Project Control and EVM Analysis with Risks and Uncertainties

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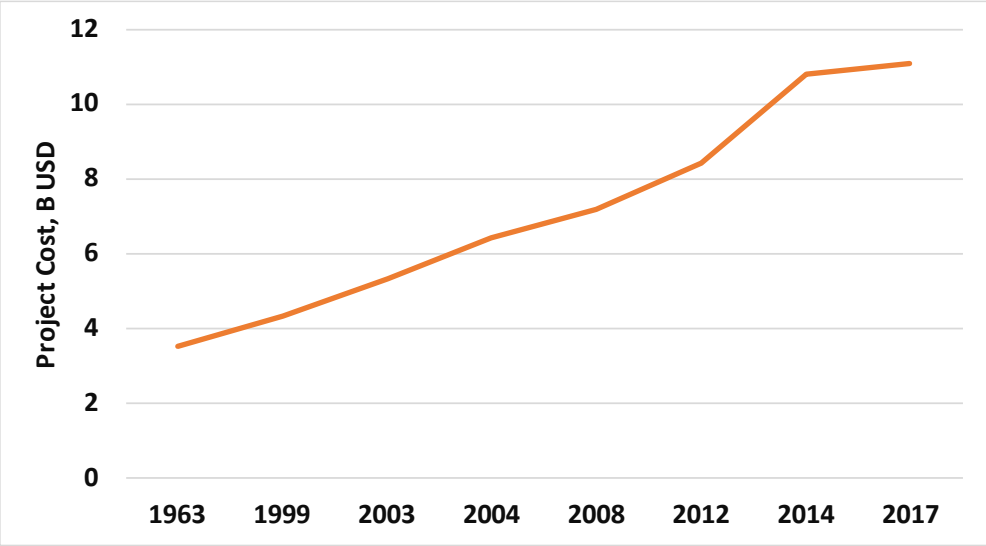
Why Project Control with Risk Analysis?

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.

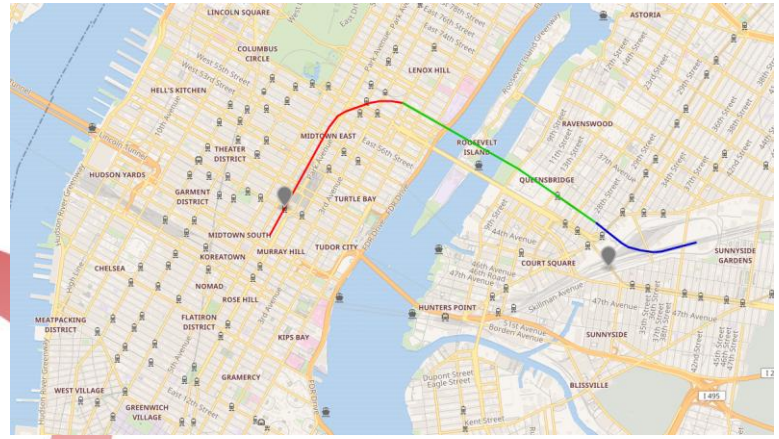


East Side Access cost estimates over time from USD $5.3B in 2002 to USD $11.2B in 2021

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 tunning projects in history per mile.

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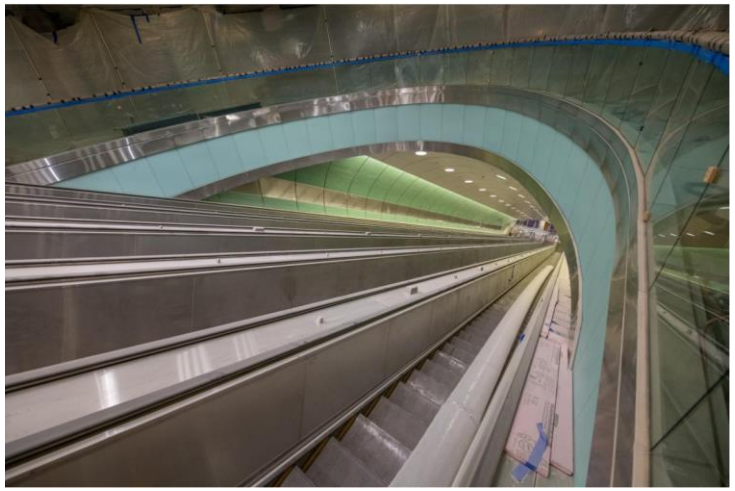
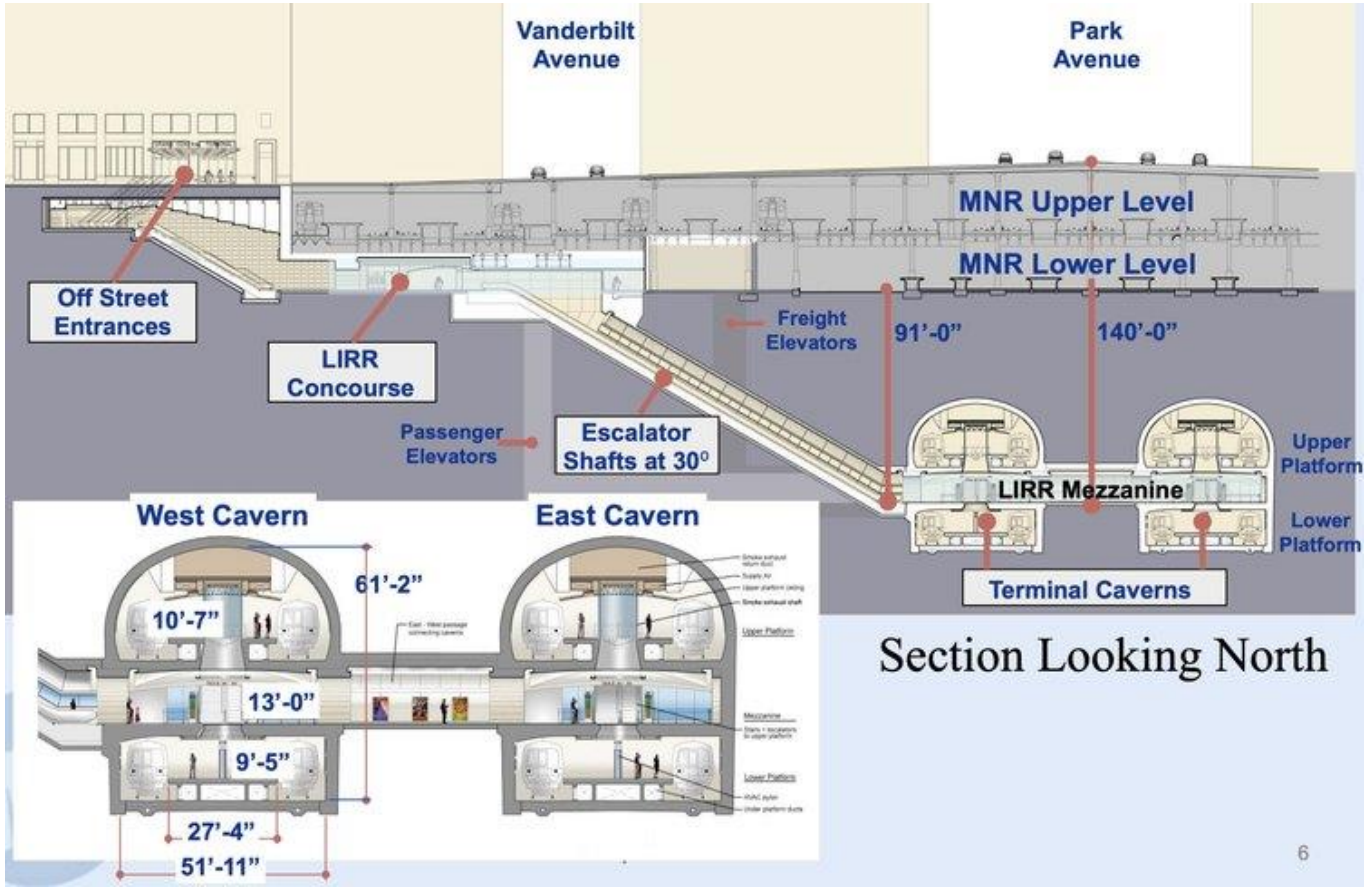
New York East Side Access Project

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

Manhattan's East Side terminal design

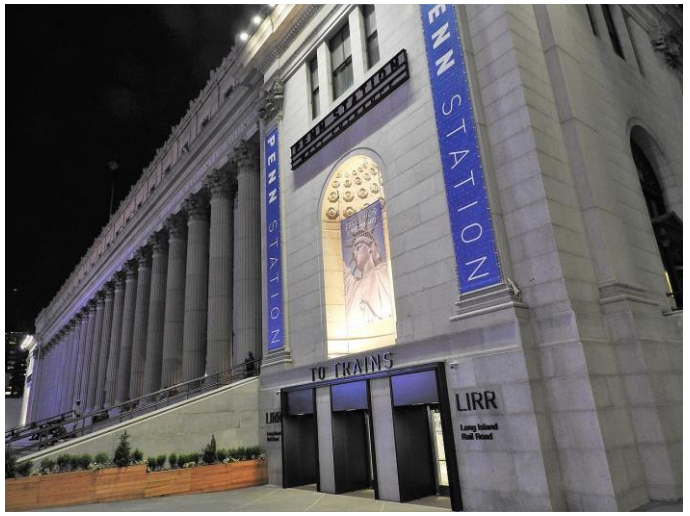
Actual problems with the project:

- 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

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



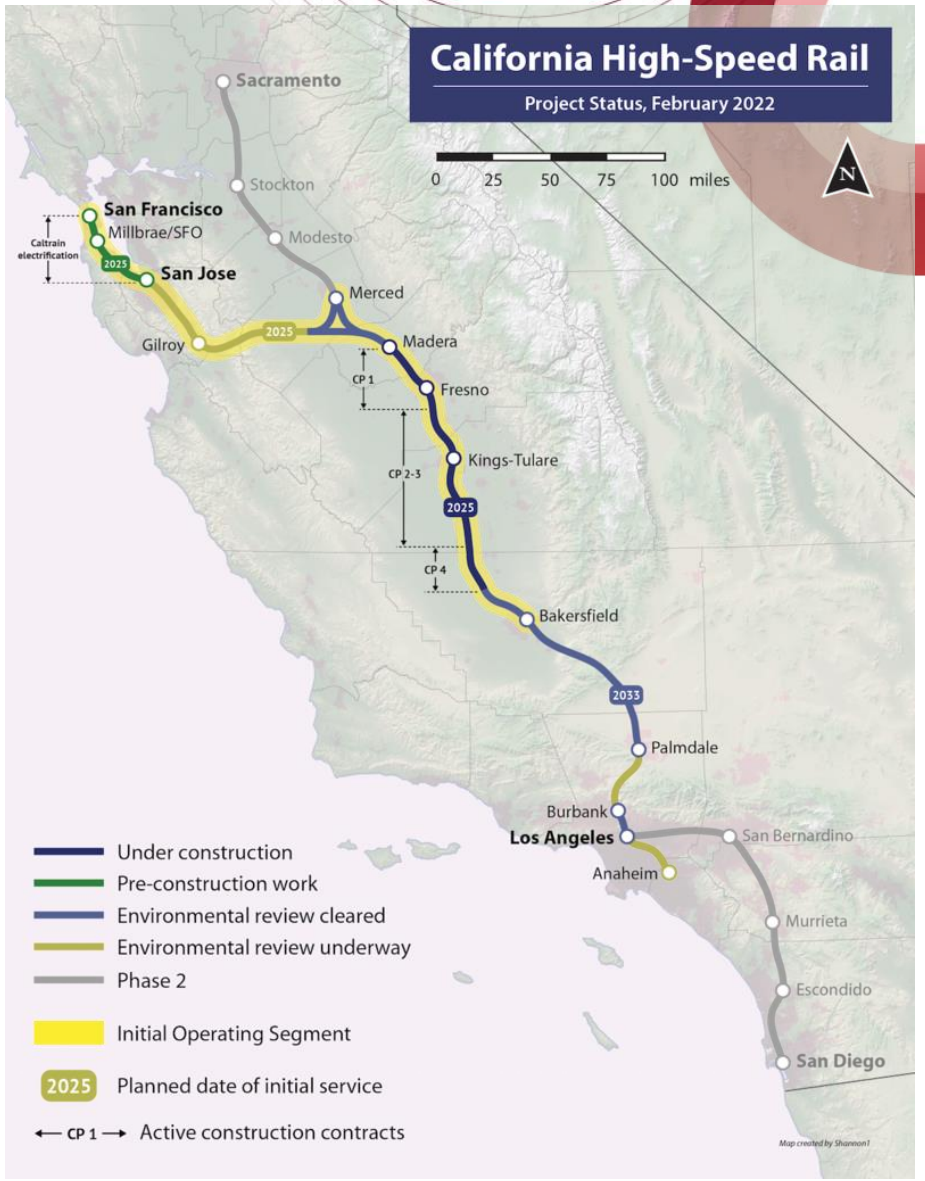
- First phase: an expansion of a concourse under the Farley Building, started in 2010 and was completed in June 2017.
- Second phase: a train hall commenced in 2017 and was opened January 1, 2021.

Cost estimate in December 2002 was $315 million

California High Speed Rail

<u>Project Cost Escalation</u>
2012 - $68.4B
2018 - $77B in year-of-expenditure dollars, assuming a 2033 completion year
3% inflation

<u>Comparing per kilometer cost in US and other regions</u>
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

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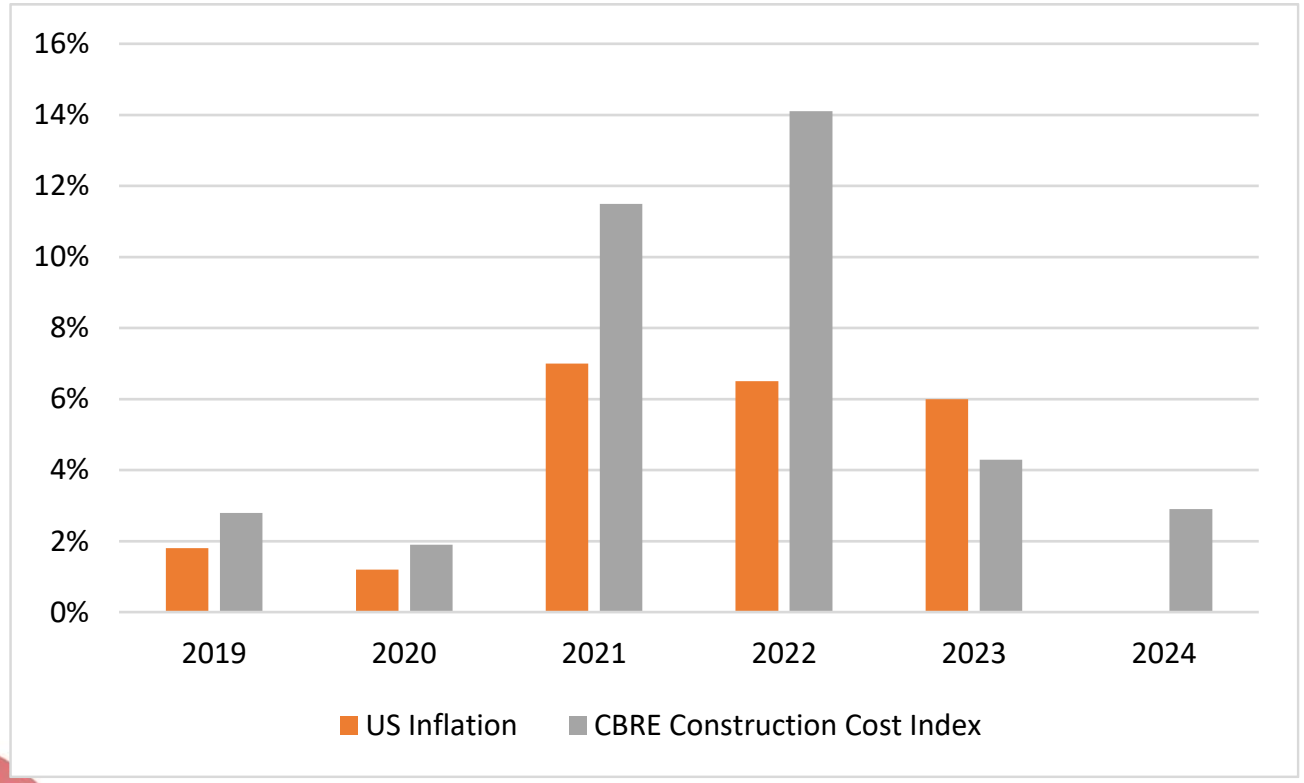
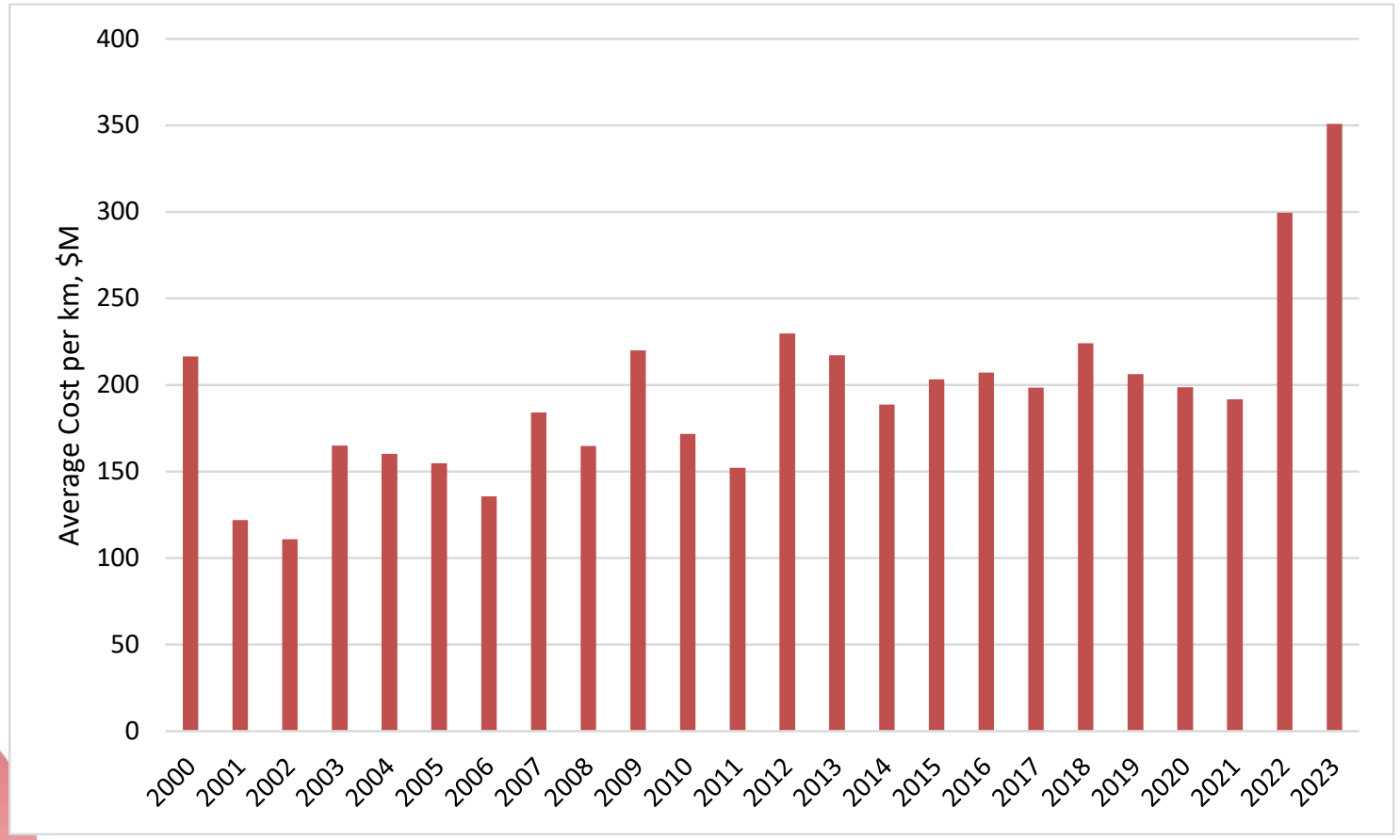
Construction Cost Growth Faster Than Inflation



Global Commercial Real Estate Services (CBRE):

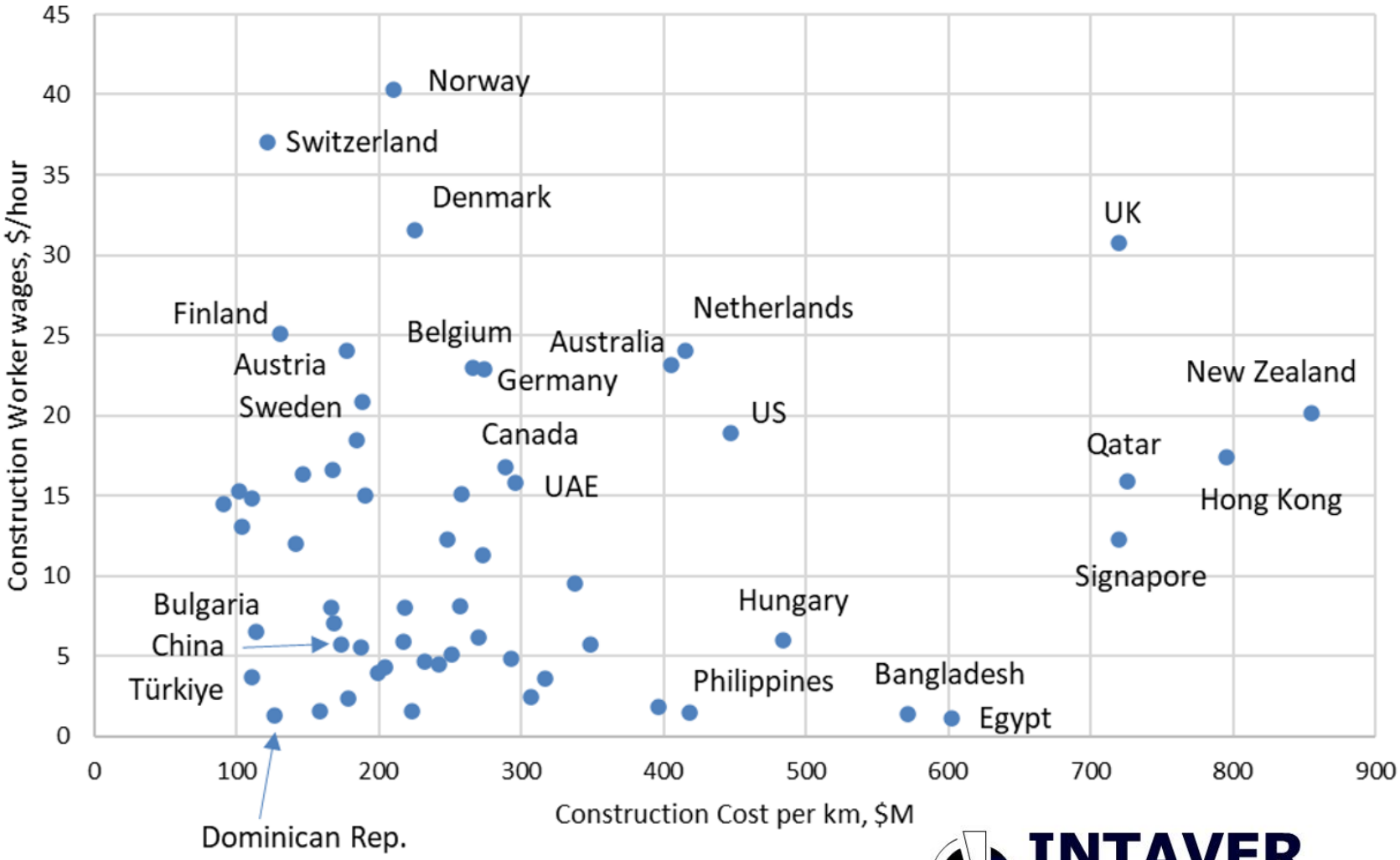
- For June 2022 new Construction Cost Index forecasts a 14.1% year-over-year increase in construction costs by year-end 2022 due to labor and material costs continuing to grow. However, the year 2022 is unusual due to high inflation.
- In 2023 and 2024 the cost Construction Cost Index should stabilize 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 Constriction Cost



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Solution:

Integrated EVM and Risk Analysis

Three Components of EVM

Project schedule	Value of Planned Work Indicators	Indicators How Much Work Was Performed
Includes necessary tracking information, such as percent completed for each task	Includes indicator as Planned Value (PV) or Budgeted Cost of Work Scheduled (BCWS)	Includes Earned Value (EV) or Budgeted Cost of Work Performed (BCWP)

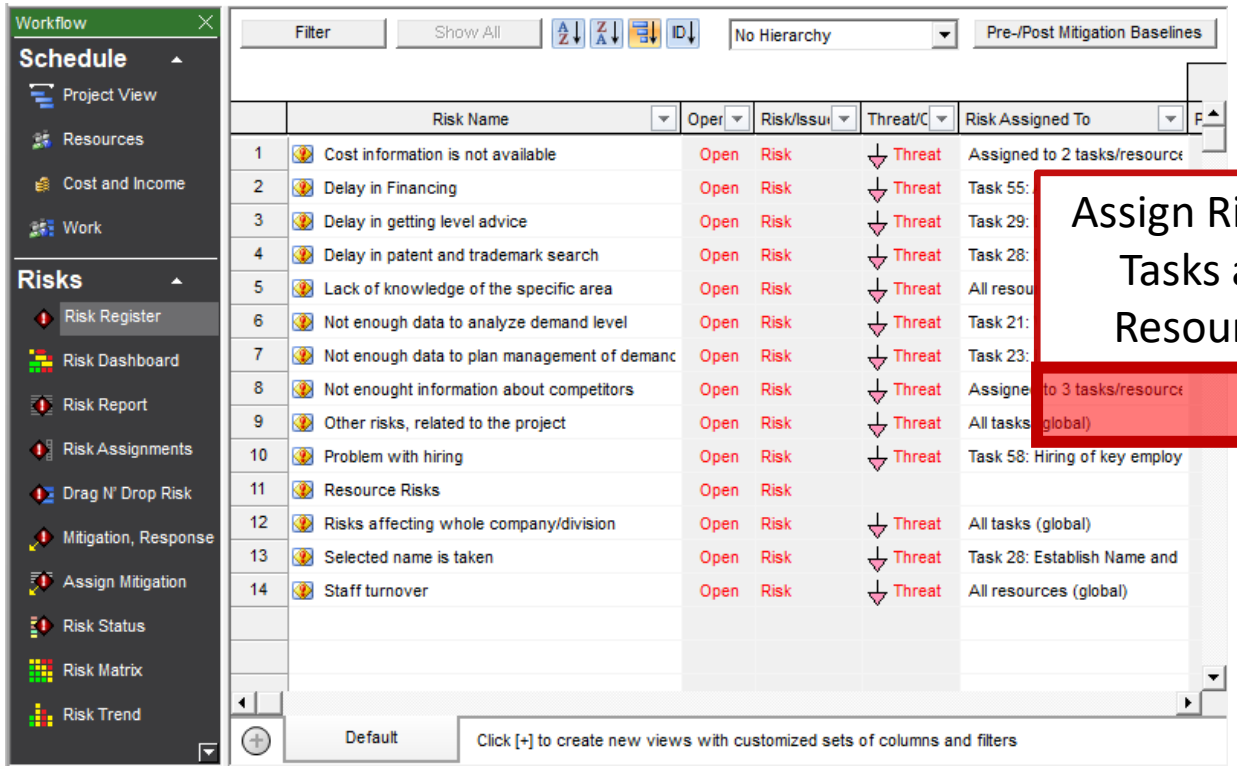
Most Used EVM Metrics for Risk Analysis

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

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

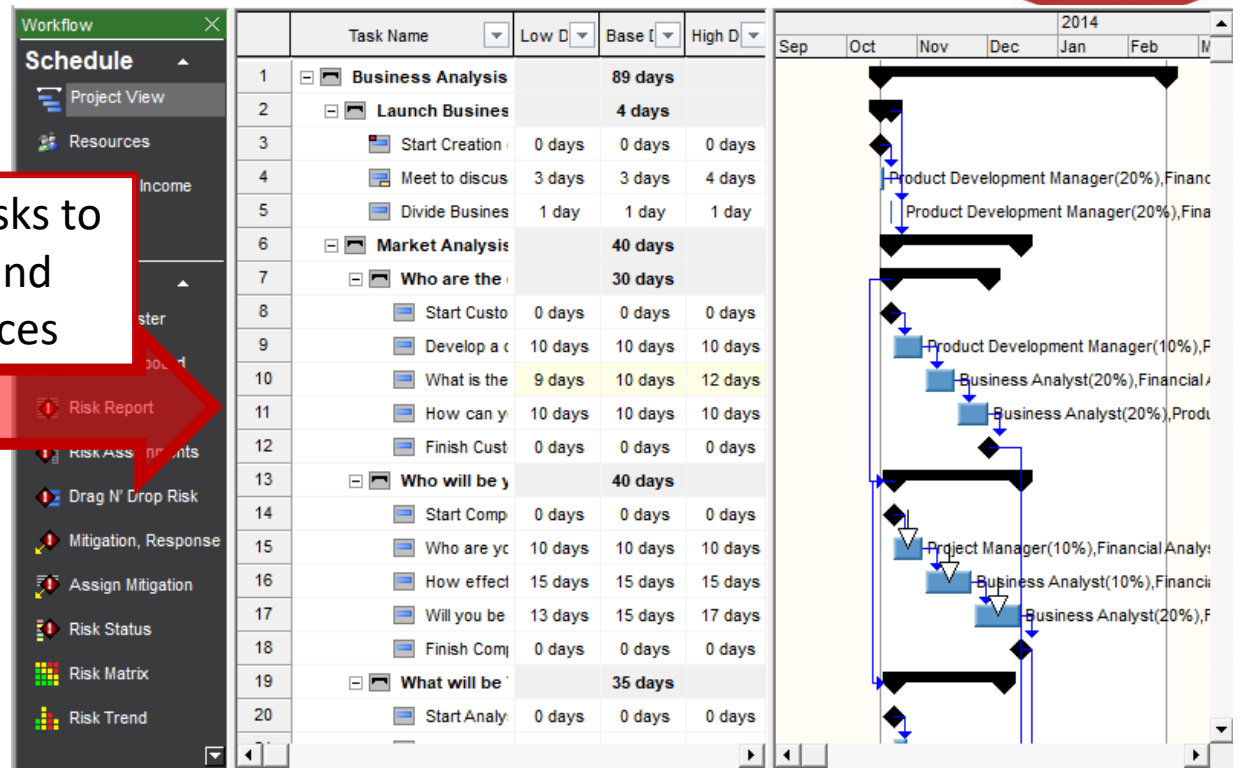
Creating the baseline spend plan (BCWS/PV)

Risk Register



Assign Risks to Tasks and Resources

Project Schedule (Resource and Cost Loaded)



Perform Monte Carlo

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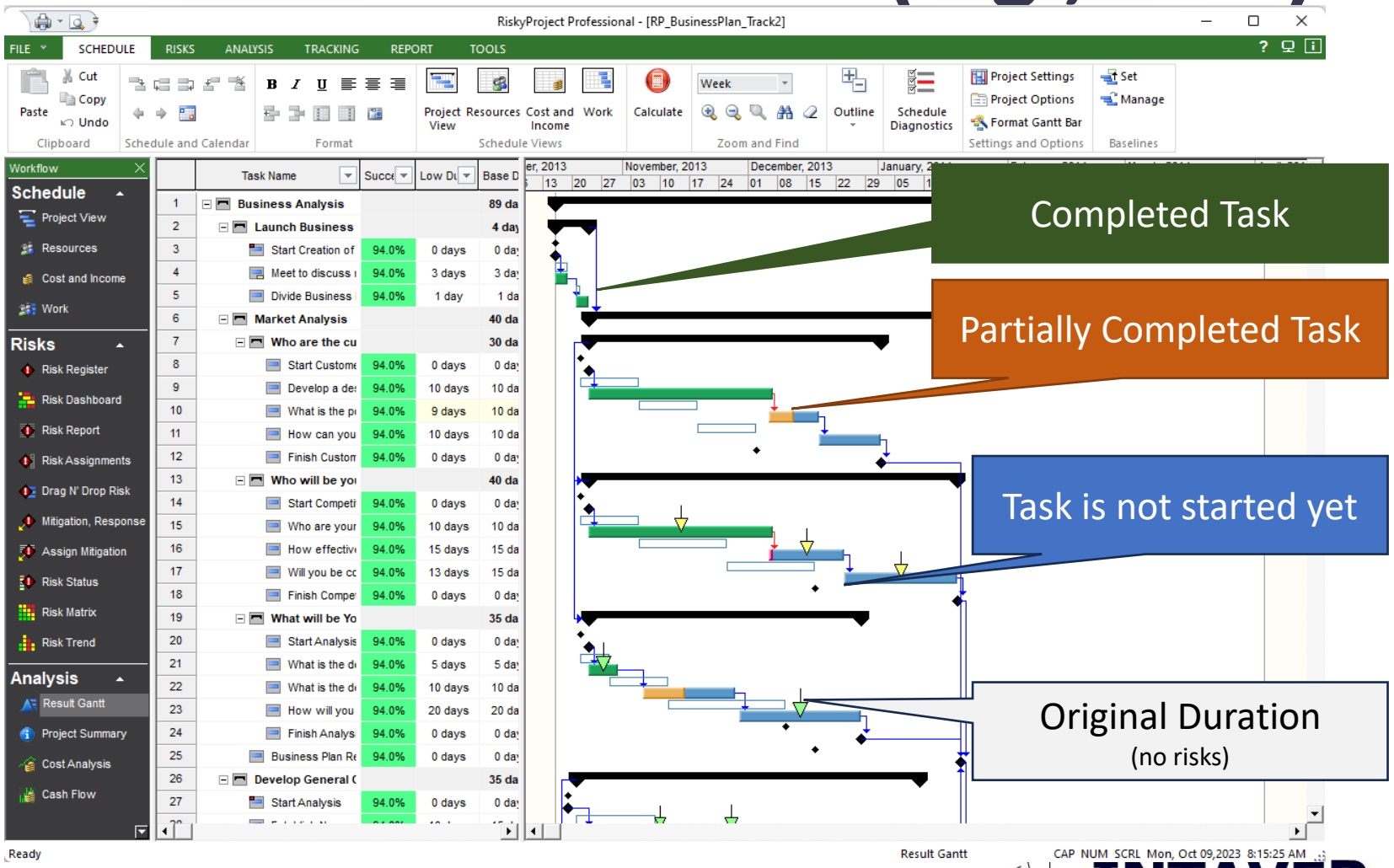
Risk Adjusted Project Schedule with Certain Confidence Level (e.g., 80%)



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

Record project progress: actual cost spent to date (ACWP), calculate earned value (BCWP)

Update schedule and cost uncertainties

Update Risk Register

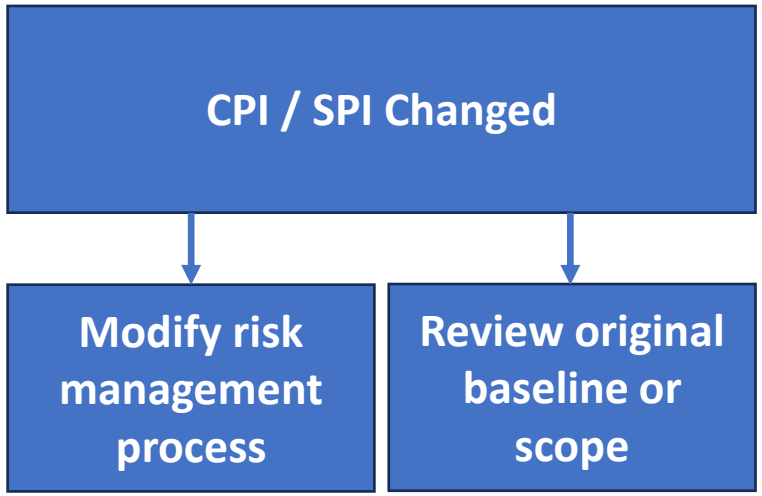
Update mitigation plans

Update Project Schedule perform Monte Carlo

New Risk Adjusted Project Schedule Update Estimate and Completion

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

- 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

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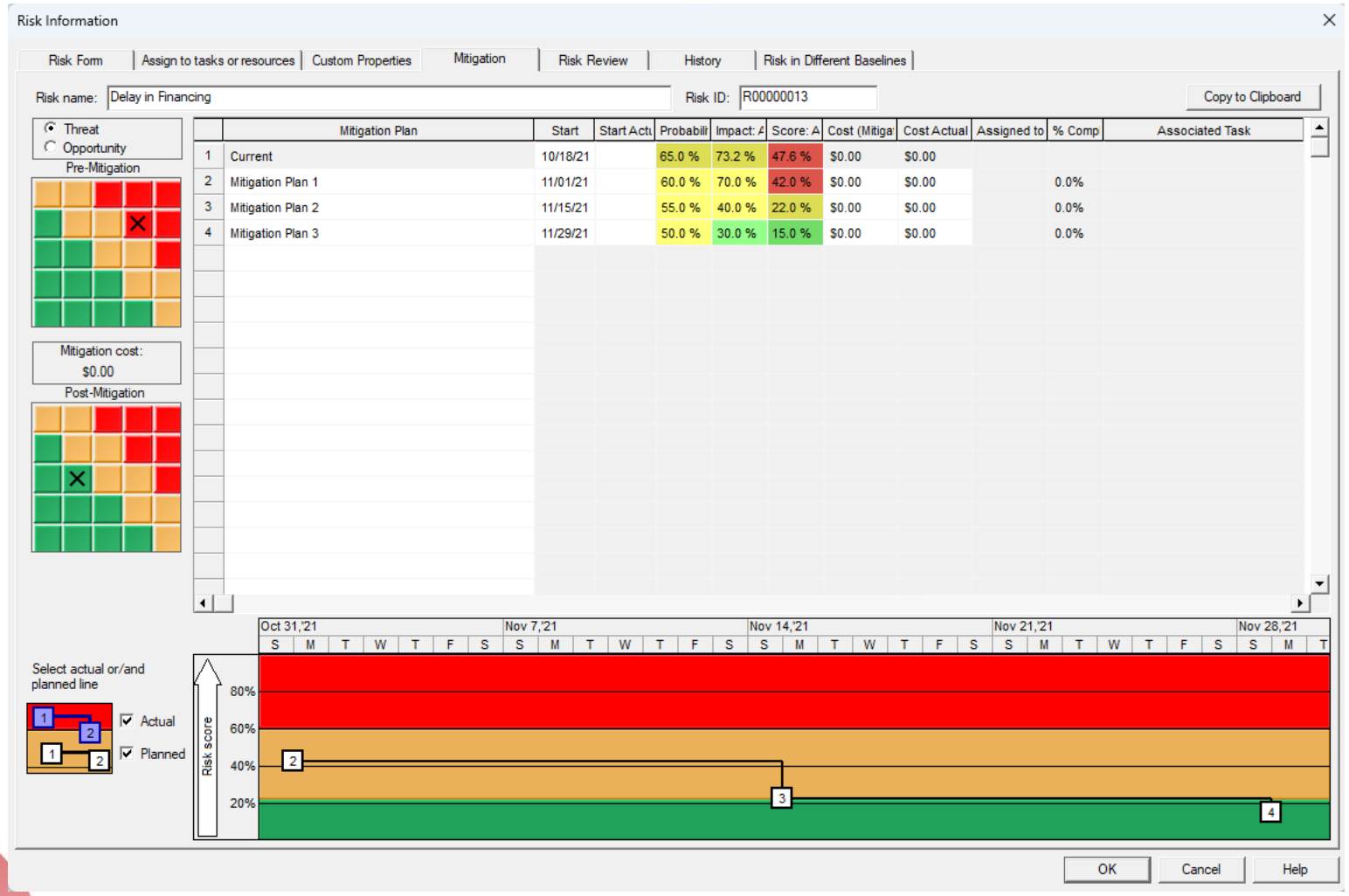
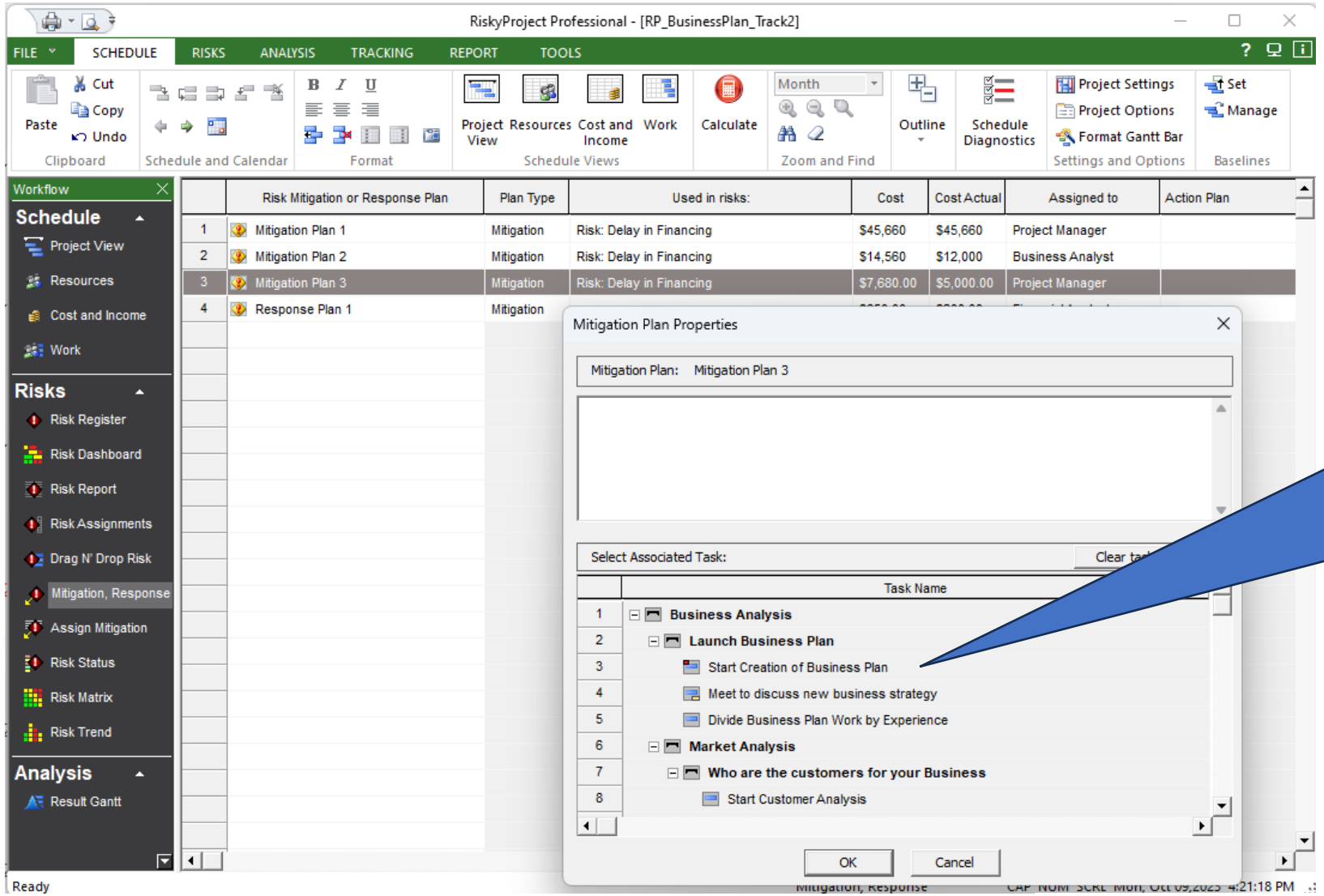
Risk Mitigation Waterfall



Risk Mitigation Waterfall Diagram

Mitigation/Response Plan Depository

Risk Mitigation Depository



Assigning task or project to mitigation plan:

Project Cost and Schedule will be recalculated

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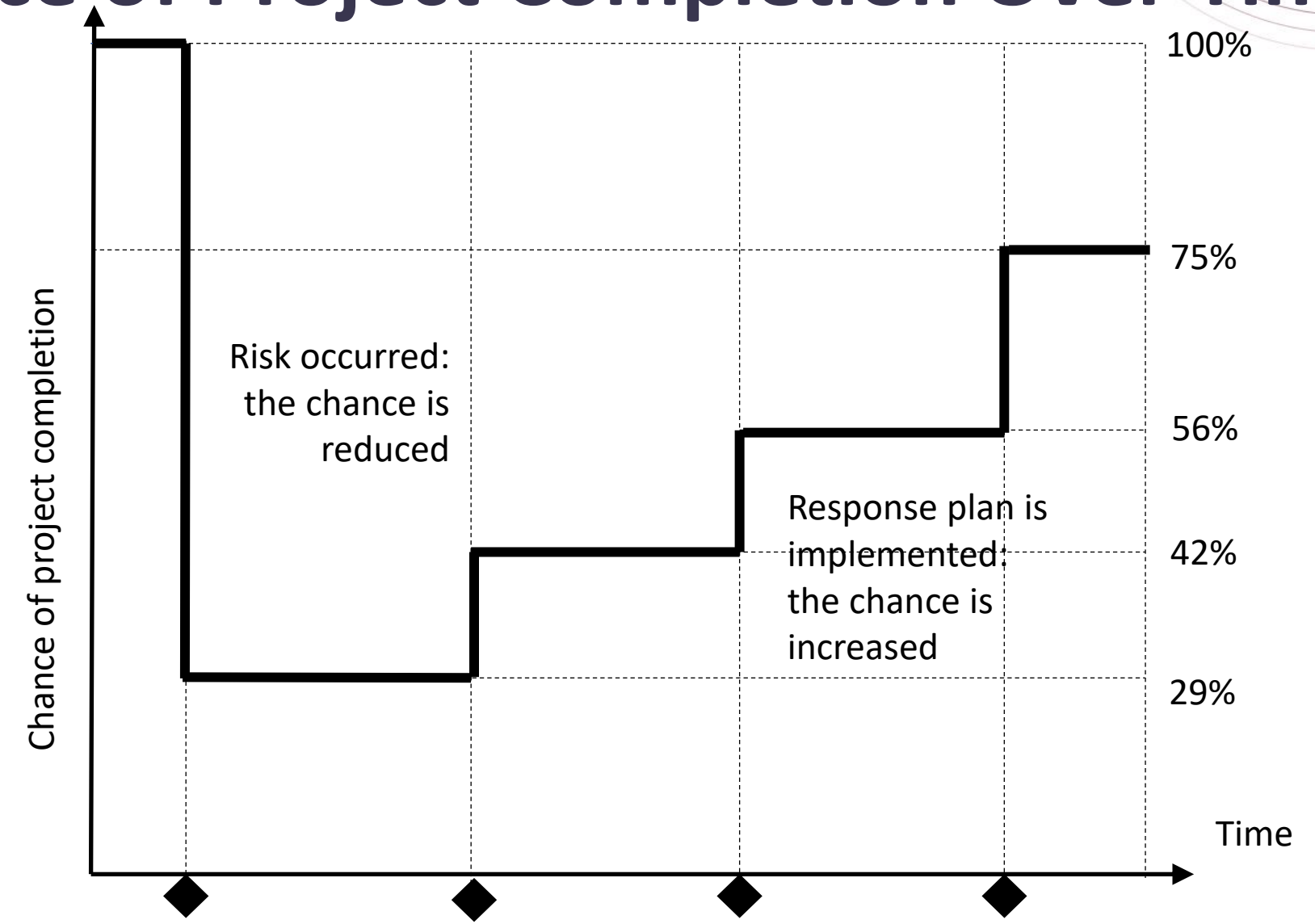
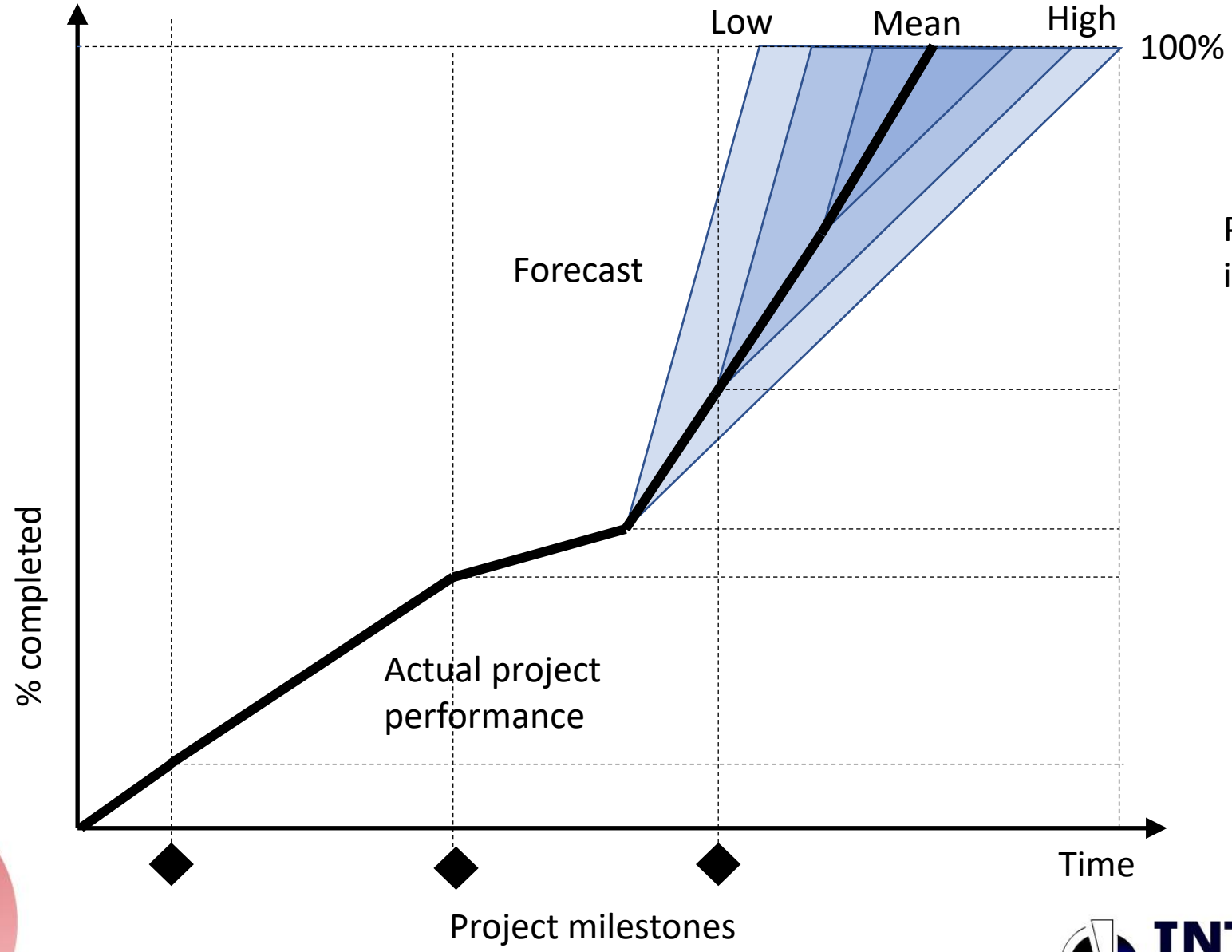
Chance of Project Completion Over Time



Project milestones: Project risk analysis is performed on each milestone

Percent Completed Over Time



Project duration cost "fork" is shrinking over time

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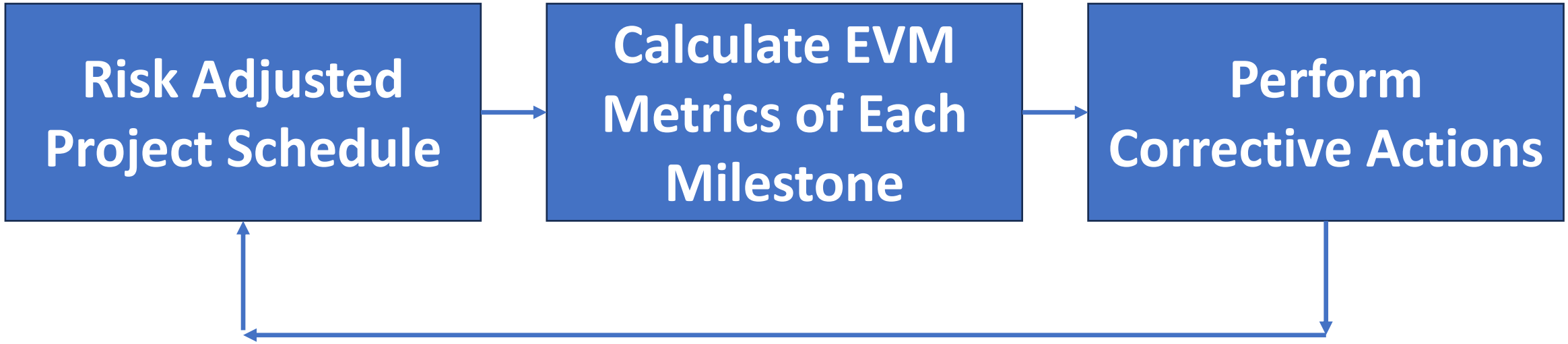
Basic steps to the EVM/Risk Analysis process



Risk Mitigation
Exploiting Opportunities
Changing Scope
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THANK YOU

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