

# Risk Management for Large Infrastructure Projects

  
www.riskcon.at

Conference

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# Personal introductions



## Prof. Dr. Philip Sander

- Managing Director at RiskConsult
- Head of the Institute for Construction Management at the University of the Bundeswehr Munich
- Senior VP at ICPMA



**Arno Van Droogenbroeck, MSc**  
Senior cost and risk management consultant RiskConsult

1. Introduction RiskConsult
2. Problem Definition for Major Infrastructure Projects
3. Digital Project Risk Twin

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# Introduction to RiskConsult GmbH



Headquarters:

- Olympiastr. 39  
6020 Innsbruck, Austria

Additional Offices:

- Vienna, Austria
- Munich, Germany



Founded in 2007

15 Employees

## Experts in Construction Cost and Risk Management:

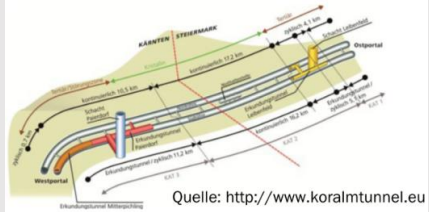
- Risk Management
- Cost Estimating
- Project Cost Controlling
- Alternative Contract Models
- RAMS - Reliability, Availability, Maintainability, Safety – Analysis
- Software Development

**Proven experience from years of supporting large infrastructure projects in Europe, North and South America and Australia.**

# Selected References

## Risk Management – Infrastructure Projects

### Rail Tunnel



### ÖBB Koralm Base Tunnel

Project volume appr. € 1.5 billion



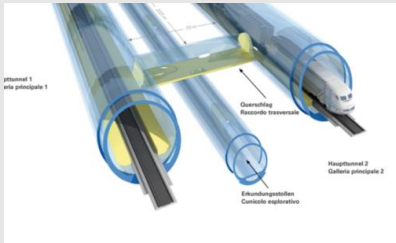
### Hydropower Plant



### Gemeinschaftskraftwerk Inn

Project volume appr. € 500 million

### Rail Tunnel



### Brenner Base Tunnel

Project volume appr. € 9 billion



### Airport



### New International Airport Lima

Project volume appr. \$ 2.5 billion



### High-Speed Rail

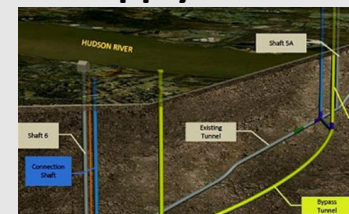


### ÖBB Lower Inn-Valley Railway

Project volume appr. € 2.3 billion



### Water Supply



### Delaware Aqueduct New York City DEP



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# Selected References

## Risk Management – Urban Transit (Metros/Subways)

### Vienna



#### Crossing / Extension U2/U5

Project volume appr. € 1 billion



### New York

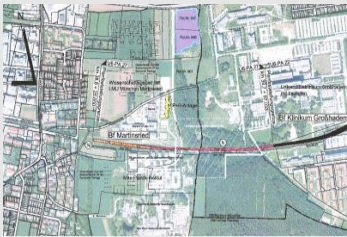


#### MTA Canarsie Tunnel, L-Train

Project volume appr. \$ 1.5 billion



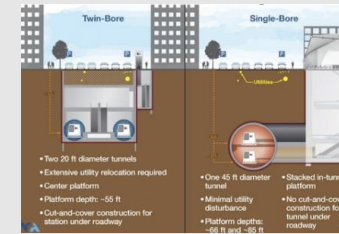
### Munich



#### U6 Extension Martinsried

Project volume appr. € 150 million

### SF Bay Area, USA



#### BART Silicon Valley – San Jose Ext.

Project volume appr. \$ 6 billion



### Hamburg

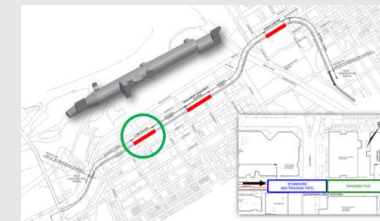


#### U5 East (Phase 1)

Project volume appr. € 1.7 billion



### Ottawa, Canada



#### Confederation Line

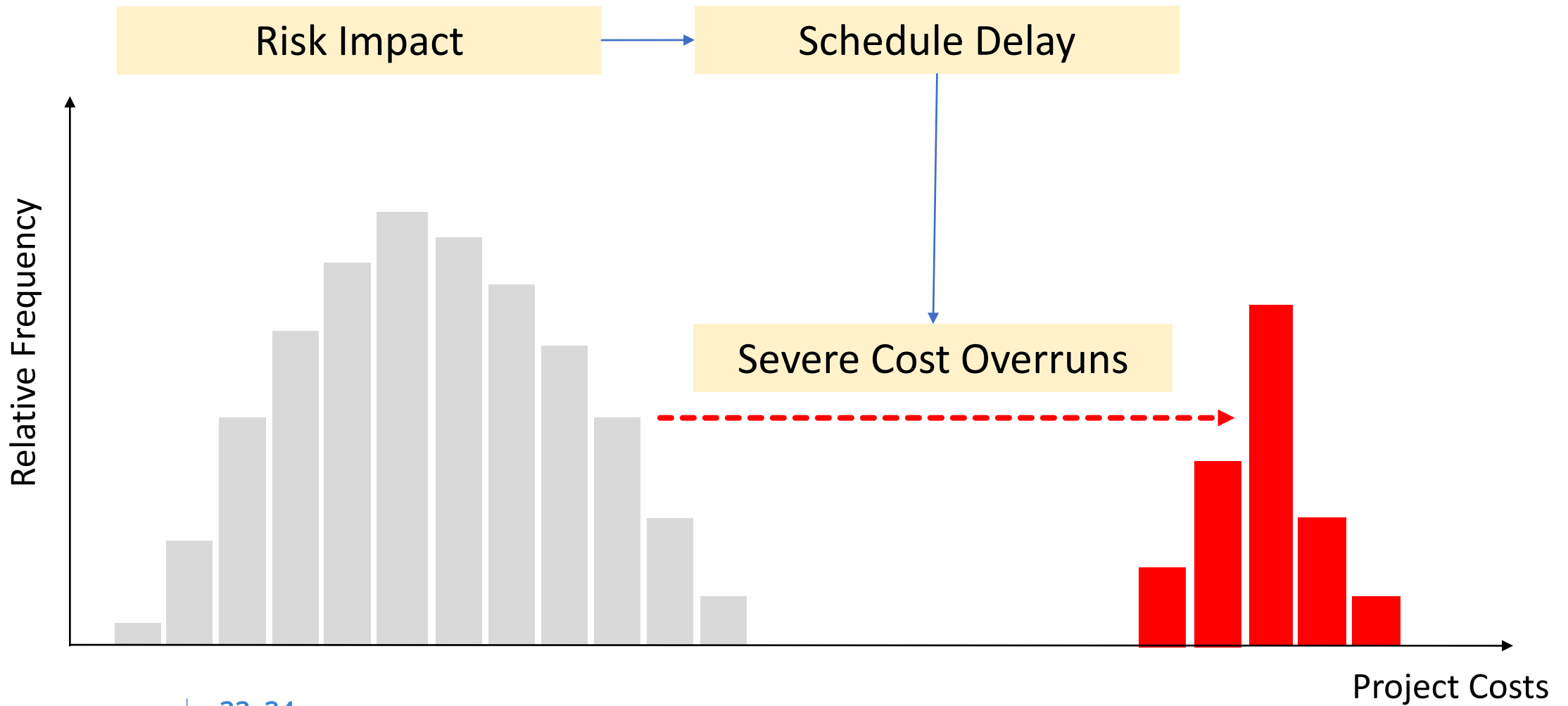
Project volume appr. \$ 2 billion



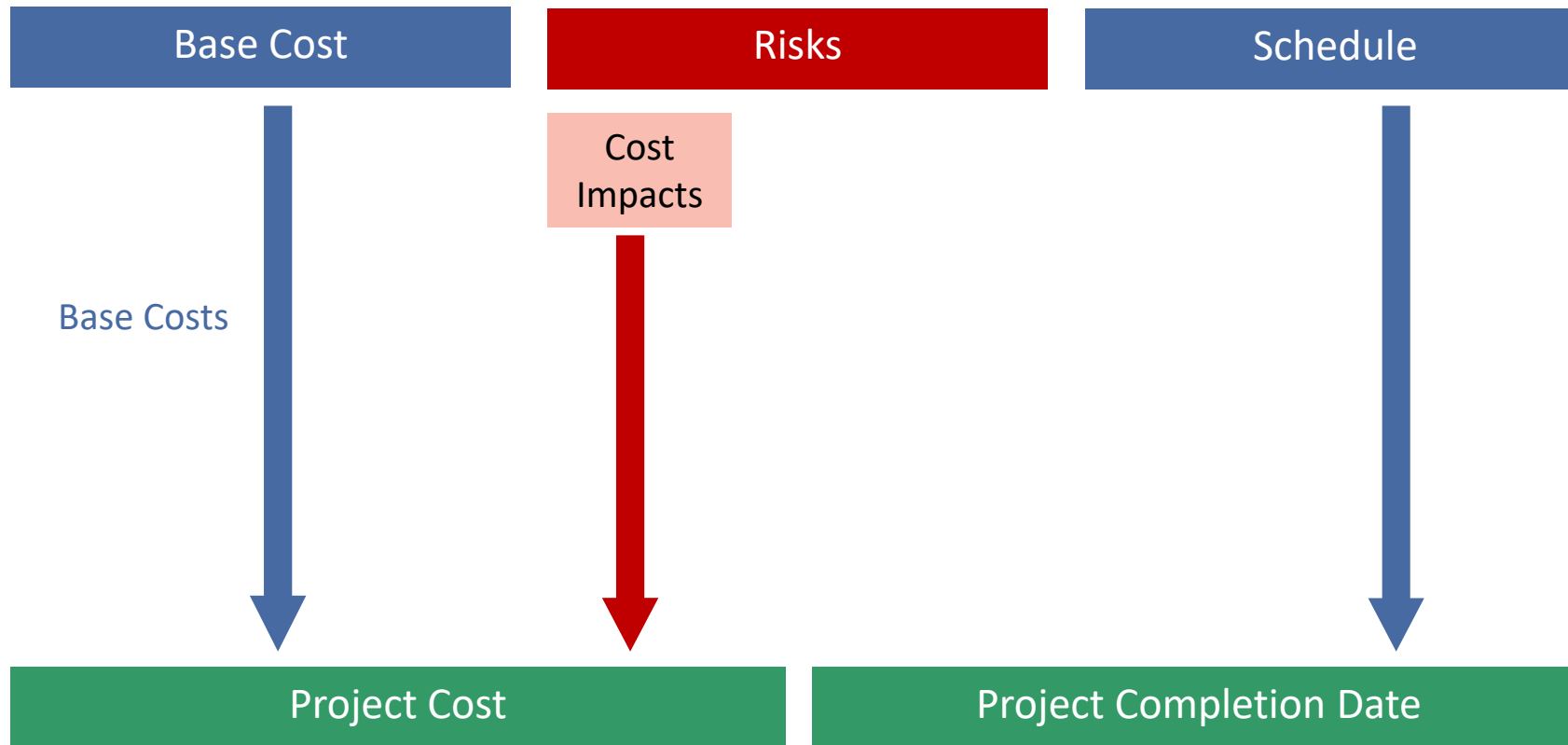
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# Impact of Delays on Project Costs



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**Deterministic Costs**  
 e.g., \$ 1,435,674,571.47

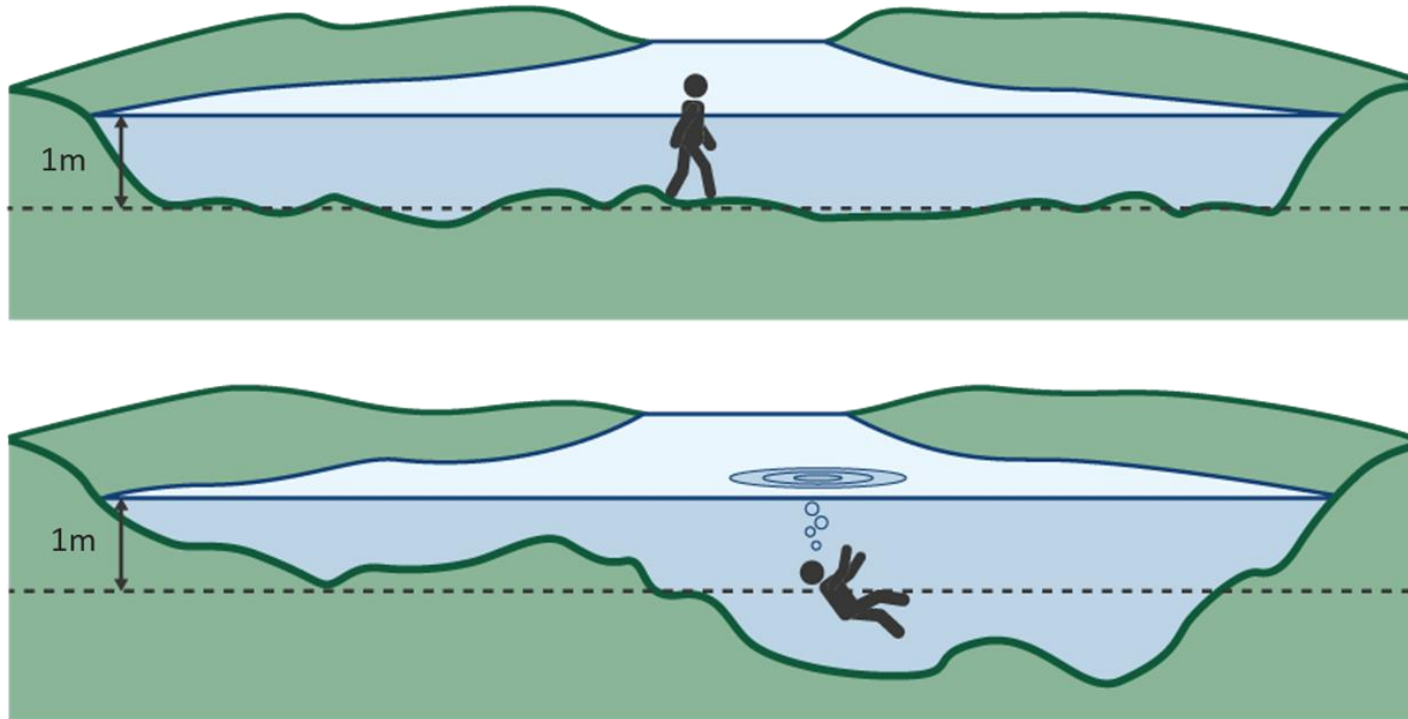
**Cost without information on uncertainty**

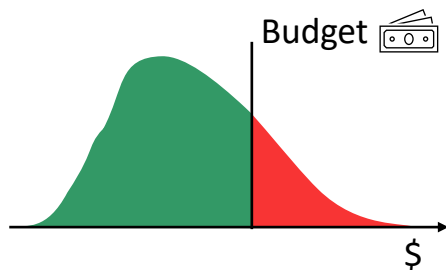
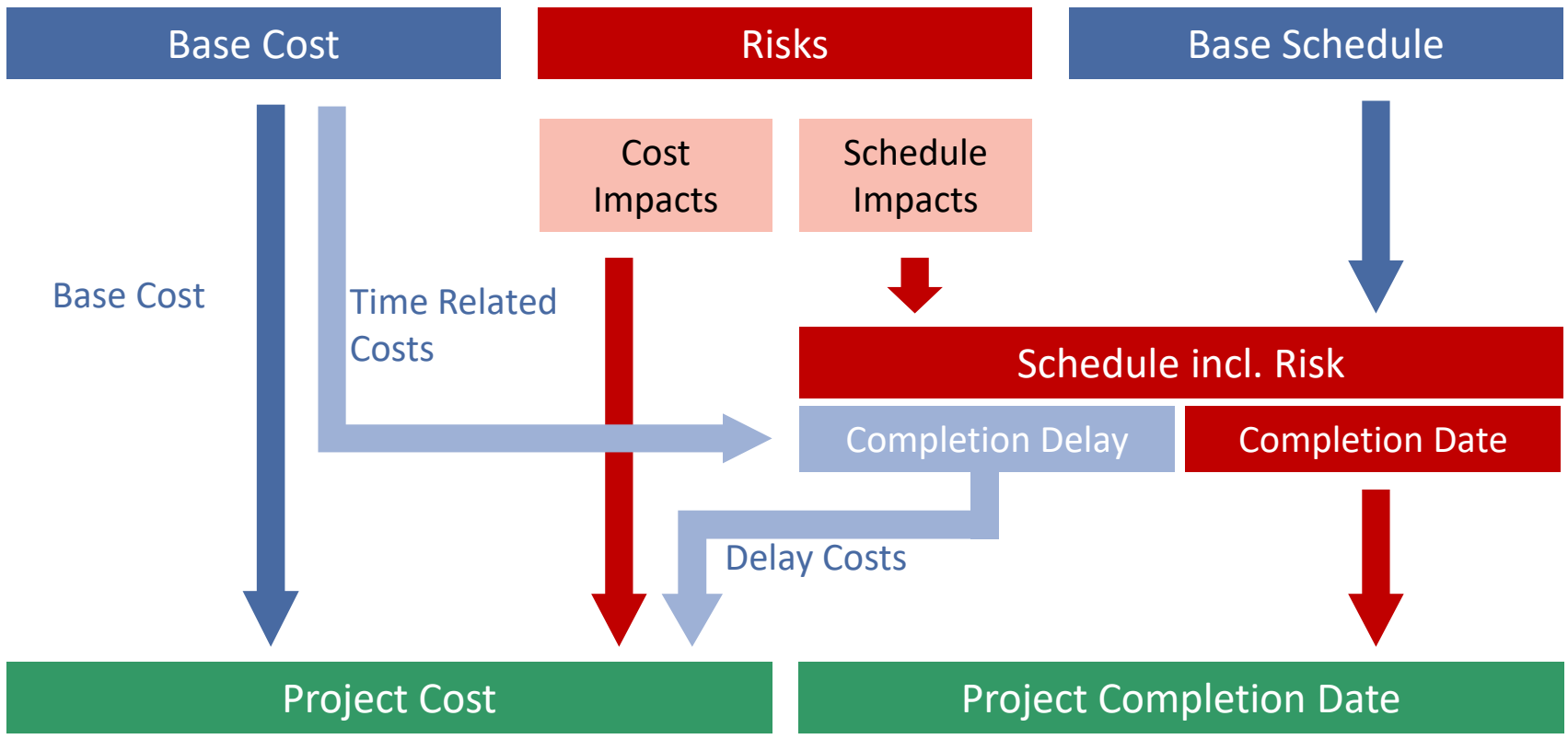
**Deterministic Date**  
 e.g., 1 April 2022

**Cost without information on uncertainty**

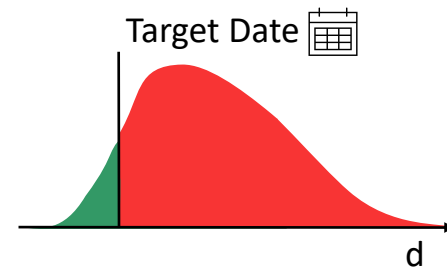
# Consider your uncertainty

Would you wade across a river with an average depth of one meter?



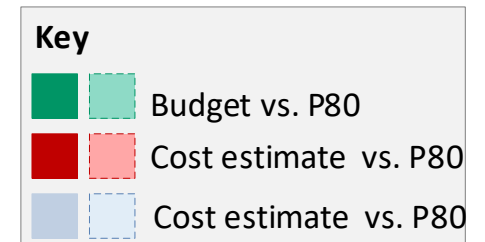
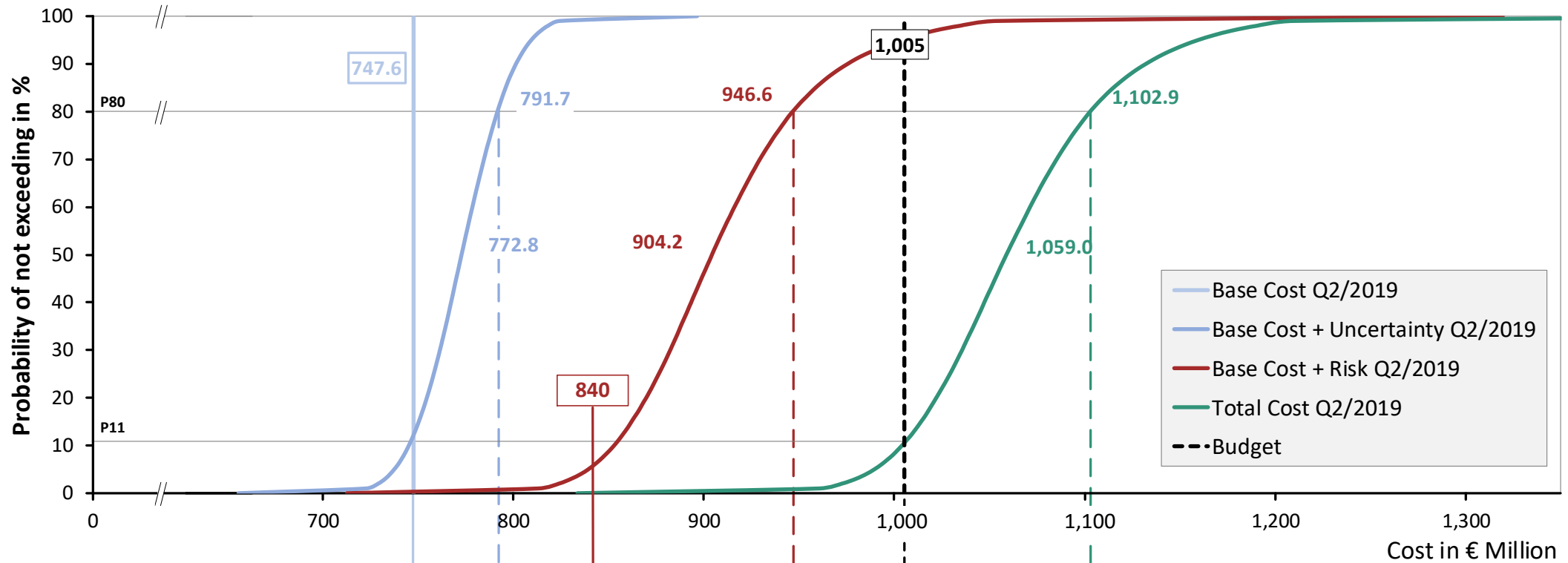


**Probability Information for Budgeting**



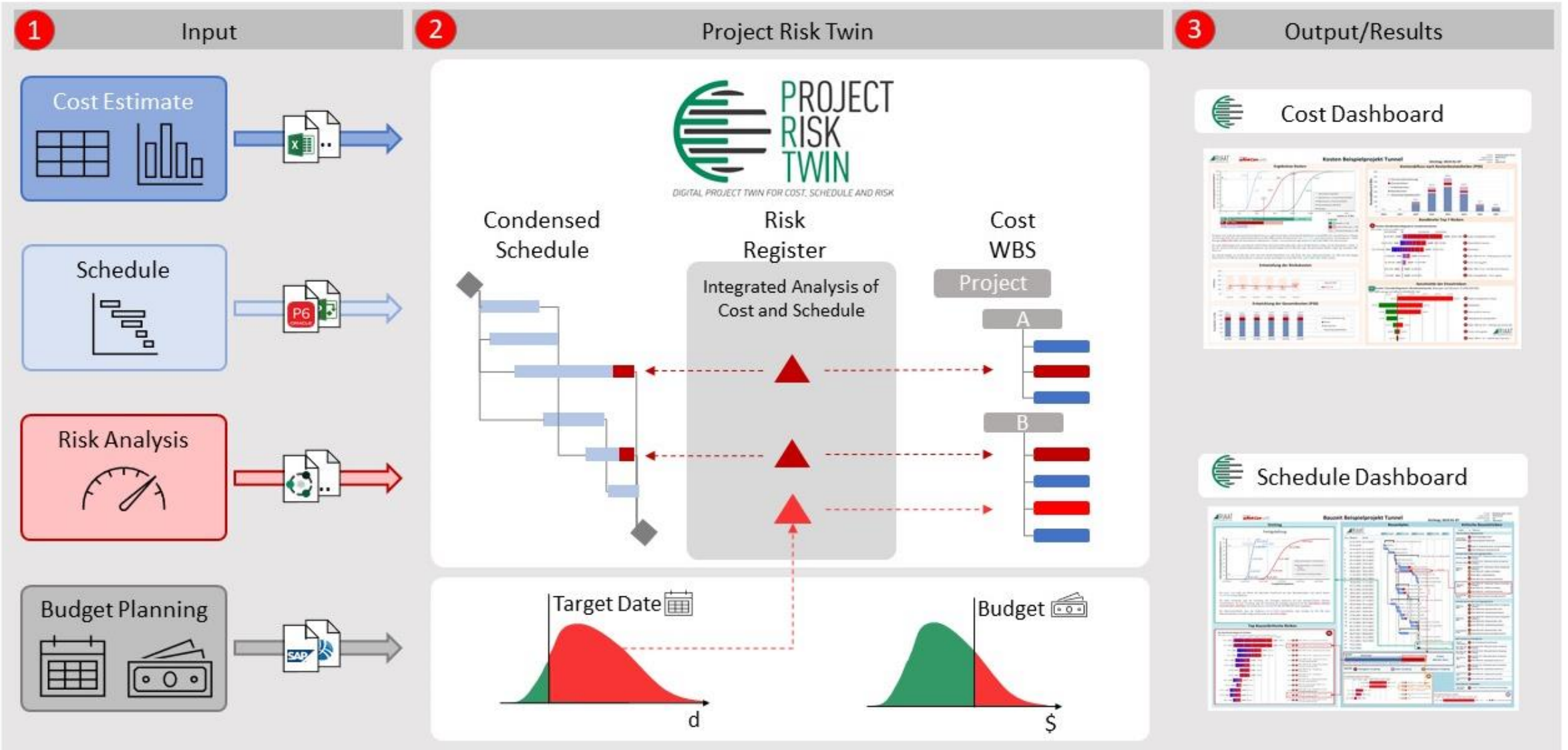
**Probability Information for Completion**

# Cost Results



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# Sample Model

The image displays two windows from Primavera software. The left window shows the Risk Register, and the right window shows a Gantt chart.

**Risk Register (Left Window):**

- Risks:** MS 40.367, MS 12.471
- R.I.R. Identified Risks:** MS 32.209, MS 13.956
  - R.I.R.P. Procurement:** MS 8.982, MS 0.100
    - R001 Market: MS 8.866, MS 0.000
    - R002 Contractor bid protest: MS 0.000, MS 0.100
  - R.I.R.G. Geological / Geotechnical:** MS 17.882, MS 9.390
    - R003 TBM N1+N2 - Extension fault zone km 2.0: MS 1.087, MS 0.900
    - R004 TBM N1+N2 - Immobilization squeezing ground: MS 0.000, MS 0.250
    - R005 TBM N1+N2 - Extension of final lining: MS 10.121, MS 4.250
    - R006 TBM N1+N2 - Tunnel water inflow > 40l/s: MS 1.507, MS 0.820
    - R007 TBM N1+N2 - Change in excavation & support categories: MS 0.088
    - R008 TBM S1+S2 - Advancing through fault zone: MS 1.265, MS 1.200
    - R009 TBM S1+S2 - Change in excavation & support categories: MS 0.000
    - R010 NATM N1+N2 - Change in excavation & support categories: MS 0.353
    - R011 NATM N1+N2 - Tunnel water inflow > 40 l/s: MS 1.358, MS 0.750
    - R012 NATM F1+F2 - Change in excavation & support categories: MS 0.045
    - R013 NATM S1+S2 - Change in excavation & support categories: MS 0.020
    - R014 NATM Cave-ins of 5m<sup>3</sup> to 20m<sup>3</sup>: MS 0.582, MS 0.505
    - R015 NATM Cave-ins > 20m<sup>3</sup>: MS 0.647, MS 0.510
    - R016 AS - Change in excavation & support categories: MS 0.047, MS 0.036
    - R017 UR - Change in excavation & support categories: MS 0.000, MS 0.004
  - R.I.R.E. Environmental:** MS 4.329, MS 4.243
  - R.I.R.A. Authorities:** MS 0.158, MS 0.018
    - R023 Closure main access road: MS 0.123, MS 0.000
    - R024 Permission for access road: MS 0.000, MS 0.018
  - R.I.R.D. Design & engineering:** MS 0.000, MS 0.005
    - R025 Incomplete design: MS 0.000, MS 0.005
  - R.I.R.C. Construction:** MS 0.000, MS 0.200
    - R026 TBM S1+S2 - Main bearing damage: MS 0.000, MS 0.200
    - R027 TBM S1 - Startup delay: MS 0.000, MS 0.000
    - R028 Logistic problems crosscut north (5-12): MS 0.000, MS 0.000
    - R029 Logistic problems crosscut south (13-25): MS 0.000, MS 0.000
  - R.D.C. Delay cost:** MS 3.041, MS -1.485
    - R030 Owner's delay cost: MS 6.626, MS 2.520
    - R031 Contractor's cost: MS 0.000, MS 0.495
    - R032 Contractor liquidated damages: MS 0.000, MS -1.980
    - R033 Economic gains/losses due to deviation from target date: MS 3.547, MS 0.000
  - R.I.R.U. Unknown risks:** MS 0.000

**Gantt Chart (Right Window):**

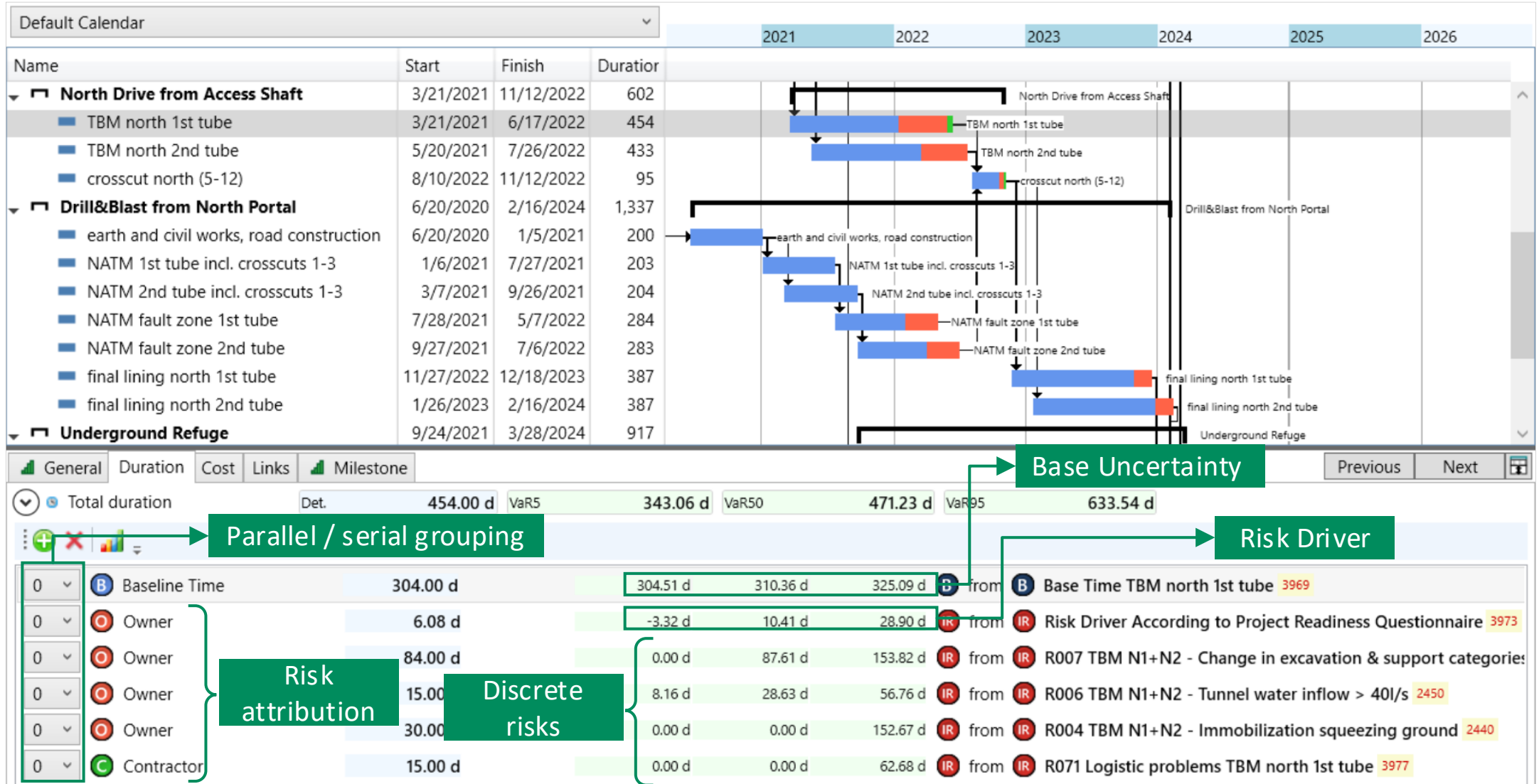
- Diagram:** Base + Risk Schedule
- Project Start:** 12/25/2018 (Construction Start)
- Default Calendar:** 2019, 2020, 2021, 2022, 2023, 2024, 2025
- Code Name Table:**

Code	Name	Start	Duration [d]
1	Tender, Access Shaft	12/25/2018	729
2	Construction Start	12/25/2018	0
3	Tender, Contract Award	12/25/2018	393
4	Access Shaft	1/22/2020	336
5	South Drive from Access Shaft	12/23/2020	1,160
6	NATM south 1st tube	12/23/2020	88
7	NATM south 2nd tube	2/21/2021	88
8	TBM south 1st tube	7/19/2021	604
9	TBM south 2nd tube	9/17/2021	588
10	crosscut south (13-25)	4/28/2023	169
11	final lining south 1st tube	10/14/2023	107
12	final lining south 2nd tube	11/13/2023	105
13	North Drive from Access Shaft	3/21/2021	602
14	TBM north 1st tube	3/21/2021	433
15	TBM north 2nd tube	5/20/2021	433
16	crosscut north (5-12)	8/10/2022	95
17	Drill&Blast from North Portal	6/20/2020	1,337
18	earth and civil works, road construction	6/20/2020	200
- Summary Statistics:**
  - Total duration: Det. 604.00 d, VaR5 456.49 d, VaR50 555.38 d, VaR95 923.36 d
  - Baseline Time: 472.00 d
  - Uncertainty: 0.00 d
  - Owner: 21.00 d
  - Contractor: 18.00 d
  - Contractor: 15.00 d
  - Owner: 78.00 d
- Risk Register Summary (Bottom Right):**
  - Owner: 71.72 d
  - Contractor: 198.59 d
  - Contractor: 74.70 d
  - Owner: 355.09 d

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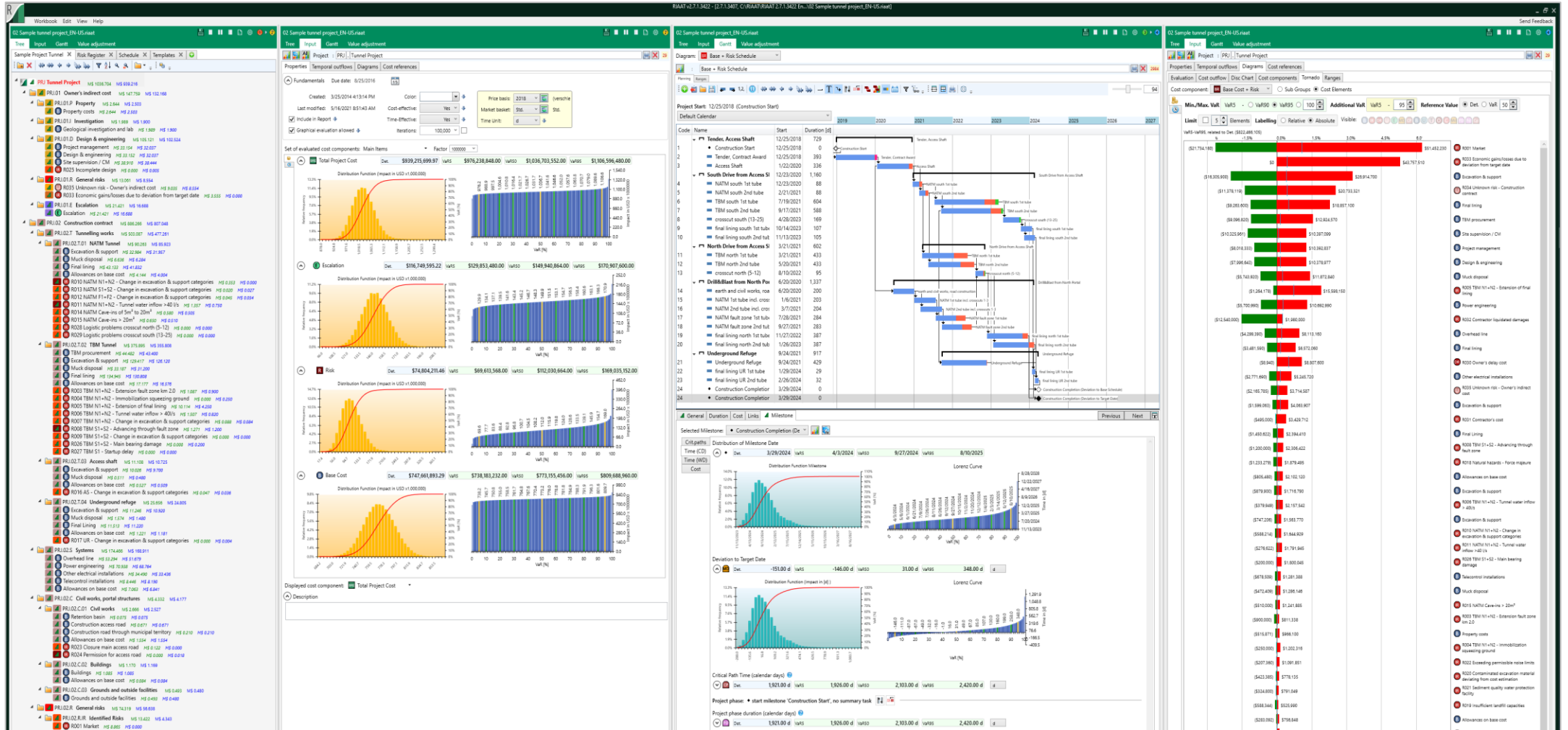


# Sample Model



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# Sample Model



WBS with structures cost components

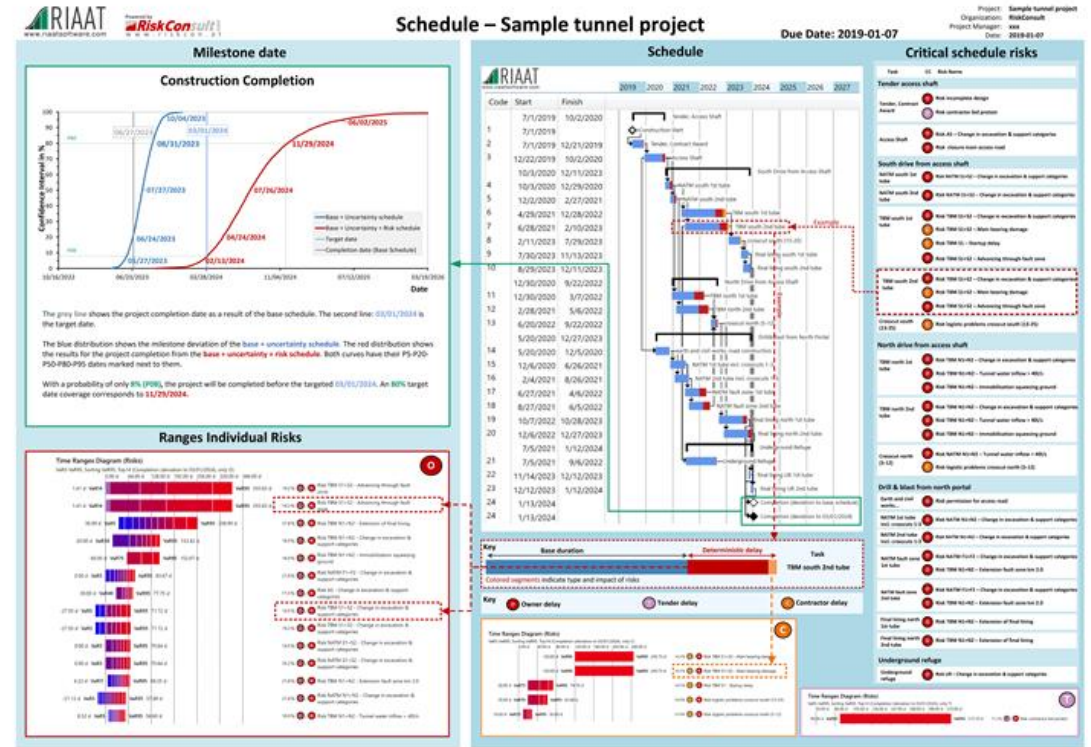
Probabilistic results for all cost components for the selected WBS level

Integrated schedule with assigned risks and milestone analysis

Tornado chart with sensitivity analysis

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# Results and Dashboards



Content adjusted according to the organization / project