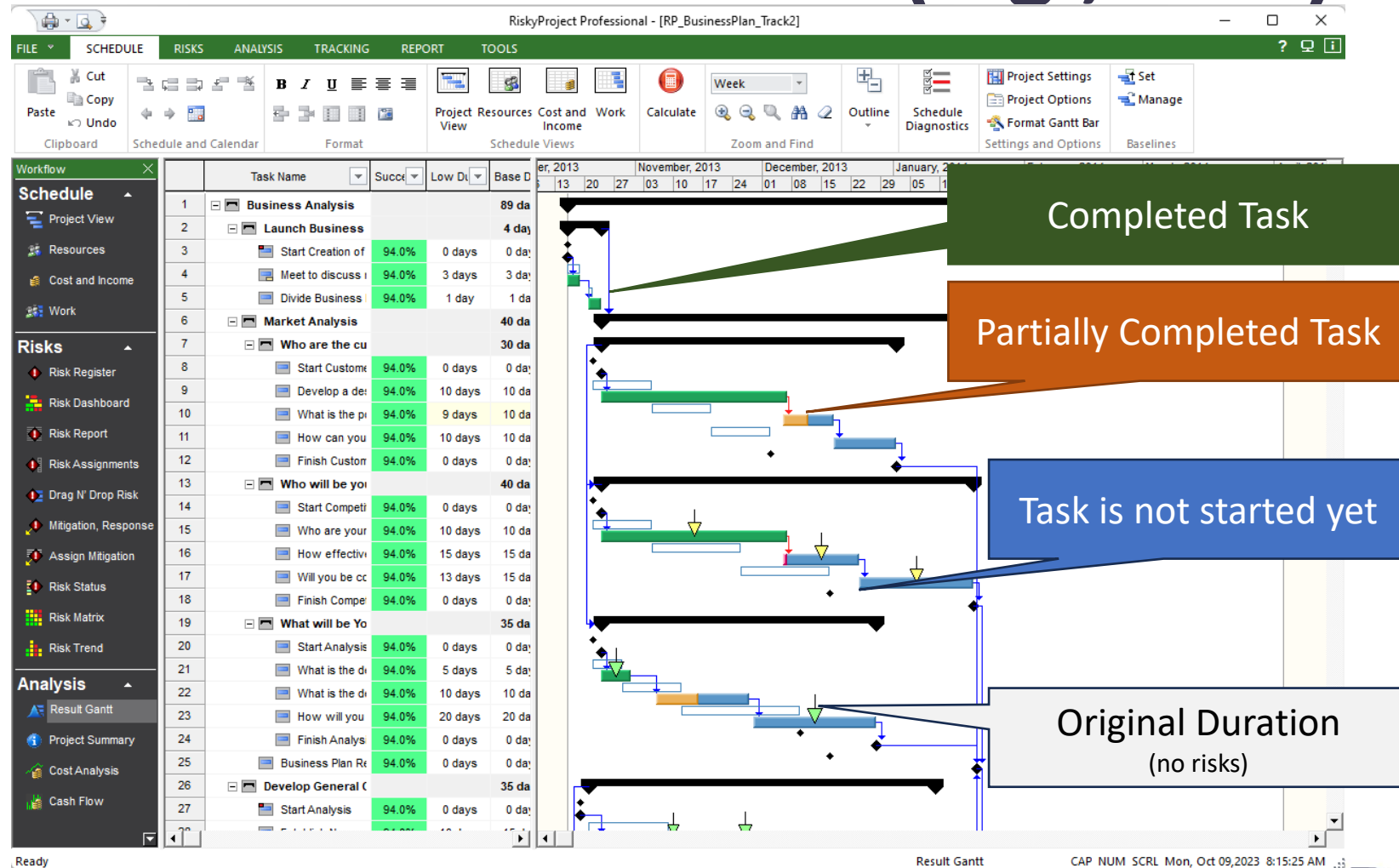
Assign Risks to Tasks and Resources

Task Name	Low D	Base	High D
1 Business Analysis		89 days	
2 Launch Busines		4 days	
3 Start Creation	0 days	0 days	0 days
4 Meet to discus	3 days	3 days	4 days
5 Divide Busines	1 day	1 day	1 day
6 Market Analysis		40 days	
7 Who are the		30 days	
8 Start Custo	0 days	0 days	0 days
9 Develop a c	10 days	10 days	10 days
10 What is the	9 days	10 days	12 days
11 How can y	10 days	10 days	10 days
12 Finish Cust	0 days	0 days	0 days
13 Who will be y		40 days	
14 Start Comp	0 days	0 days	0 days
15 Who are yc	10 days	10 days	10 days
16 How effect	15 days	15 days	15 days
17 Will you be	13 days	15 days	17 days
18 Finish Com	0 days	0 days	0 days
19 What will be		35 days	
20 Start Analy	0 days	0 days	0 days

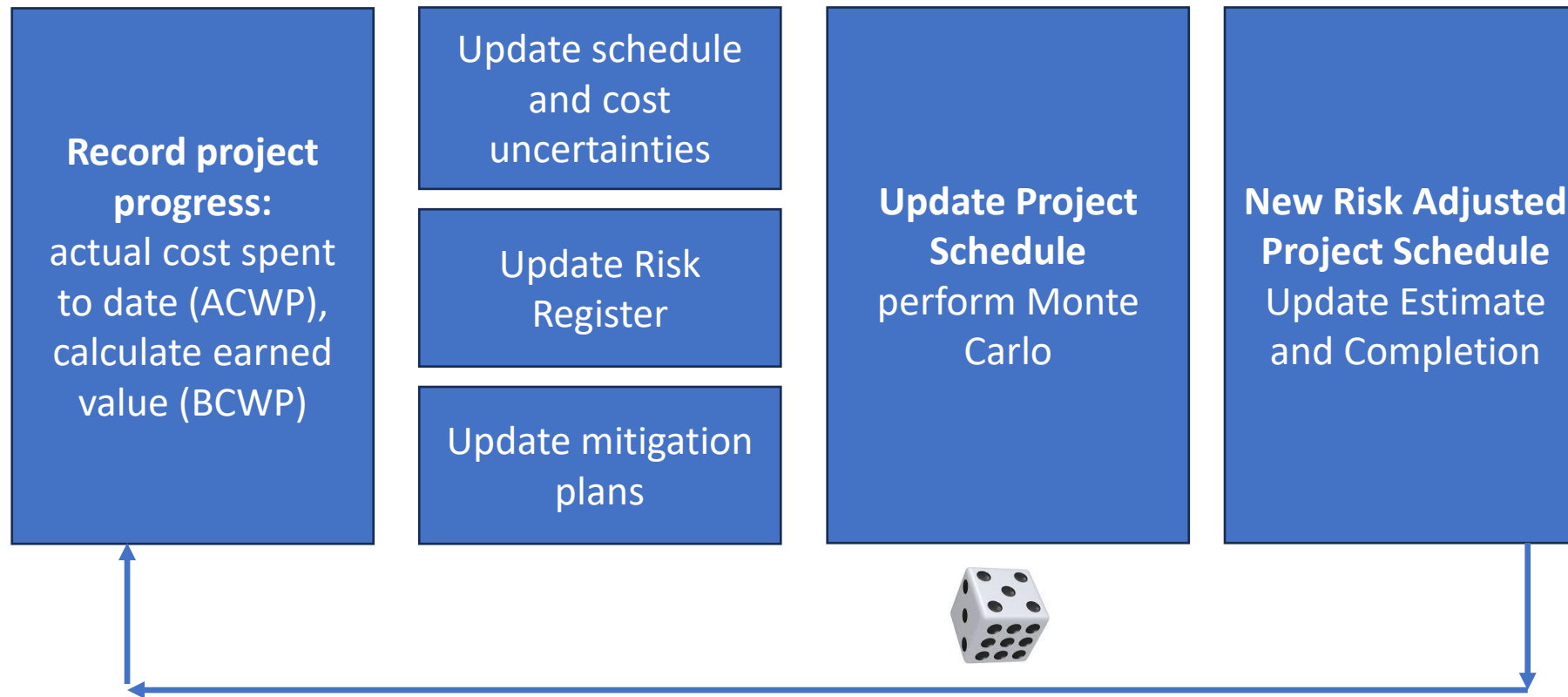


Perform Monte Carlo

Risk Adjusted Project Schedule with Certain Confidence Level (e.g., 80%)

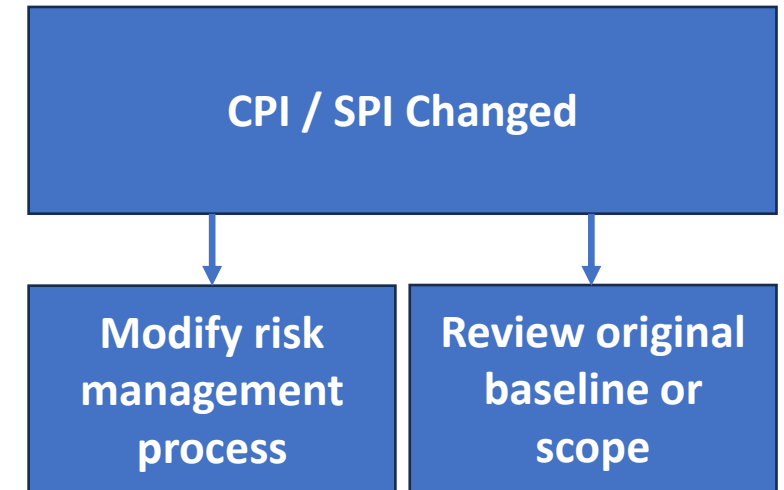


Measuring actual project performance and forecast future project outcome (EAC)



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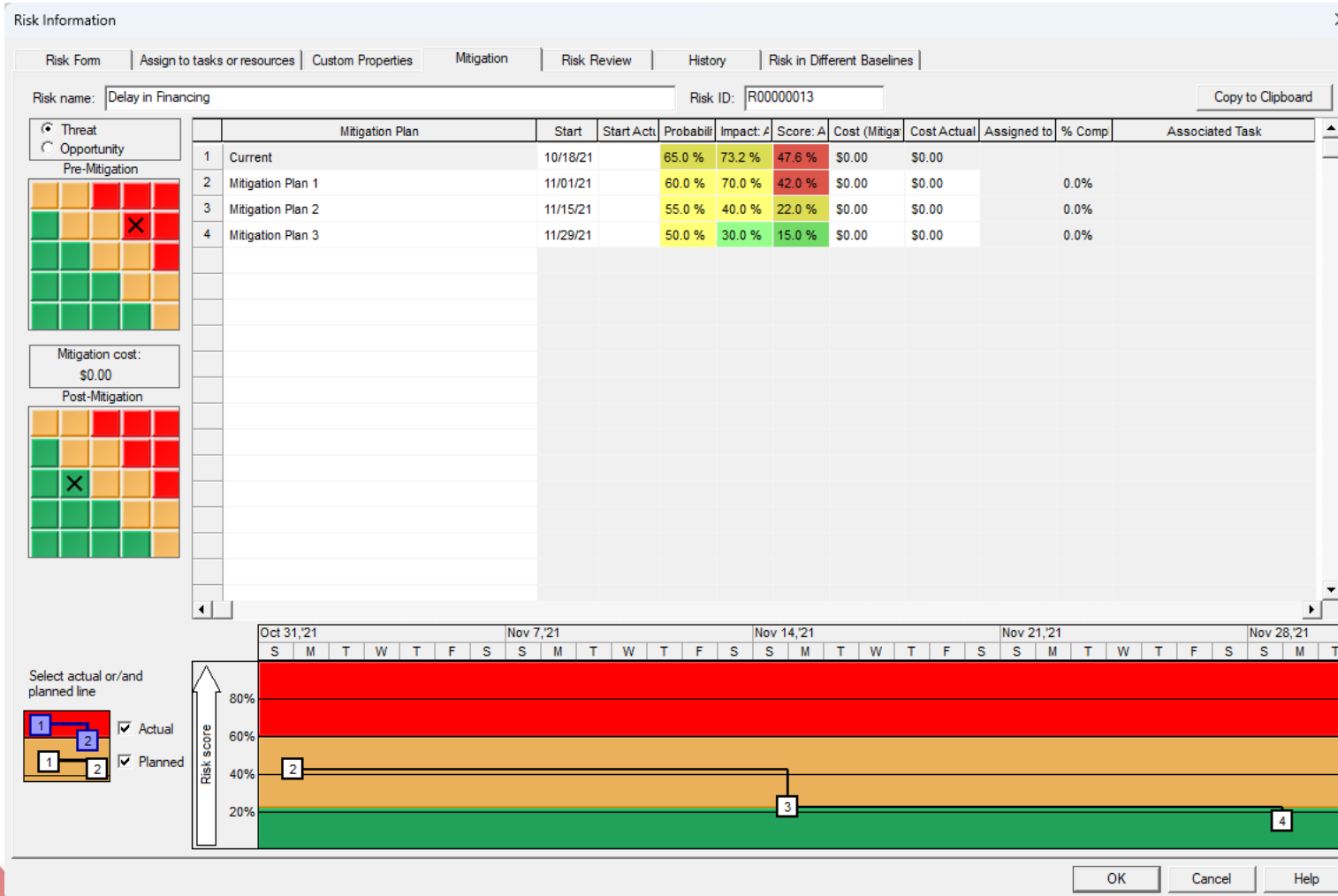
- Select EVM metrics, for example CPI and SPI to trigger **corrective action** in risk process and calculate them.
- **Consider modifications to risk processes**, for example perform risk mitigation if CPI and/or SPI cross thresholds.
- **Consider the need to review initial baseline or scope** if CPI and/or SPI persistently have unusually high or low values.



Risk Mitigation Process



Risk Mitigation Waterfall



Mitigation/Response Plan
Depository

Risk Mitigation Waterfall Diagram

Risk Mitigation Depository

The screenshot displays the RiskyProject Professional interface. The main window shows a table of Risk Mitigation or Response Plans. A dialog box titled 'Mitigation Plan Properties' is open, showing the 'Mitigation Plan' dropdown set to 'Mitigation Plan 3' and a list of tasks to be associated with it. The task 'Start Creation of Business Plan' is highlighted.

	Risk Mitigation or Response Plan	Plan Type	Used in risks:	Cost	Cost Actual	Assigned to	Action Plan
1	Mitigation Plan 1	Mitigation	Risk: Delay in Financing	\$45,660	\$45,660	Project Manager	
2	Mitigation Plan 2	Mitigation	Risk: Delay in Financing	\$14,560	\$12,000	Business Analyst	
3	Mitigation Plan 3	Mitigation	Risk: Delay in Financing	\$7,680.00	\$5,000.00	Project Manager	
4	Response Plan 1	Mitigation					

Mitigation Plan Properties

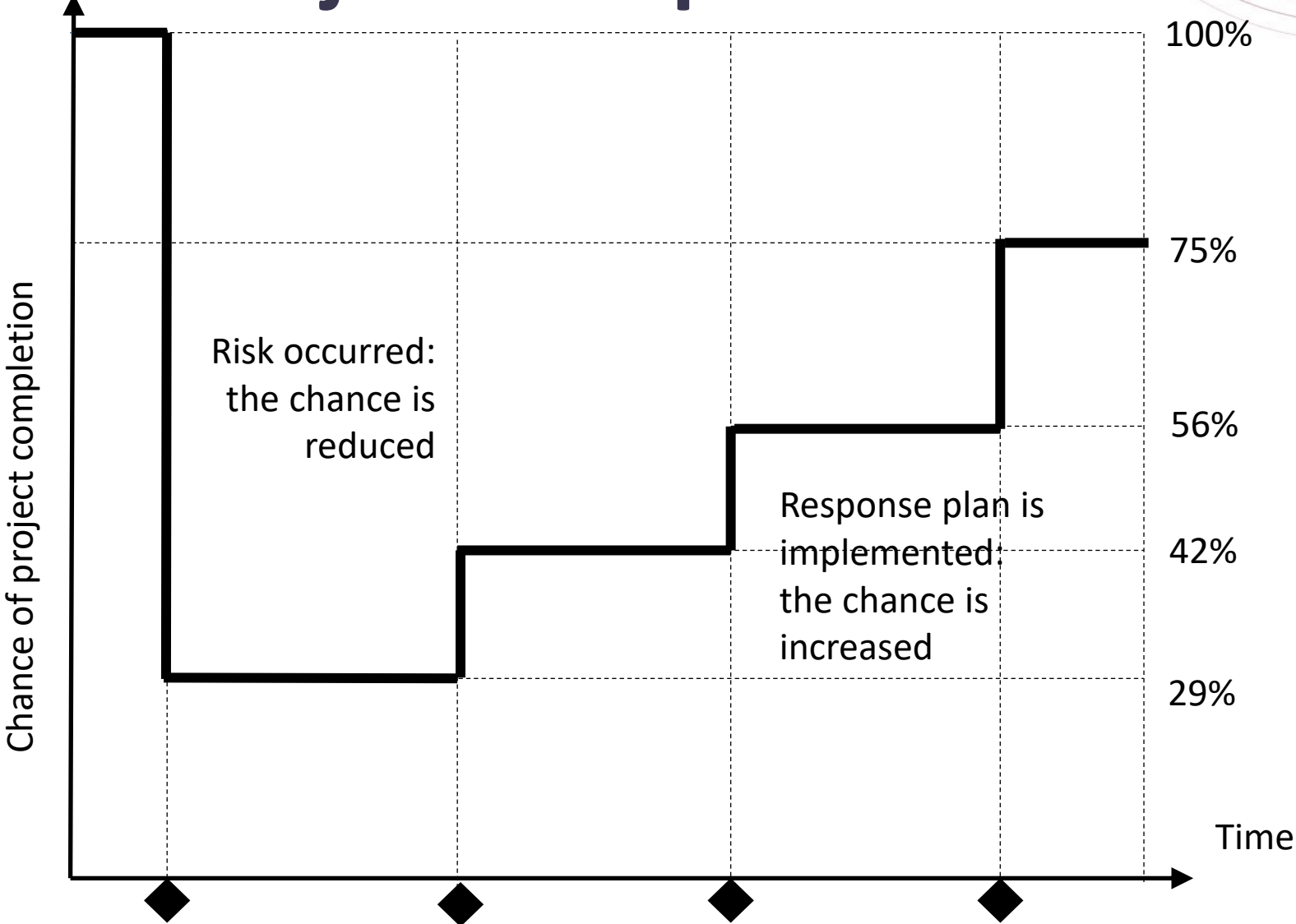
Mitigation Plan: Mitigation Plan 3

Select Associated Task:

	Task Name
1	Business Analysis
2	Launch Business Plan
3	Start Creation of Business Plan
4	Meet to discuss new business strategy
5	Divide Business Plan Work by Experience
6	Market Analysis
7	Who are the customers for your Business
8	Start Customer Analysis

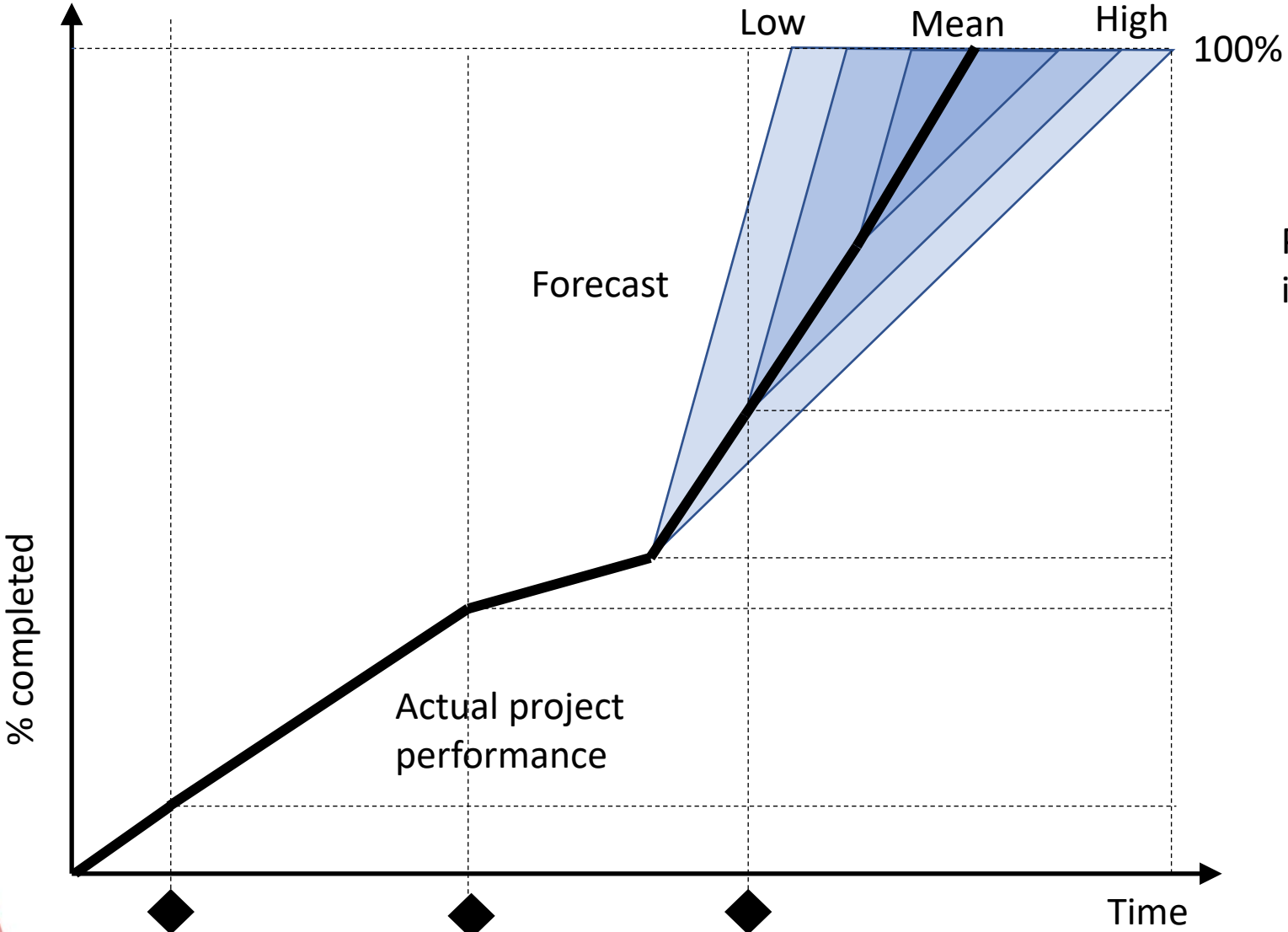
Assigning task or project to mitigation plan:
Project Cost and Schedule will be recalculated

Chance of Project Completion Over Time



Project milestones: Project risk analysis is performed on each milestone

Percent Completed Over Time

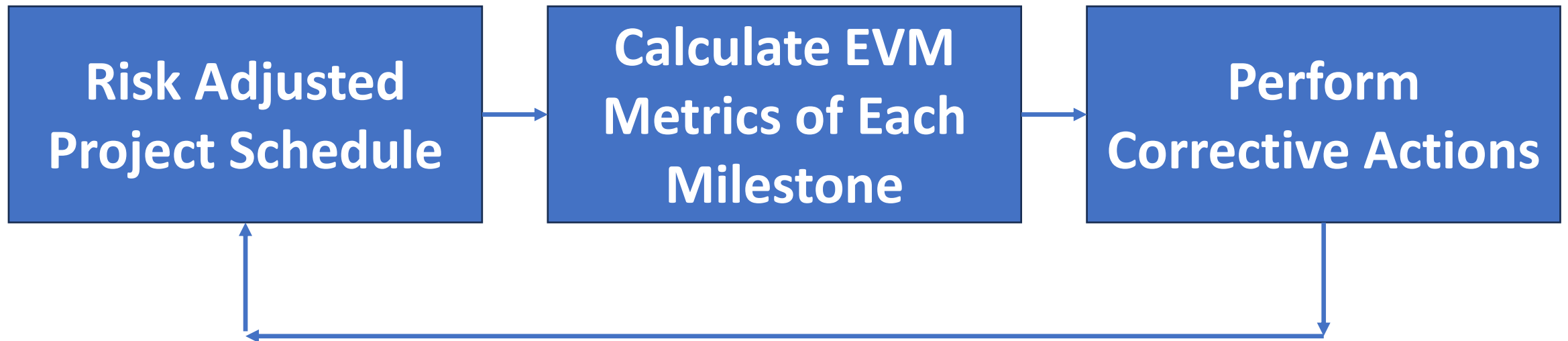


Project duration cost “fork” is shrinking over time

Project milestones



Basic steps to the EVM/Risk Analysis process



Risk Mitigation
Exploiting Opportunities
Changing Scope

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THANK YOU

