Boston Society of Civil Engineers Section (BESCES)
Construction Institute & Engineering Management Group

Risk Management –
How Do You Control Your Risks in Practice?

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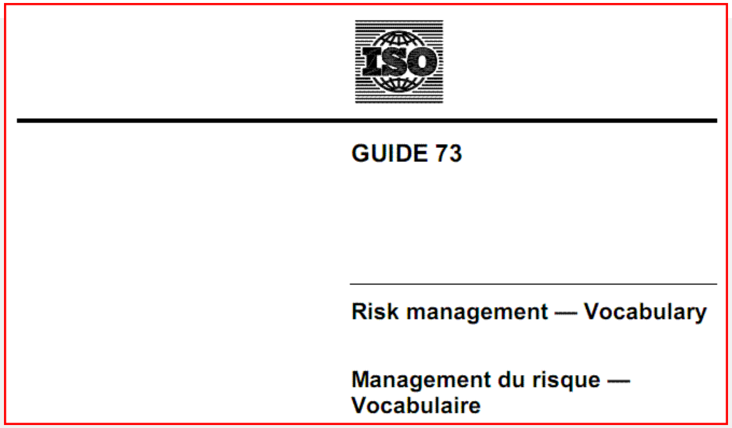
Contents

Today, you will learn how to successfully …

1. Control your uncertainties
2. Perform qualitative and quantitative risk analysis

Basics

Use Generic Terms and Definitions (e.g. by International Organization for Standardization, ISO)


ISO

GUIDE 73

Risk management — Vocabulary

Management du risque — Vocabulaire

Definitions by ISO Guide 73:2009

Uncertainty	Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of, an event, its consequence, or likelihood
Event	Occurrence or change of a particular set of circumstances
Hazard	Source of potential harm
Consequence	Outcome of an event affecting objectives
Frequency	Number of events or outcomes per defined unit of time
Likelihood	Chance of something happening
Probability	Measure of the chance of occurrence expressed as a number between 0 and 1, where 0 is impossibility and 1 is absolute certainty
Risk	Effect of uncertainty on objectives; an effect is a deviation from the expected — positive and/or negative
Risk Analysis	Process to comprehend the nature of risk (and to determine the level of risk
Risk Assessment	Overall process of risk identification, risk analysis and risk evaluation
Risk criteria	Terms of reference against which the significance of a risk is evaluated
Risk estimation	Process used to assign values to the probability and the consequences of a risk
Risk Evaluation	Process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable
Risk Management	Coordinated activities to direct and control an organization with regard to risk
Risk Management Process	Systematic application of management policies, procedures and practices to the activities of communicating, consulting, establishing the context, and identifying, analyzing, evaluating, treating, monitoring and reviewing risk
Risk Management Framework	Set of components that provide the foundations and organizational arrangements for designing, implementing, monitoring, reviewing and continually improving risk management throughout the organization
Risk Management Plan	Scheme within the risk management framework, specifying the approach, the management components and resources to be applied to the management of risk
Risk Owner	Person or entity with the accountability and authority to manage a risk
Risk Source	Element which alone or in combination has the intrinsic potential to give rise to risk
Risk Treatment	Process to modify risk
Residual Risk	Risk remaining after risk treatment

Use Generic Terms and Definitions (e.g. by ISO)

ISO IEC

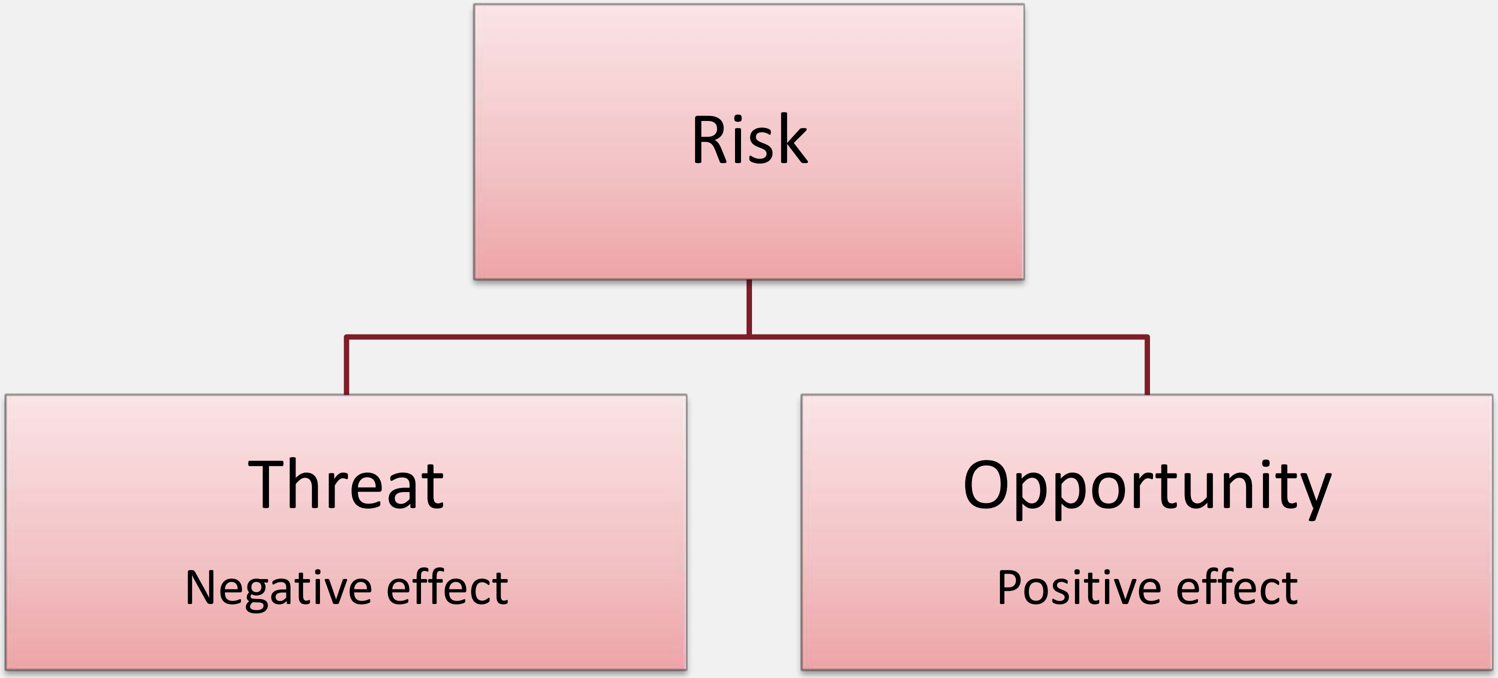
GUIDE 51

Safety aspects — Guidelines for their inclusion in standards

Definitions by ISO Guide 51:1999

Harm	Physical injury or damage to the health of people or damage to property or the environment
Hazard	Potential source of **harm**
Harmful event	Occurrence in which a **hazardous situation** results in **harm**
Hazardous situation	Circumstance in which people, property or the environment is exposed to one or more **hazards**
Safety	Freedom from unacceptable **risk**
Tolerable risk	Risk which is accepted in a given context based on the current values of society

Risk – Threats and Opportunities



Risk definition by ISO 31000:2010

Risk is the effect of uncertainty on objectives

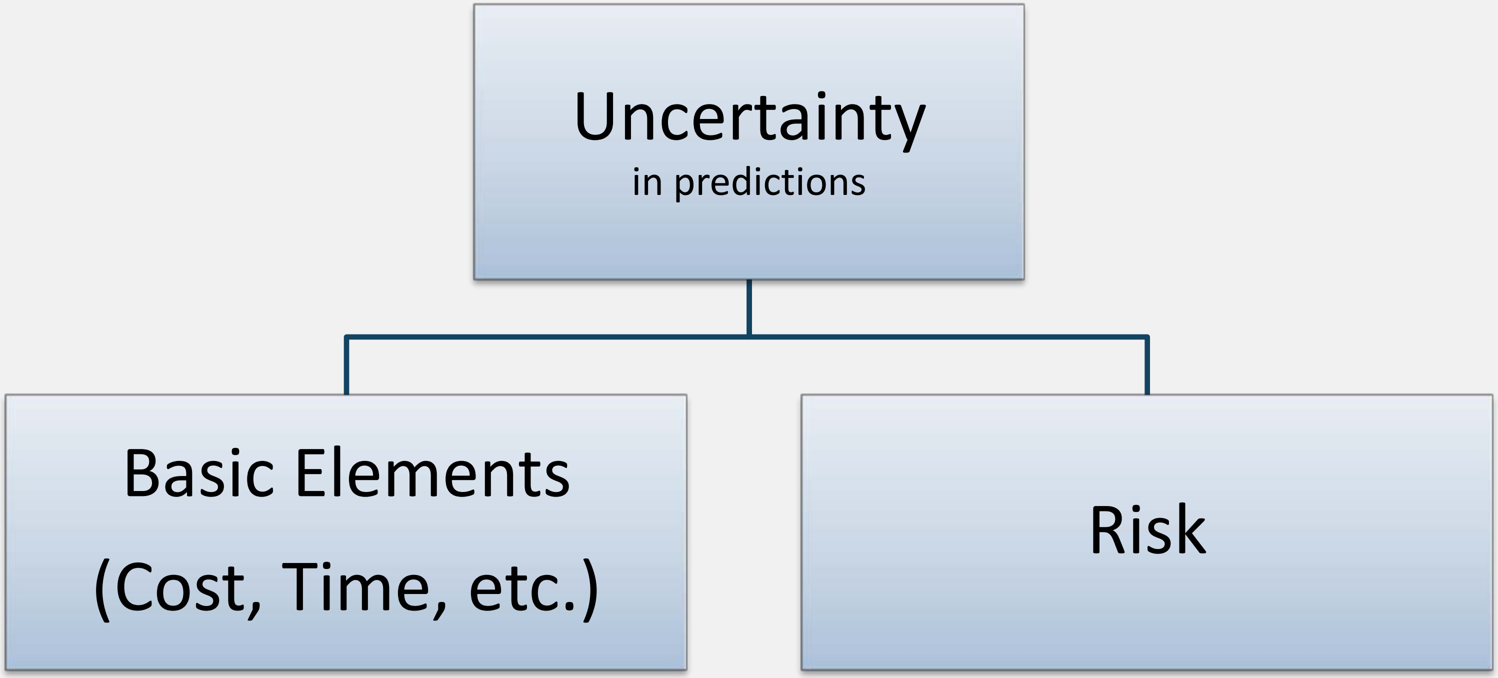
NOTE: An effect is a deviation from the expected – positive and/or negative.

ISO 31000:2010

Basic definitions

No guideline to implement risk management to projects or on company level.

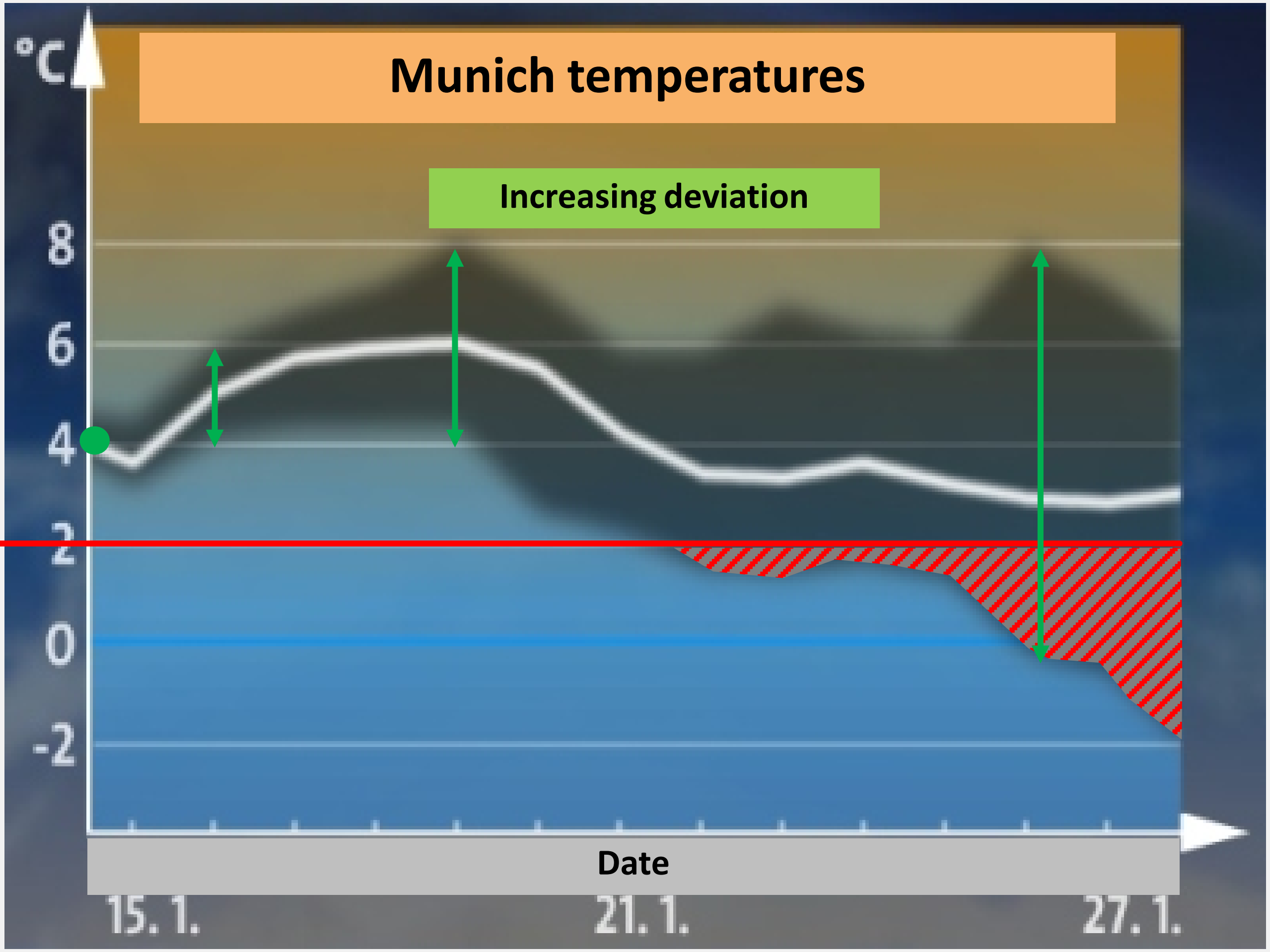
Uncertainty – Distinguish Between Basic Elements and Risk



- → Will always occur
  (e.g. elements in a cost estimation)
- → Exact price or time is uncertain

- → Has a probability of occurrence
- → Consequences (costs, time, etc.) are uncertain

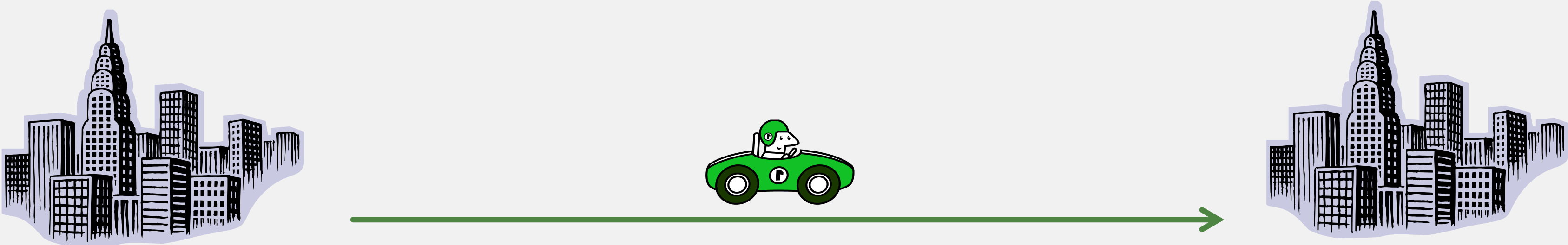
Example temperatures (German television):



Example risk:
no construction works
below 2°C

➔ Additional probability that risk will occur

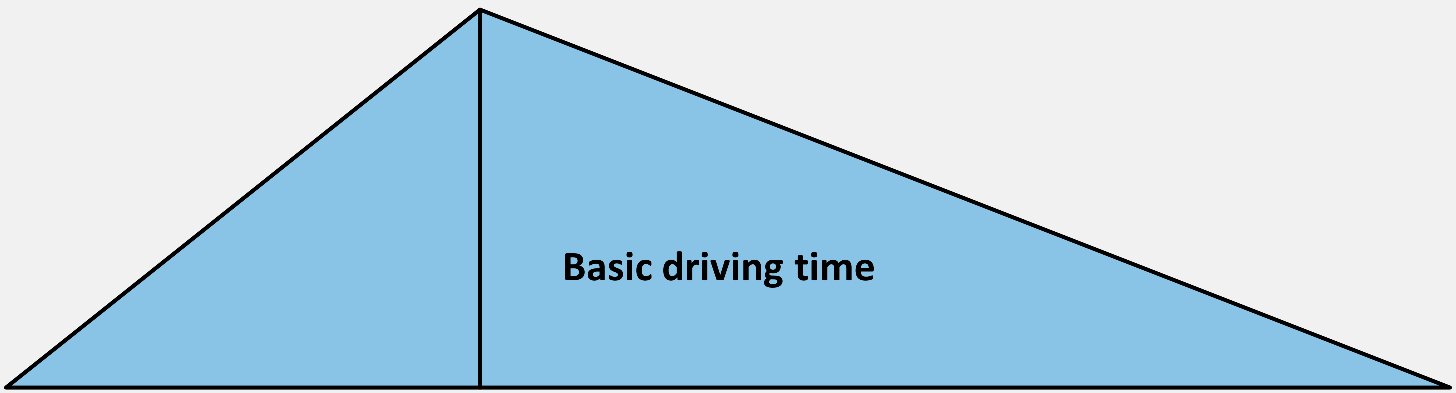
Example: Basic Driving Time from New York City to Boston



New York City

Boston

Estimation of the basic driving time from New York City to Boston
Premise: Normal traffic and weather conditions

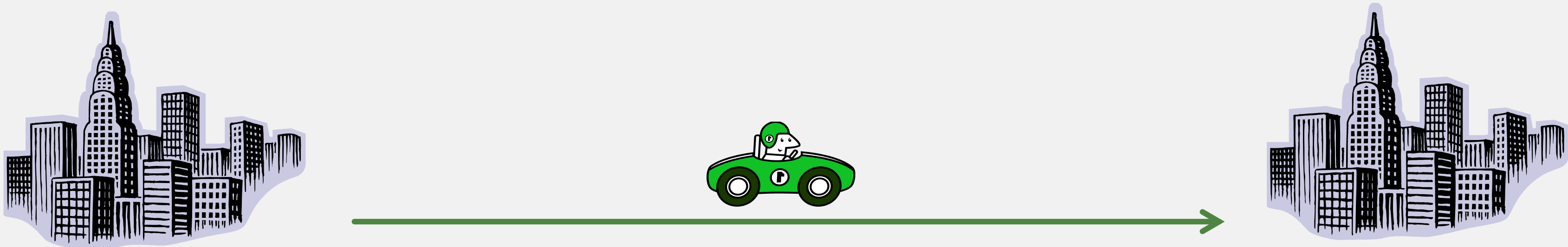


Best case: 3.5 h

Most likely: 4 h

Worst case: 5 h

Example: Add a Risk – Bad Weather



New York City

Boston

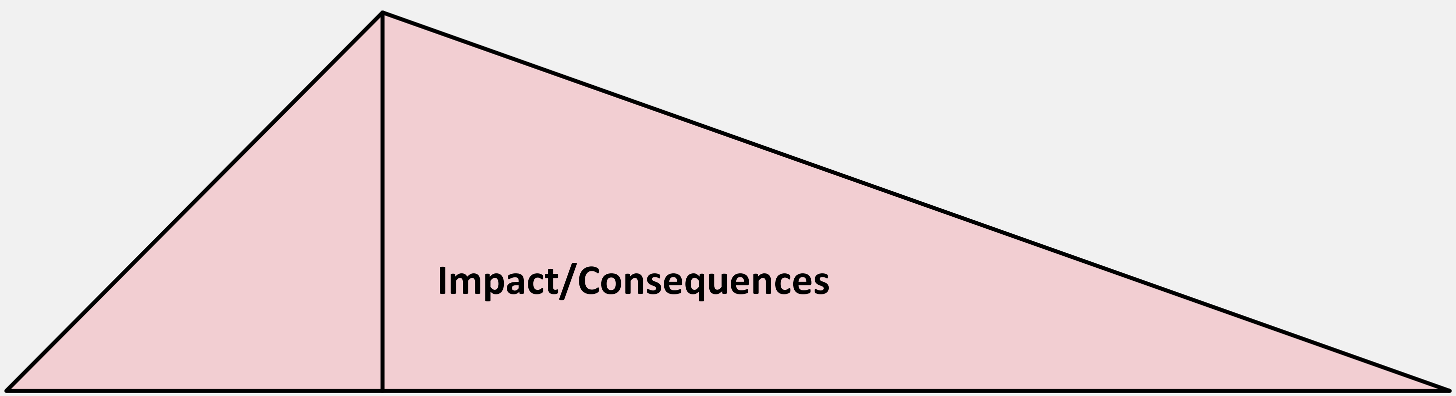
Risk: Bad weather in January

→ Snow and icy roads

→ Scenario has a probability of occurrence – can occur but does not have to

→ Estimated probability: **45 %**

→ Additional time is needed (impact if risk does occur)



Best case: 0.5 h

Most likely: 1 h

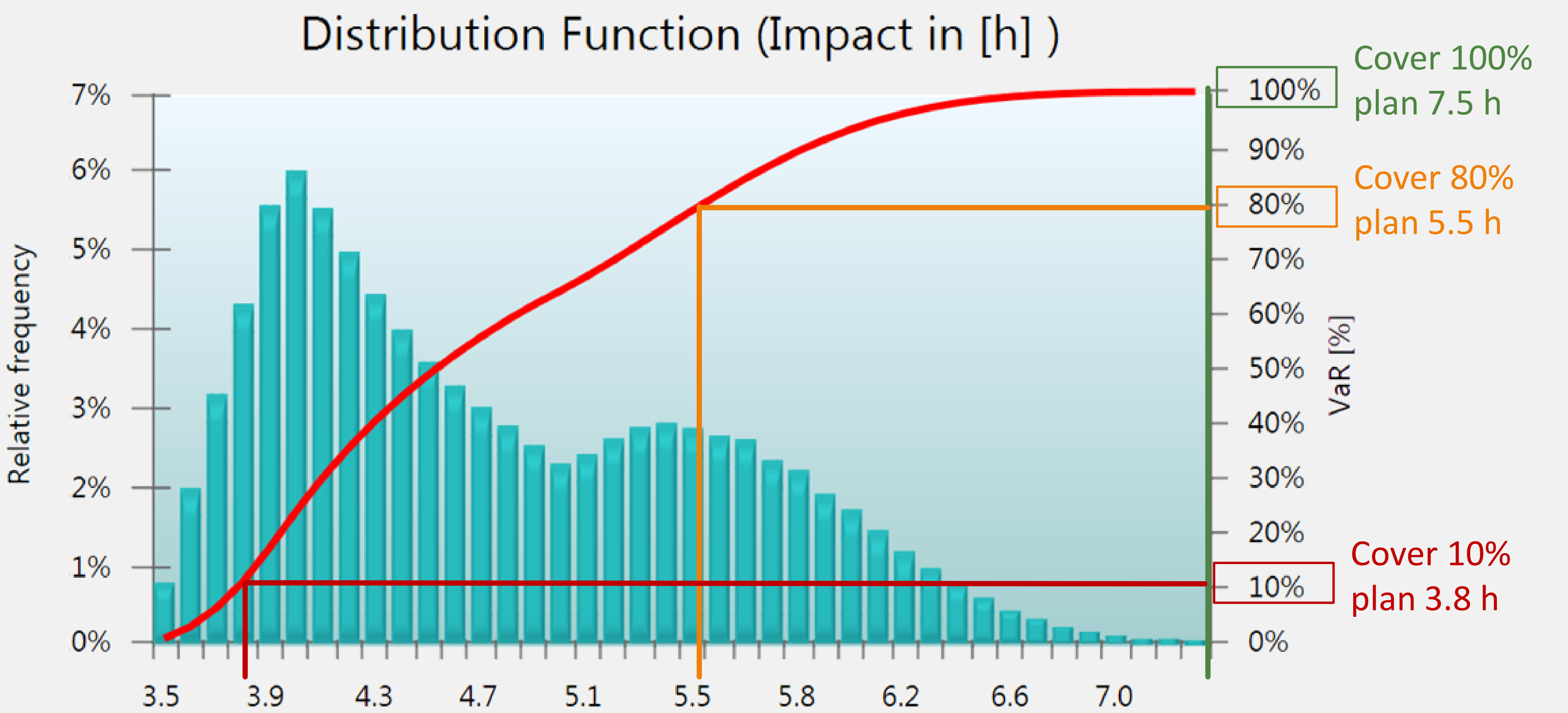
Worst case: 2.5 h

Now it is up to you as your own risk manager:

→ How important is your appointment in Boston?

→ Can you afford being late?

→ Cover the risk of being too late → start earlier or not?



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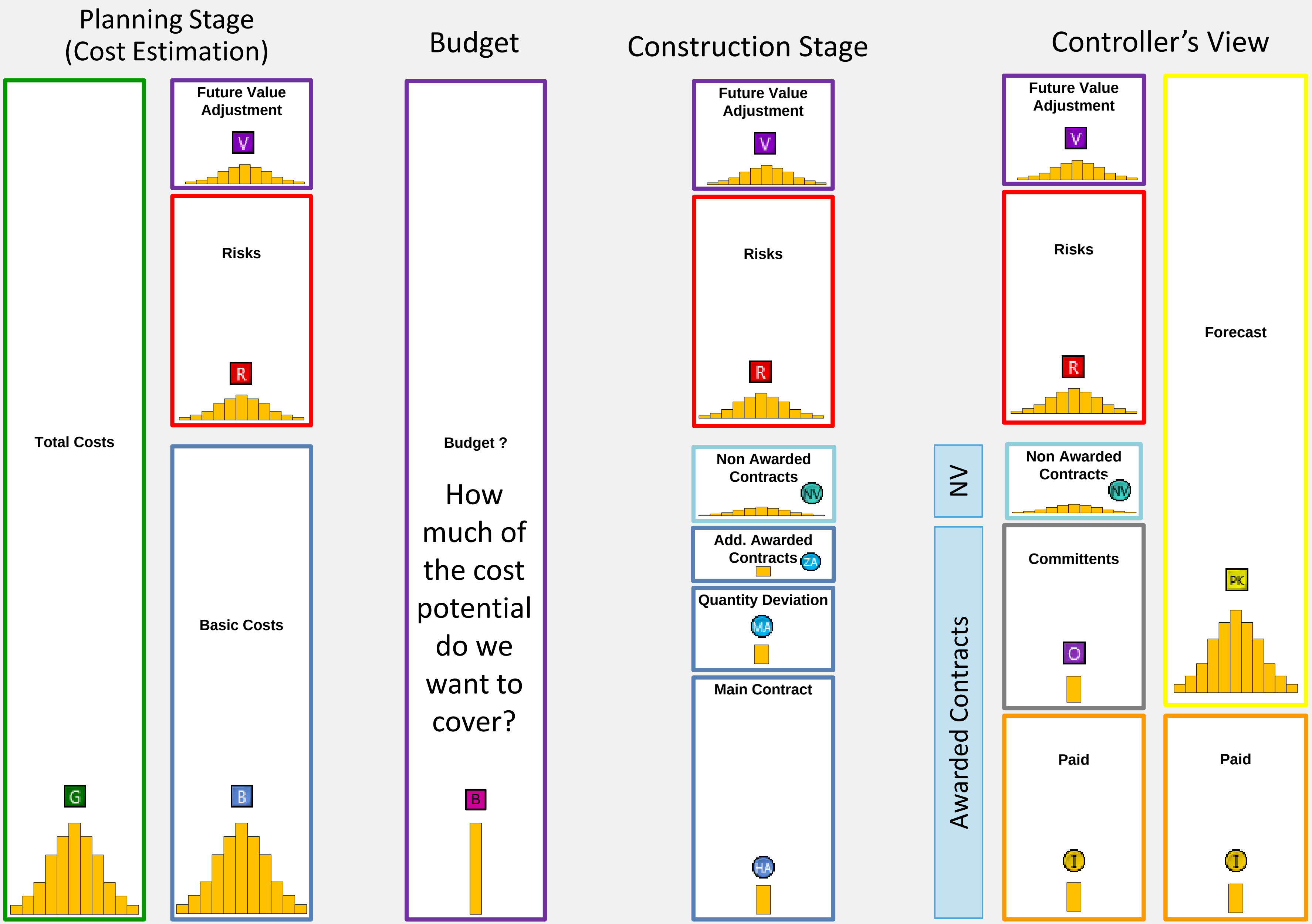
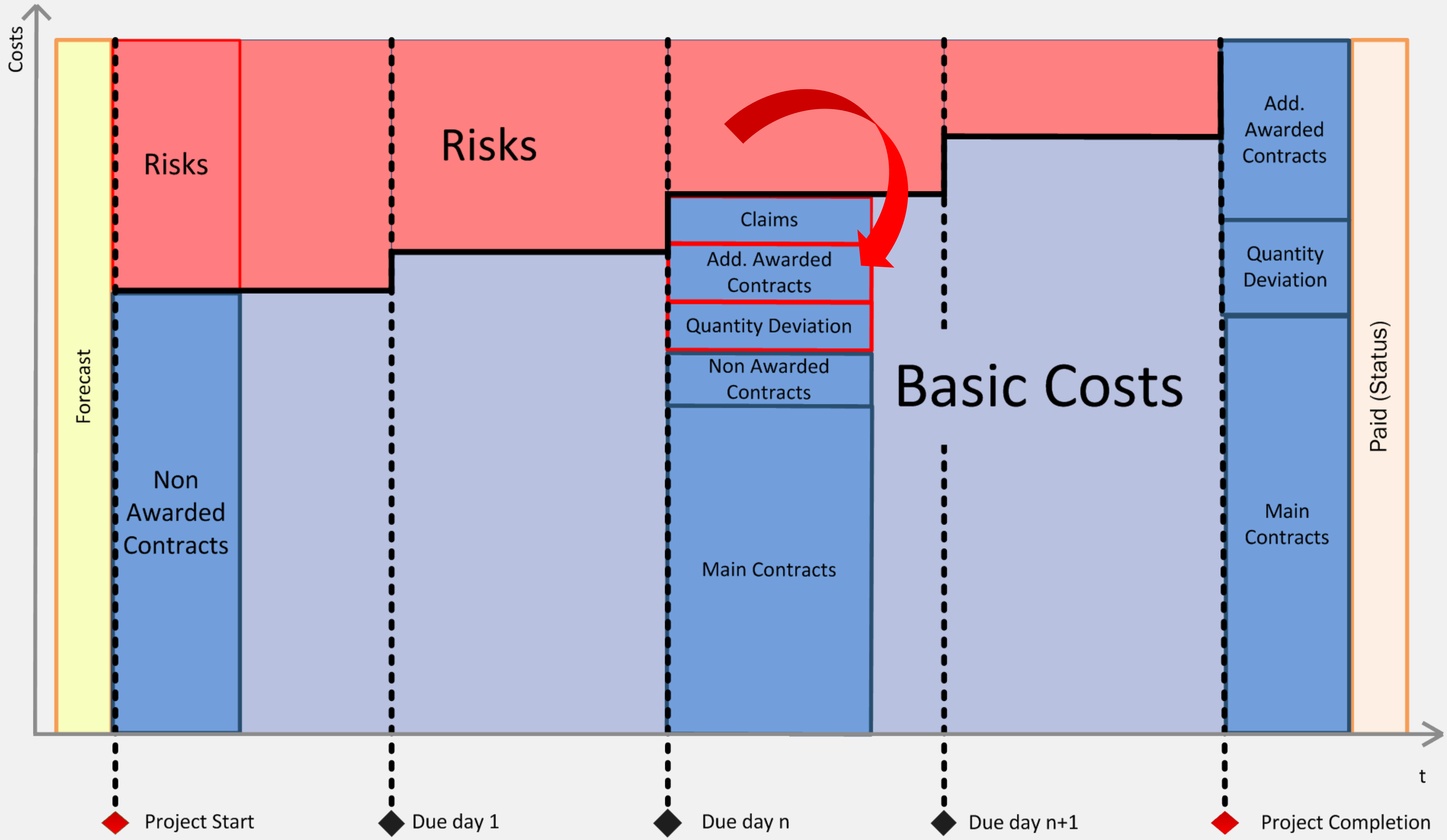
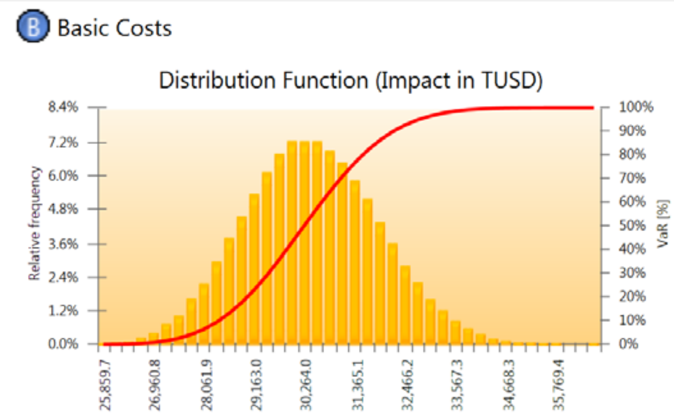
Cost Components of a Project Cost Structure – Static View

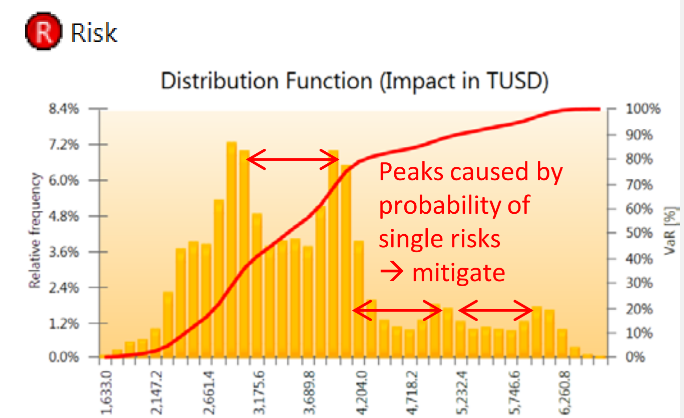


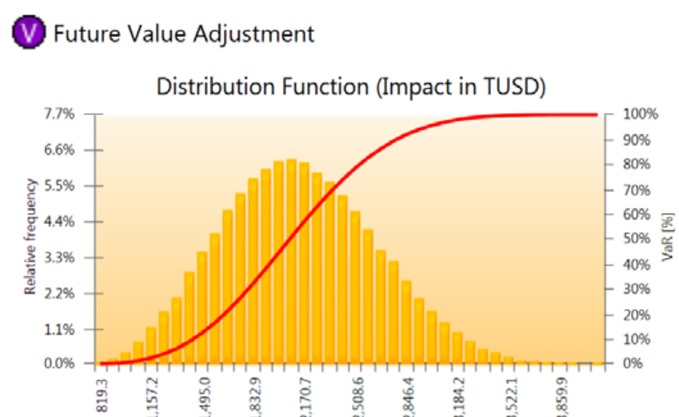
Integrate Change Order Management into RM – Dynamic View



Aggregating the Cost Components → Determine a Budget

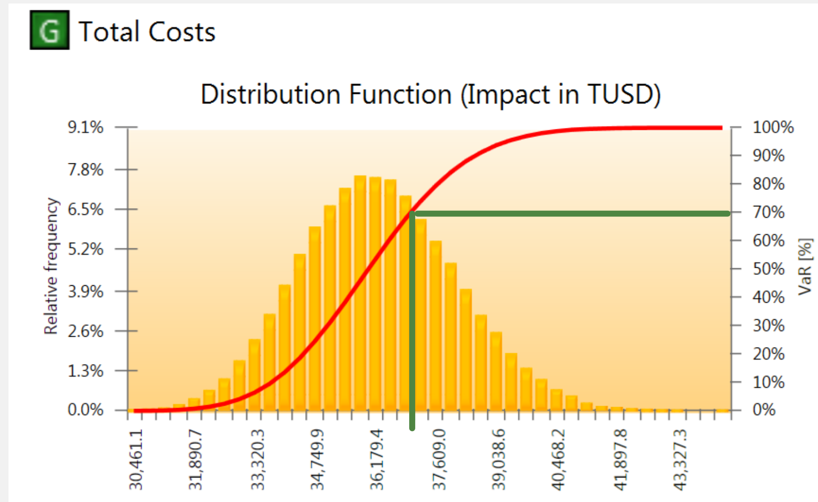


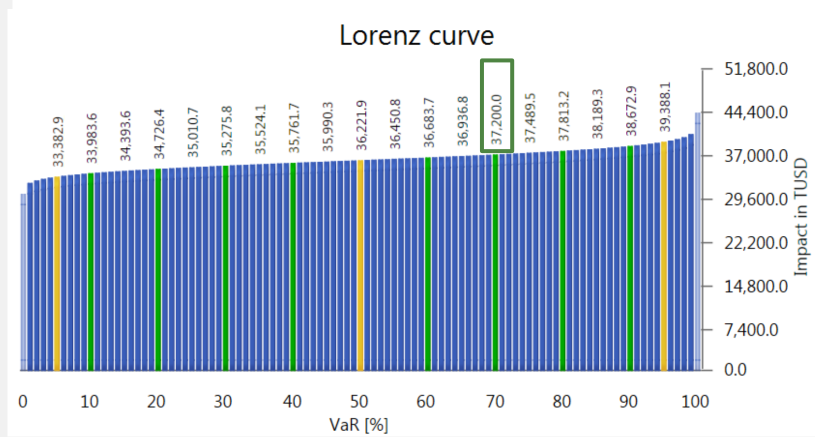




Create a budget for each cost component or for the total costs.

How much of the cost potential do you want to cover? → **Say 70%** → **Budget: 37.2 Mio USD**





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Success Factors and Goals in Risk Management

Methods
Generic risk management according to ISO 31000.
Design and integration of methods (e.g. ISO 31010)
according to project or enterprise requirements.

Raising awareness
Workshops prepare the
field for common perception of
risk management by all stakeholders.

Moderation
Experts guide through the process
and provide a consistent framework
for analysis and assessment of risks.

Comprehensive overview (Risk Map) of all relevant Threats and Opportunities

Systematic mitigation and control of all relevant risks

In case risks occur there will be clear evidence that everything expectable / feasible was done according to “best practice” at the right time.

Risk Management Process - Overview

Avoid repeating one of the most frequent mistakes …

Define the limits of your system (“Context”) – by giving answers to ...

1. What is your **project/task**? (give a short general description)
2. What is your **goal** - the **intended use** of your task/project?
3. Who will be the foreseeable **user** (customer) of your product?
4. **Boundaries** (define the spatial limits in 3 dimensions)?
5. **Time** frame (define the life expectancy of your result/product)?
6. Which risk analysis/management **method** are you using?
7. Who is part of your risk analysis/management **team?**
8. What **resources** (HR, infrastructure, materials) are available?
9. What could go (reasonably, by foreseeable misuse) **wrong**?
10. What will (have to) be **excluded** (because outside your influence)?

Devil's Slide Tunnel, Pacifica - CA

2nd Level Risk Management Support for Caltrans

Risk Management (RM) …

- ☑ **Enhances your performance**
- ☑ **Cuts your costs**
- ☑ Helps you to **develop innovative solutions**
- ☑ Helps you to **optimize your process**
- ☑ Brings you value added through **interdisciplinary team work**
- ☑ **Ensures your Legal Compliance –** Your Liability remains limited

Challenges you will have to master …

- ❑ The **earlier** you start with RM the **bigger are your profits**
- ❑ RM may bind **valuable resources** in critical project phases
- ❑ RM needs **additional time** (and time is money …)

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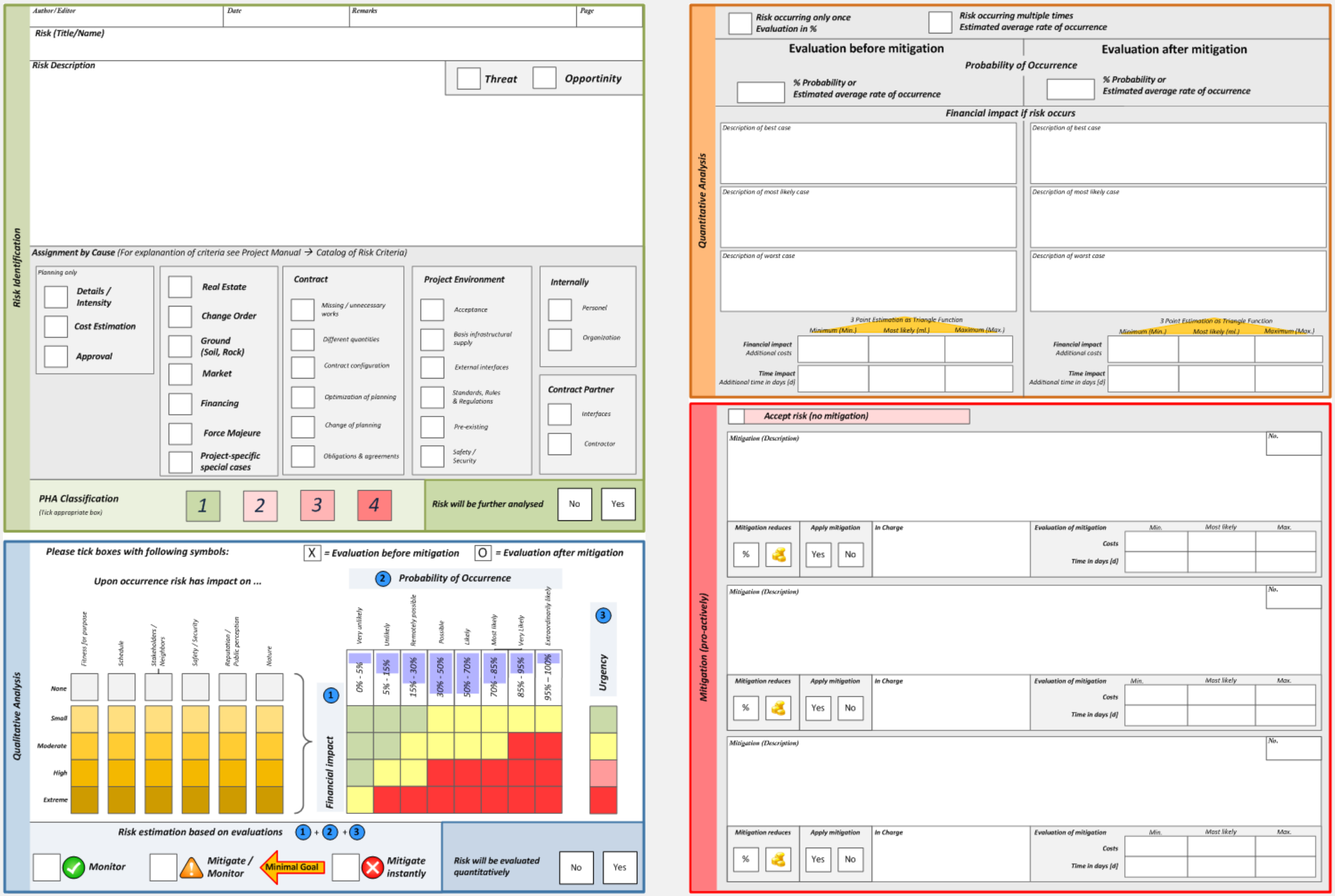
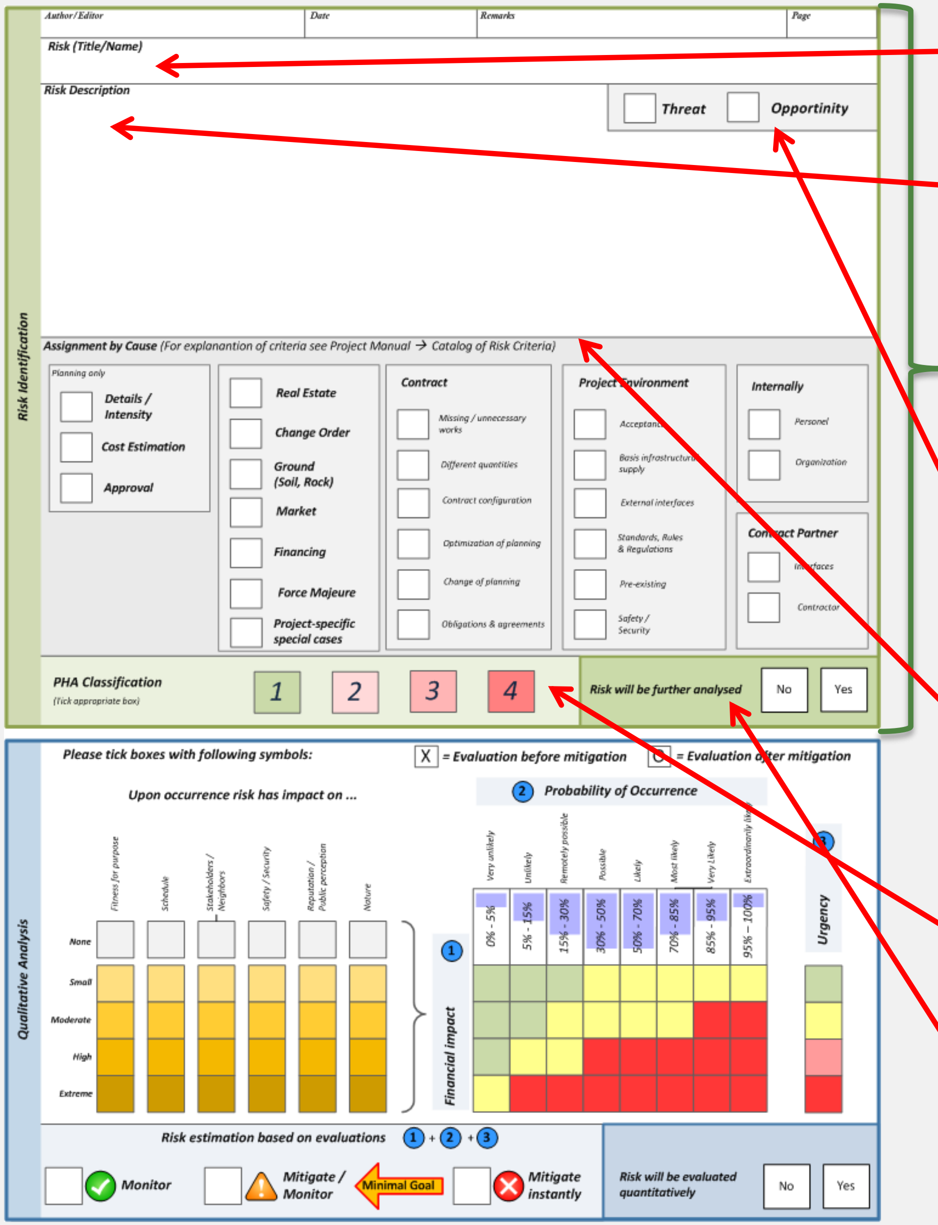
Risk Fact Sheet – Everything you need on just two pages (Overview - empty template)



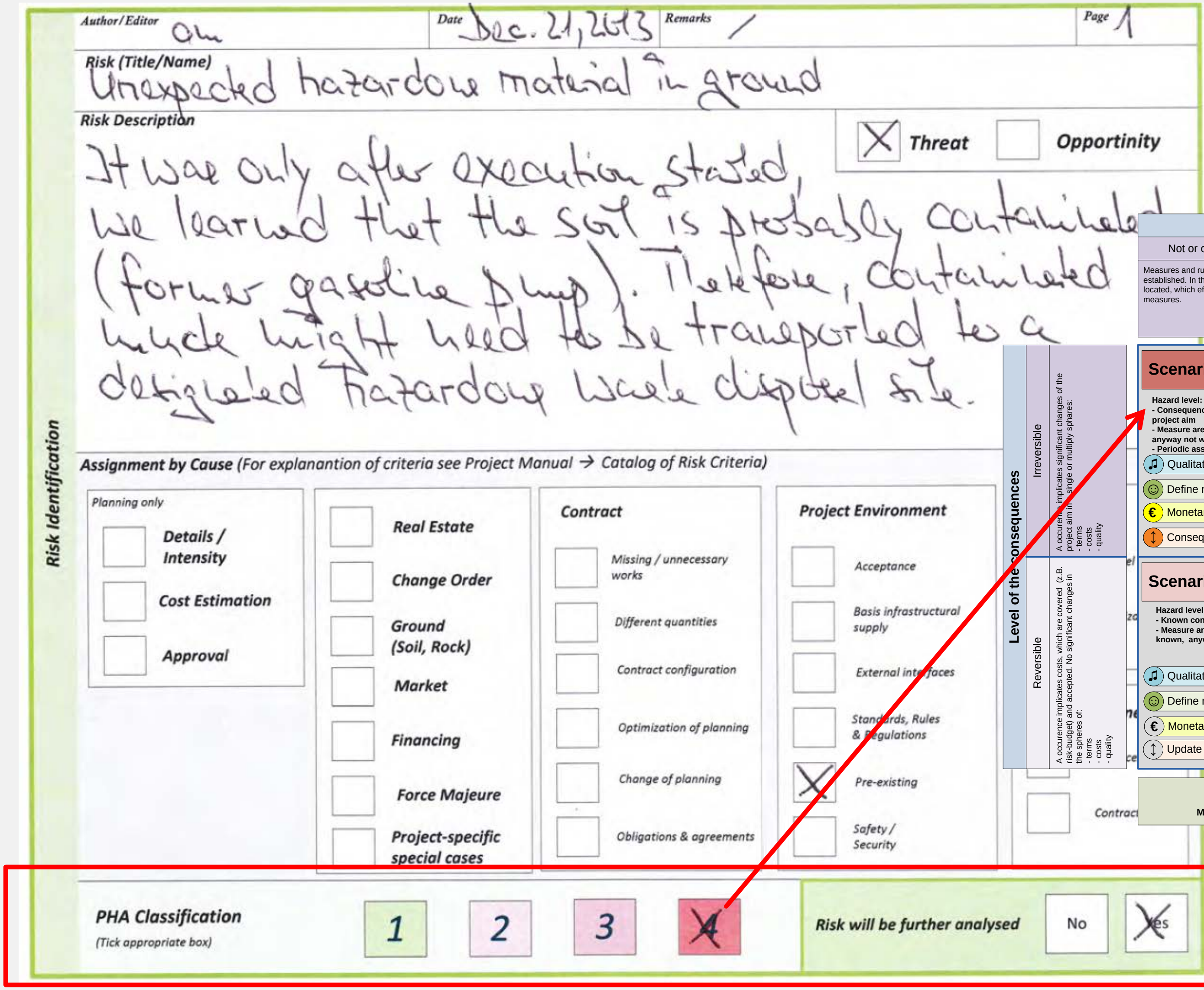
Risk Fact Sheet (RFS) – Risk Identification



1. **Title/Name** of your risk
2. **Describe your risk**
   - Why is it a risk?
   - What might be the impact?
   - ... [whatever is important to you]
3. Qualify as **Threat or Opportunity** (upside / downside risk)
4. Qualify your risk by **cause** (multiple answers are possible)
5. Qualify your risk according to **PHA**
6. Make a **decision** **– Do you need further analysis?**

Risk Fact Sheet (RFS) – Risk Identification - Example

Our Example



Risk Identification

Author/Editor: Ou | Date: Dec. 21, 2013 | Remarks: / | Page: 1

Risk (Title/Name): Unexpected hazardous material in ground

Risk Description

☒ Threat ☐ Opportunity

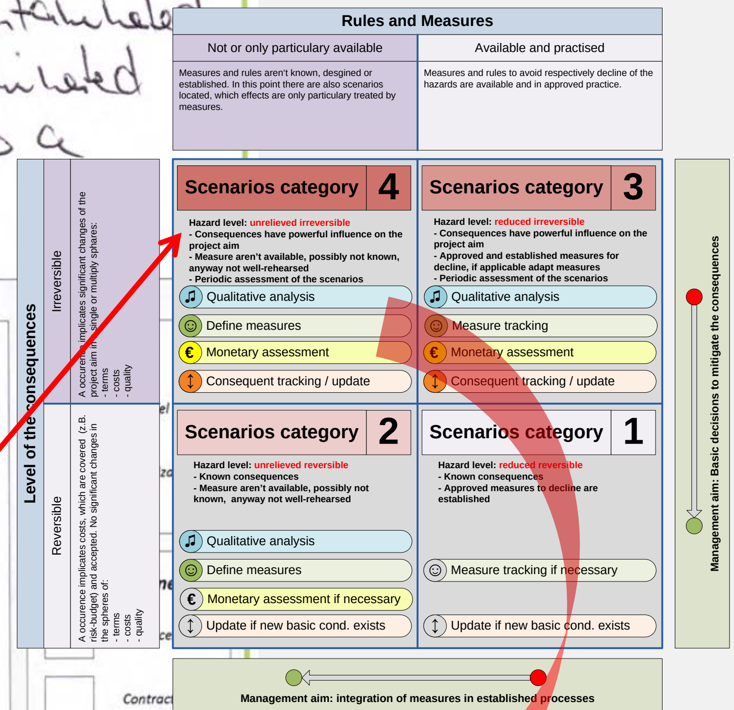
It was only after execution started, we learned that the soil is probably contaminated (former gasoline pump). Therefore, contaminated must might need to be transported to a designated hazardous waste disposal site.

Assignment by Cause (For explanantion of criteria see Project Manual → Catalog of Risk Criteria)

Planning only		Contract	Project Environment
☐ Details / Intensity	☐ Real Estate	☐ Missing / unnecessary works	☐ Acceptance
☐ Cost Estimation	☐ Change Order	☐ Different quantities	☐ Basis infrastructural supply
☐ Approval	☐ Ground (Soil, Rock)	☐ Contract configuration	☐ External interfaces
	☐ Market	☐ Optimization of planning	☐ Standards, Rules & Regulations
	☐ Financing	☐ Change of planning	☒ Pre-existing
	☐ Force Majeure	☐ Obligations & agreements	☐ Safety / Security
	☐ Project-specific special cases		

PHA Classification (Tick appropriate box): 1 | 2 | 3 | ☒ 4

Risk will be further analysed: No | ☒ Yes



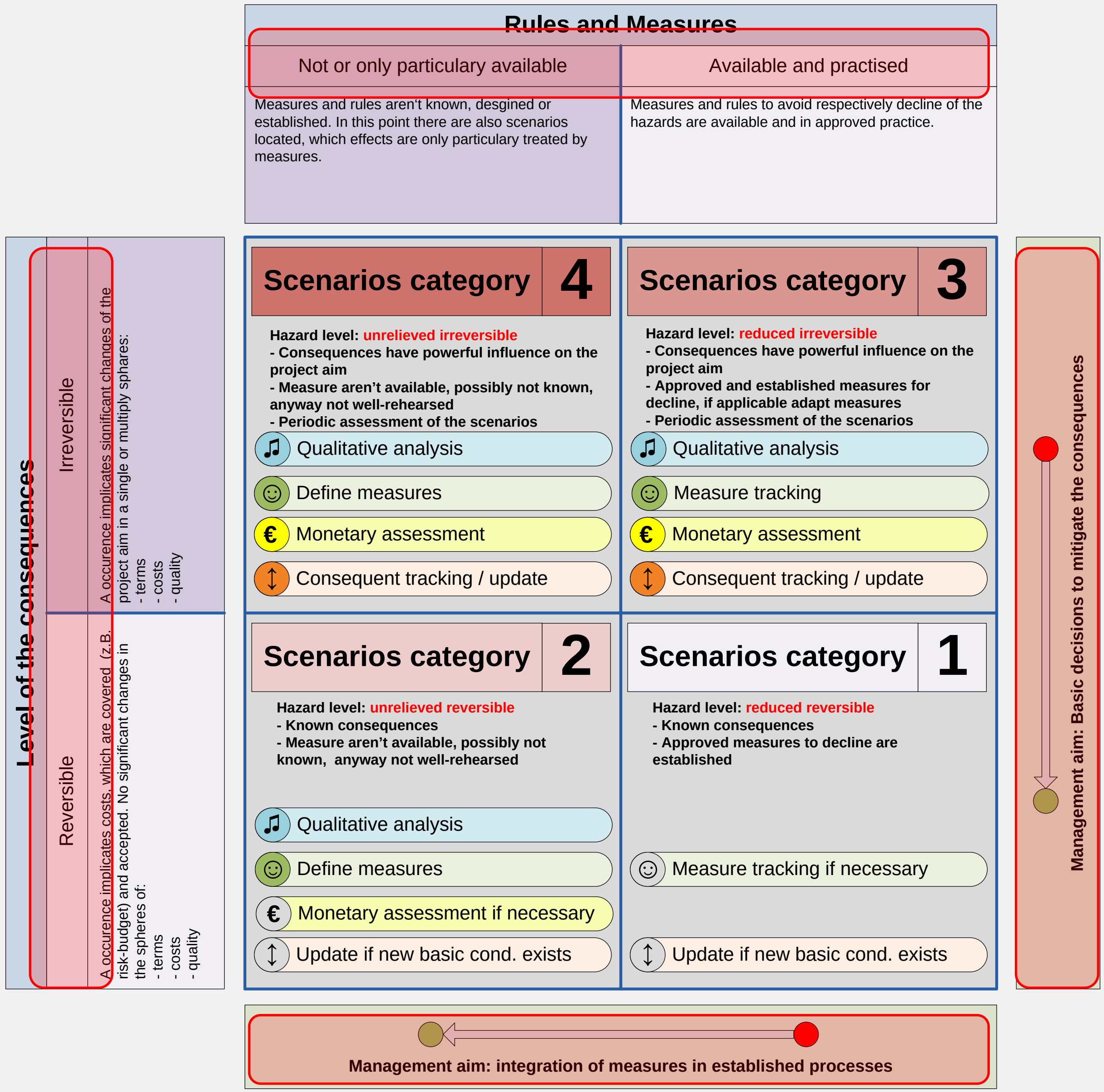
Preliminary Hazard Analysis (PHA)

Preliminary Hazard Analysis (PHA) is an established method (IEC/ISO 31010) that is particularly ideal for the **pre-classification of hazards at an early stage**.

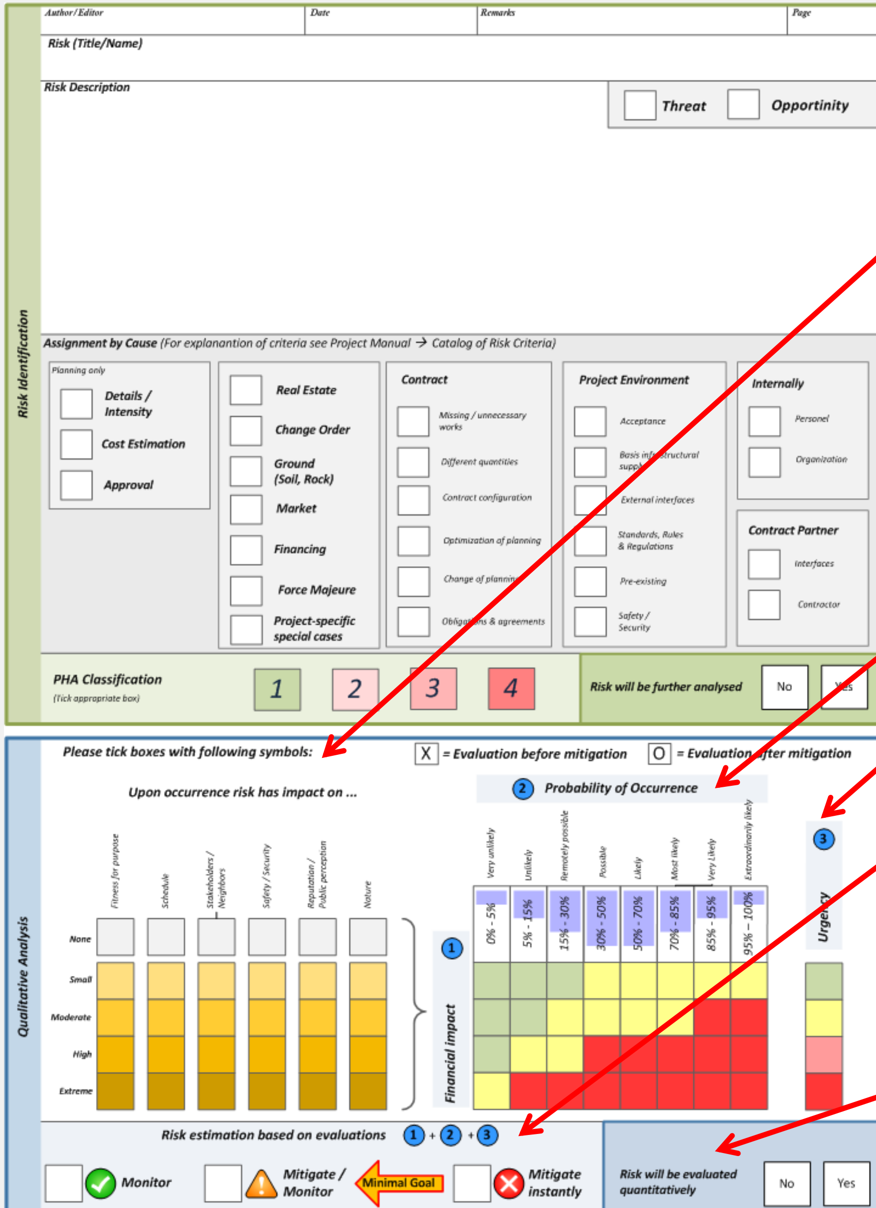
The aim is to differentiate **relevant** from **less relevant hazards**. Based on the results, specific resources and further analyzing methods can be applied to deal with the top hazards.

Goals:

- **Listing** of identified hazards
- Application of the PHA matrix
  → **Classification** of hazards
- **Decision which hazards are potential top risks** and therefore should be analyzed in more detail
- Documentation of results

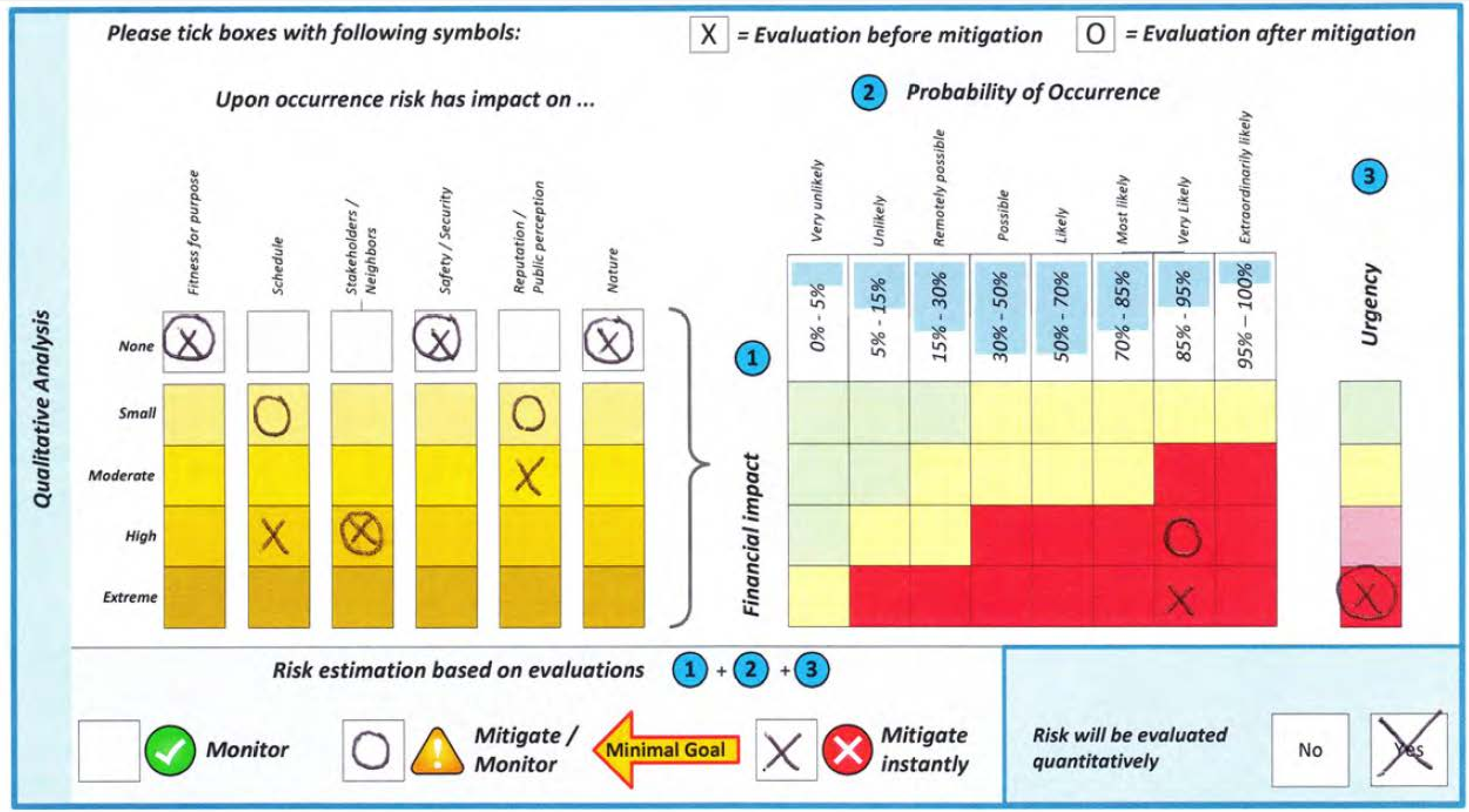


Risk Fact Sheet (RFS) – Qualitative Risk Analysis

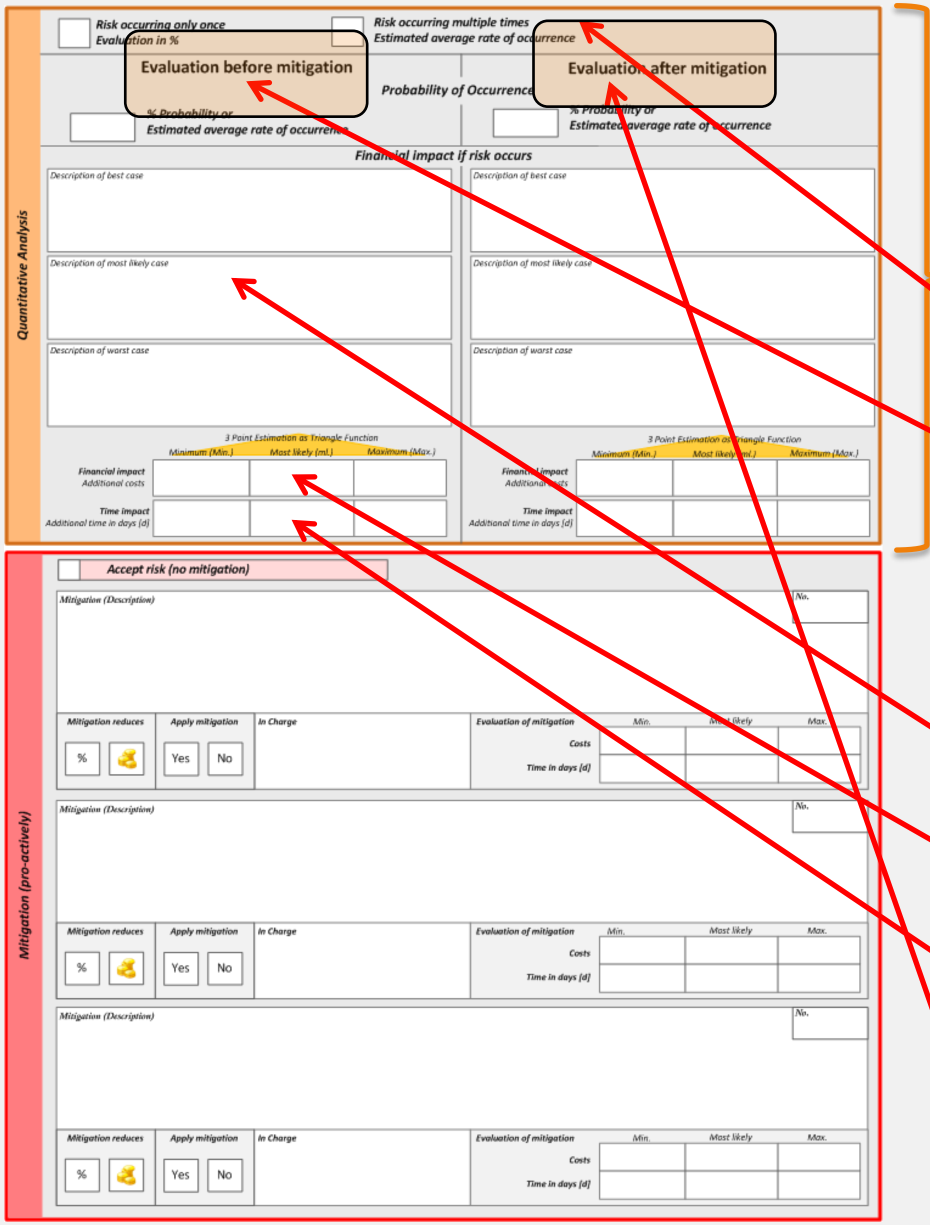


1. Evaluate **impact** of your risk on
   - Fitness for purpose
   - Schedule
   - Stakeholders /Neighbors
   - Safety / Security
   - Reputation / Public perception
   - Nature
2. Evaluate **probability of occurrence**
3. Evaluate **urgency** of your risk
4. Make a **decision**
   - **Monitor**, or
   - **Mitigate &** monitor, or
   - **Mitigate instantly**
5. Make a **decision**
   - Do you need **quantitative** analysis?

Our Example


Please tick boxes with following symbols:
X = Evaluation before mitigation
O = Evaluation after mitigation
Qualitative Analysis
Upon occurrence risk has impact on ...
Fitness for purpose
Schedule
Stakeholders / Neighbors
Safety / Security
Reputation / Public perception
Nature
None
Small
Moderate
High
Extreme
1
Financial impact
2 Probability of Occurrence
Very unlikely
Unlikely
Remotely possible
Possible
Likely
Most likely
Very Likely
Extraordinarily likely
0% - 5%
5% - 15%
15% - 30%
30% - 50%
50% - 70%
70% - 85%
85% - 95%
95% – 100%
3
Urgency
Risk estimation based on evaluations 1 + 2 + 3
Monitor
Mitigate / Monitor
Minimal Goal
Mitigate instantly
Risk will be evaluated quantitatively
No
Yes

Risk Fact Sheet (RFS) – Quantitative Risk Analysis



As you **made a decision**
to **evaluate your risk quantitatively**
[see bottom line of RFS's Front Page]
continue …

1. Do you expect your risk **only once** … **or multiple times**?
2. Evaluate your risk **before mitigation** [on left hand side] with a **Three-Point-Estimation** for
   - **Best** Case
   - **Most Likely** Case
   - **Worst** Case

   with short scenario descriptions and an estimation of
   => **Financial** impact
   and
   => **Time** impact
3. Repeat your risk evaluation **after mitigation** has been implemented [on right hand side] (= Residual Risk)

Our Example

Quantitative Analysis

[X] *Risk occurring only once — Evaluation in %*

[ ] *Risk occurring multiple times — Estimated average rate of occurrence*

Evaluation before mitigation	Evaluation after mitigation
Probability of Occurrence	
90 — *% Probability or Estimated average rate of occurrence*	90 — *% Probability or Estimated average rate of occurrence*

Financial impact if risk occurs

Evaluation before mitigation	Evaluation after mitigation
Description of best case - Decision-making - ca. 1 truck to Hazmat Site	*Description of best case* - ca. 1 truck to Hazmat Site - cheaper disposal price
Description of most likely case - Decision making - ca. 10 trucks to Hazmat Site	*Description of most likely case* - ca. 10 trucks to Hazmat Site - cheaper disposal price
Description of worst case - Decision-making - Entire excavation to Hazmat Site (ca. 50 trucks)	*Description of worst case* - ca. 50 trucks to Hazmat Site - cheaper disposal price

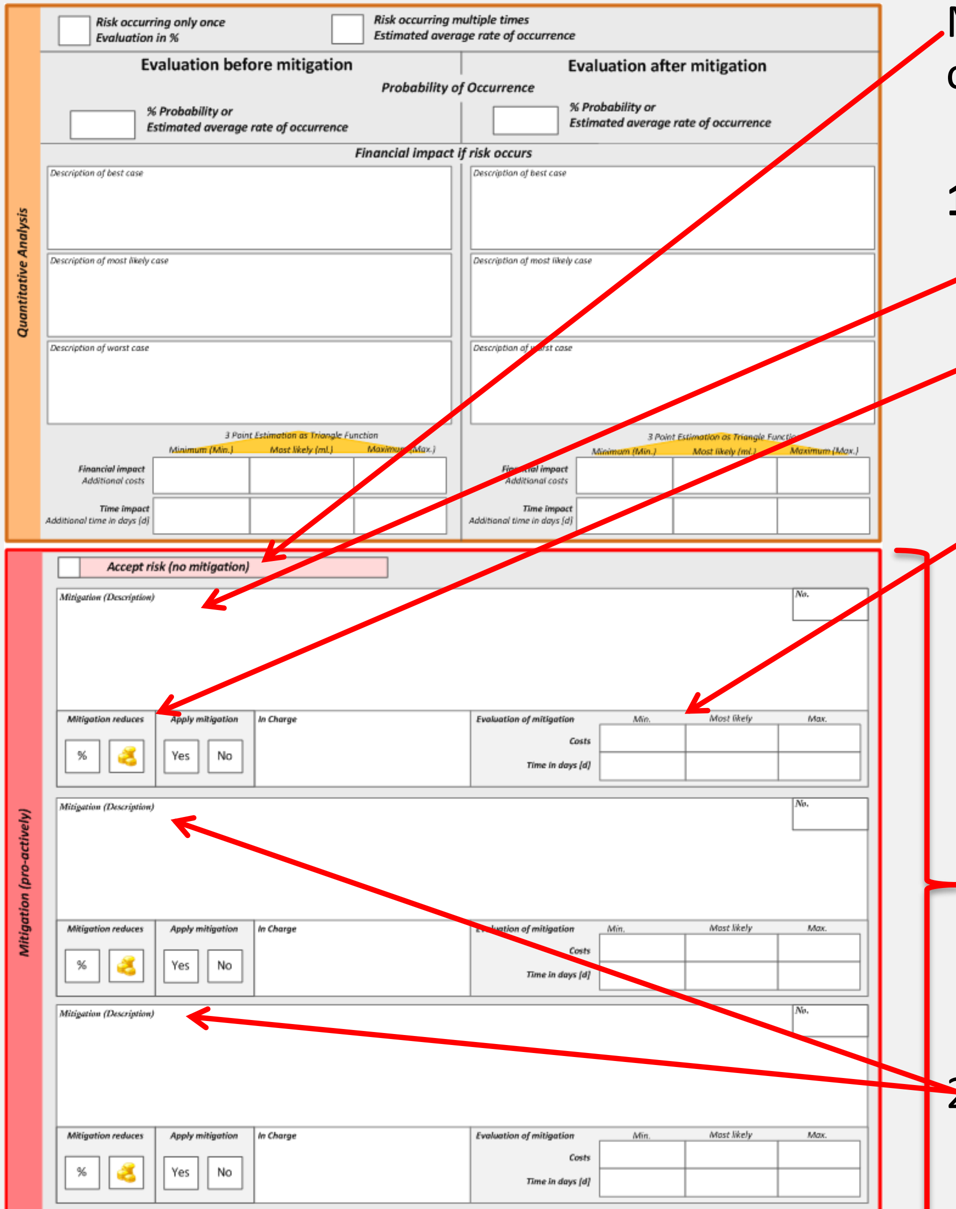
Before mitigation — *3 Point Estimation as Triangle Function*

	Minimum (Min.)	*Most likely (ml.)*	*Maximum (Max.)*
Financial impact *Additional costs*	10,000	100,000	500,000
Time impact *Additional time in days [d]*	3	5	20

After mitigation — *3 Point Estimation as Triangle Function*

	Minimum (Min.)	*Most likely (ml.)*	*Maximum (Max.)*
Financial impact *Additional costs*	8,000	80,000	400,000
Time impact *Additional time in days [d]*	3	5	9

Risk Fact Sheet (RFS) – Mitigation



Make a decision to **accept your risk** or continue to …

1. **Mitigate** your risk
   with a short **description** of your mitigation measure, and
   the **impact** it should produce on **probability of occurrence** and/or **costs**,
   and a
   Three-Point-Estimation
   - **Minimum**
   - **Most Likely**
   - **Maximum**

   for the
   Additional **Costs**
   and
   Additional **Time**
   due to/required for your mitigation measure.

2. Continue with your **mitigation planning** as required

Risk Fact Sheet (RFS) – Mitigation - Example

Our Example

Mitigation (pro-actively)

☐ *Accept risk (no mitigation)*

Mitigation (Description) — No. 1

Detailed site investigation to determine degree of contamination and expected quantity

Mitigation reduces	Apply mitigation	In Charge	Evaluation of mitigation	Min.	Most likely	Max.
% / [coins]	Yes (X) / No	AF	Costs	8,000	10,000	20,000
			Time in days [d]	3	5	9

Mitigation (Description) — No. 2

Immediately start to search for an adequate hazardous waste disposal site

Mitigation reduces	Apply mitigation	In Charge	Evaluation of mitigation	Min.	Most likely	Max.
% / [coins] (X)	Yes (X) / No	AM	Costs	3,000	5,000	8,000
			Time in days [d]	Ø	Ø	Ø

Mitigation (Description) — No.

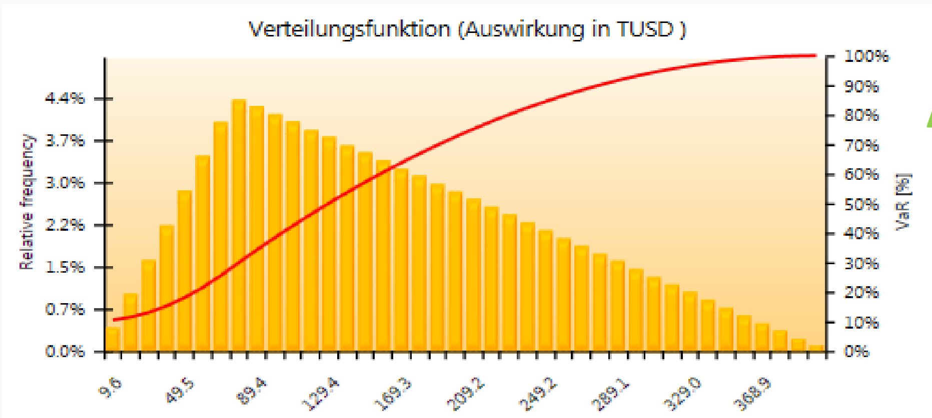
/

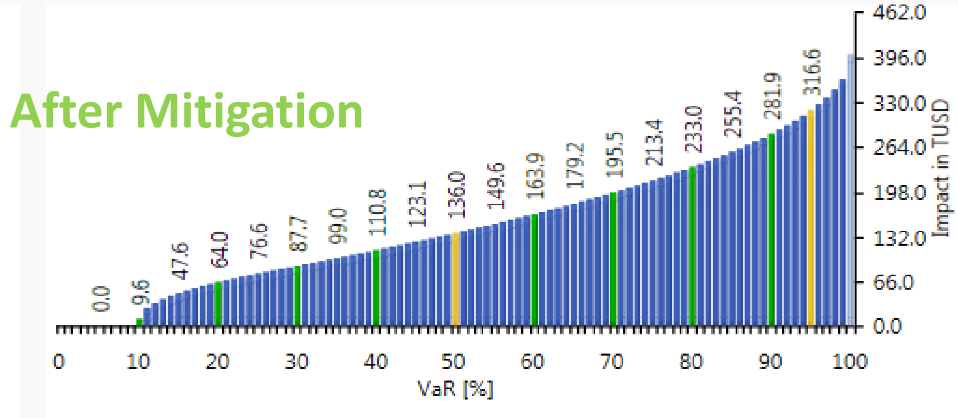
Mitigation reduces	Apply mitigation	In Charge	Evaluation of mitigation	Min.	Most likely	Max.
% / [coins]	Yes / No		Costs			
			Time in days [d]			

Our Example

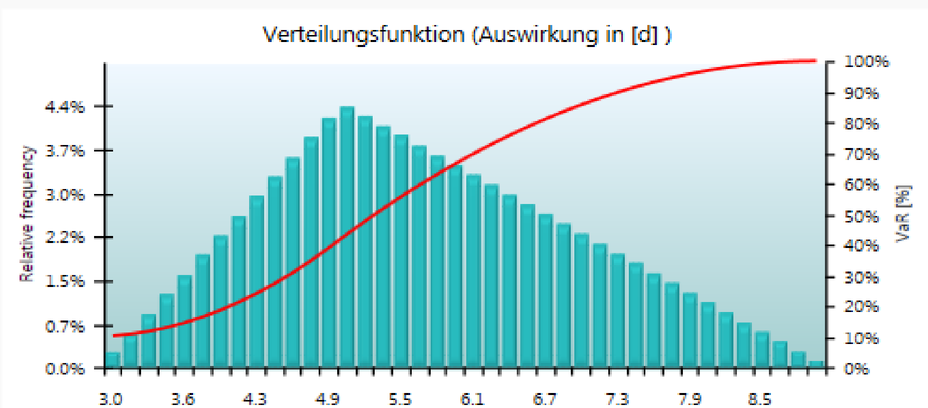
Risk before Mitigat	VaR5	$0.00	VaR50	$170,030.36	VaR95	$395,692.97	Det.	$90,000.00
Risk After Mitigatic	VaR5	$17,659.91	VaR50	$153,986.42	VaR95	$334,569.56	Det.	$87,000.00
Mitigated Risk	VaR5	$0.00	VaR50	$136,024.30	VaR95	$316,554.38	Det.	$72,000.00
Mitigation	VaR5	$13,943.00	VaR50	$17,650.86	VaR95	$23,097.06	Det.	$15,000.00

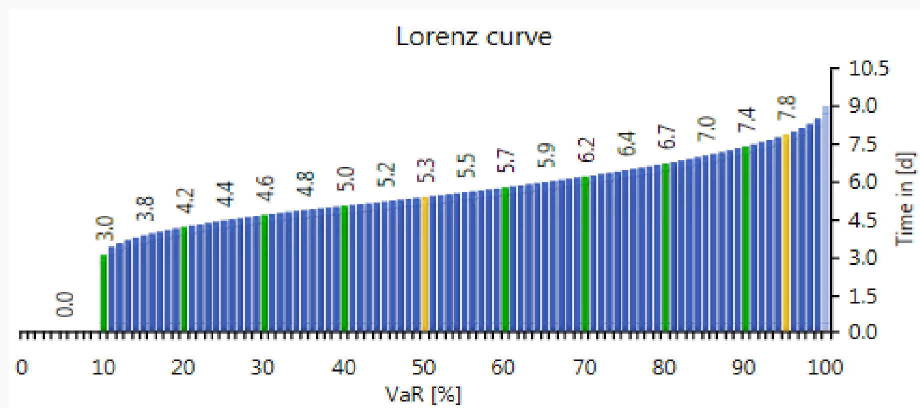
VaR5	$0.00	VaR50	$136,024.30	VaR95	$316,554.38	Det.	$72,000.00



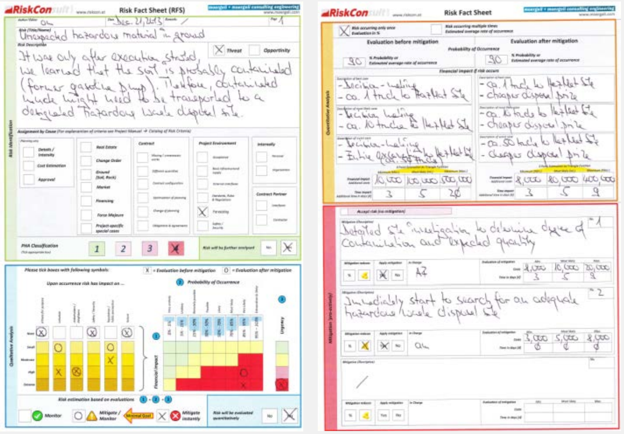


VaR5	0.00 d	VaR50	5.35 d	VaR95	7.85 d	Det.	4.50 d

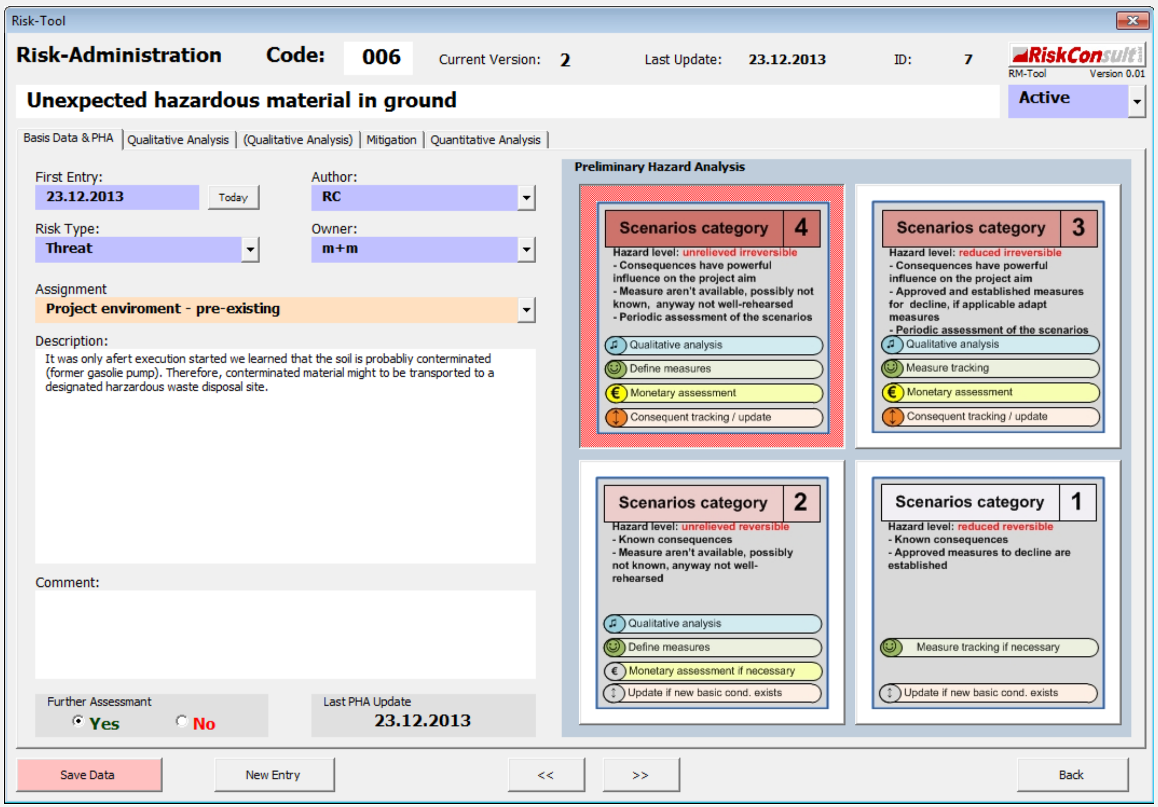




Use Adequate Tools to Manage Your Risks



Transfer results from Risk Fact Sheets into an administrating tool



Identify your threats

=> Rank your risks

=> Manage your risks

=> Realize your opportunities

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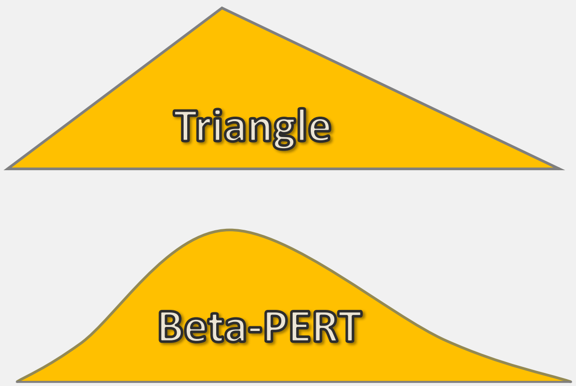
Risk Assessment:

1) Probability of occurrence (in %)

2) Financial consequences (e.g. in USD)

Reality can be modelled better by using distribution densities than by using single deterministic figures

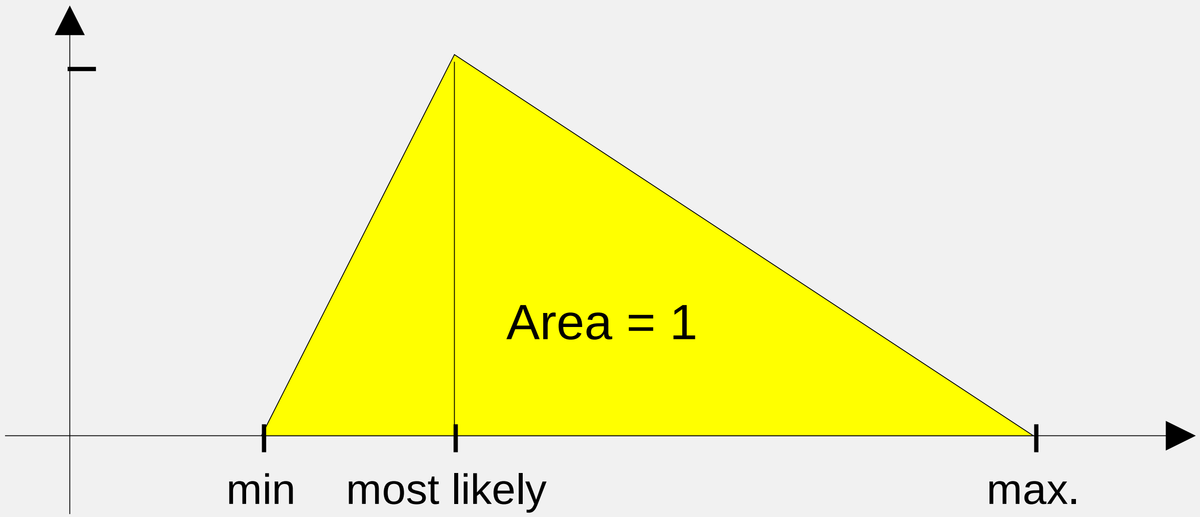


Deterministic method	Probabilistic method
Single figure	Values within a bandwidth Additional weighting

Most cases: no statistical background - better using “simple” function - subjective probability

Example Triangle Distribution

Example: The triangle function is easy to determine and offers flexibility in its shape.



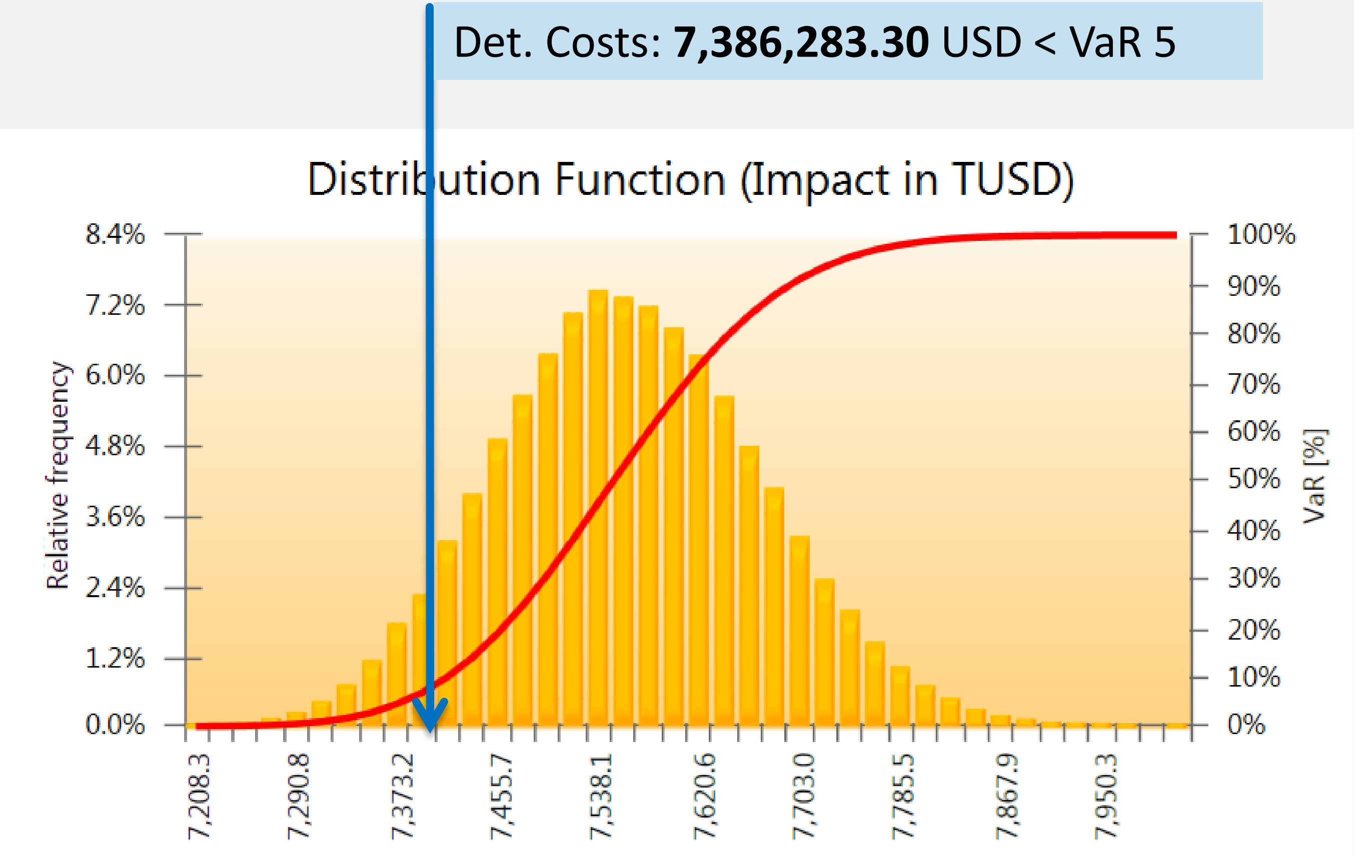
Advantages of triangle function:

- Three-Point Estimation (minimum, most likely, maximum)
- Exact definition of min. and max.
- Requires no additional and complex input parameters (e.g. standard deviation)
- Easy handling of asymmetric shapes

Effect of Right-Skewed Distributions in Cost Estimations

Description	Quantity					Unit Price				Item Price
	Dist.	Min	ML	Max	Unit	Dist.	Min	ML	Max	USD
Concrete works										**7,386,283.30**
Concrete Tower Floor	Triangle	210.700	**215.000**	221.450	m^3	Triangle	101.85	**105.00**	115.50	**22,575.00**
Reinforcement Tower Floor	Triangle	51,049.200	**53,736.000**	59,109.600	kg	Triangle	1.04	**1.15**	1.32	**61,796.40**
Concrete Newsroom	Triangle	78.400	**80.000**	84.000	m^3	Triangle	94.50	**105.00**	115.50	**8,400.00**
Reinforcement Newsroom	Triangle	19,150.100	**20,158.000**	22,173.800	kg	Triangle	1.04	**1.15**	1.23	**23,181.70**
Concrete Basement	Triangle	77.126	**78.700**	82.635	m^3	Triangle	101.85	**105.00**	115.50	**8,263.50**
Reinforcement Basement	Triangle	18,696.950	**19,681.000**	21,649.100	kg	Triangle	1.12	**1.15**	1.26	**22,633.15**
Concrete Walls	Triangle	5,355.700	**5,465.000**	5,738.250	m^3	Triangle	346.70	**361.15**	390.04	**1,973,684.75**
Reinforcement Walls	Triangle	519,206.350	**546,533.000**	601,186.300	kg	Triangle	1.10	**1.15**	1.23	**628,512.95**
Concrete Slabs	Triangle	9,122.820	**9,309.000**	9,774.450	m^3	Triangle	220.80	**230.00**	248.40	**2,141,070.00**
Reinforcement Slabs	Triangle	1,072,502.500	**1,128,950.000**	1,241,845.000	kg	Triangle	1.10	**1.15**	1.23	**1,298,292.50**
Concrete Base Slab	Triangle	3,608.360	**3,682.000**	3,866.100	m^3	Triangle	220.80	**230.00**	248.40	**846,860.00**
Reinforcement Base Slab	Triangle	289,967.550	**305,229.000**	335,751.900	kg	Triangle	1.10	**1.15**	1.23	**351,013.35**

Deterministic Value falls below VaR 5



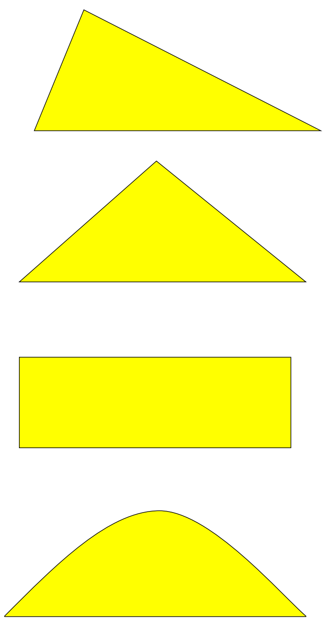
Cost in USD

det.	7,386,283.30	
VaR5	7,393,916	100.1 %
VaR10	7,429,348	100.6 %
VaR20	7,473,807	101.2 %
VaR30	7,507,054	101.6 %
VaR40	7,535,144	102.0 %
VaR50	7,562,386	102.4 %
VaR60	7,590,037	102.8 %
VaR70	7,619,675	103.2 %
VaR80	7,655,080	103.6 %
VaR90	7,703,938	104.3 %
VaR95	7,745,234	104.9 %

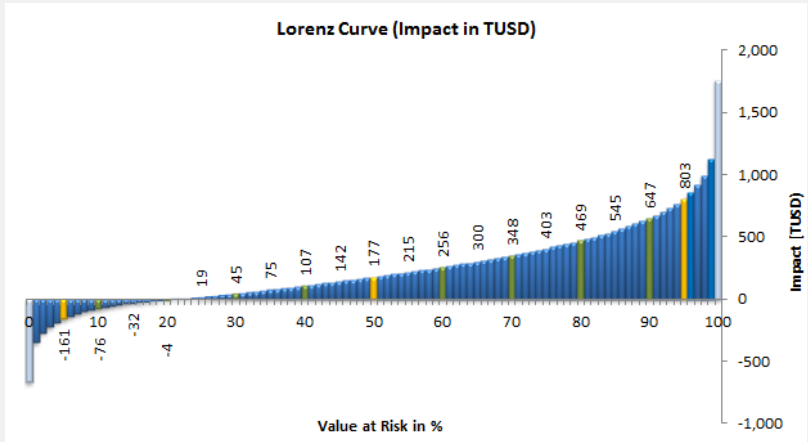
Aggregation of distributions density through simulation

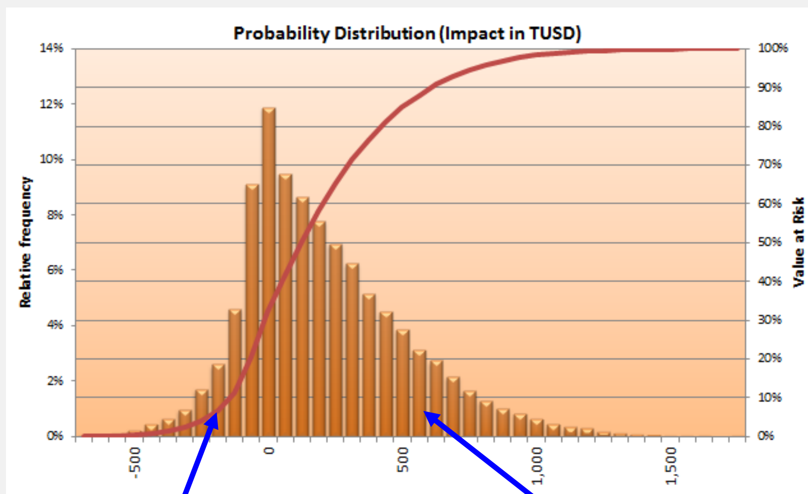
Monte Carlo Simulation or Latin Hypercube Sampling

Input:
Probability Distributions



... other distributions





Distribution Function

Distribution Density

Result:

Probability distribution which displays the overall risk potential

Software is necessary!

Evaluated risk form Risk Fact Sheet

Aggregate to overall risk potential

Probabilistic Risk Analysis

Briefly describe your risk scenarios or cost items. In this trial version a maximum of 12 items can be aggregated.

Probability of occurrence is defined as how likely a risk scenario is predicted to occur.

The deterministic analysis provides a single value for the financial impact in case of risk occurrence. Probabilistic analysis uses a three-point estimation (max., expected, min.) to model a distribution. Three-point estimations allow for differentiation between hazards and opportunities. A negative sign is added to flag opportunities.

The distribution is modeled with a three-point estimation.

Mandatory field for probabilistic method.

The deterministic expected value is calculated as the simple product of probability of occurrence and deterministic value (i.e. expected value).

Nr.	Risk scenario (hazard or opportunity) or cost item	Probability of occurrence [%]	Minimum [$]	Determ. value Most likely [$]	Maximum [$]	Distribution	Deterministic expected value [$]
01	Increased or reduced quantities of concrete, general contractor	**100%**	-100.000	**50.000**	300.000	Triangle	**50.000**
02	Penalty	**10%**	50.000	**75.000**	500.000	Beta	**7.500**
03	Opportunity: standardization of ceiling formwork (concrete ceilings)	**25%**	-45.000	**-35.000**	-25.000	Triangle	**-8.750**
04	Weather-related construction delays (time-dependent costs)	**5%**	50.000	**80.000**	200.000	Triangle	**4.000**
05	Hazard x	**50%**	100.000	**175.000**	475.000	Triangle	**87.500**
06	Hazard y	**3%**	600.000	**800.000**	1.000.000	Triangle	**24.000**
07							**0**

Qualitative Risk Analysis – Probabilistic Approach – Example in MS Excel VBA

The deterministic result is a simple sum of the expected values.

Deterministic calculation

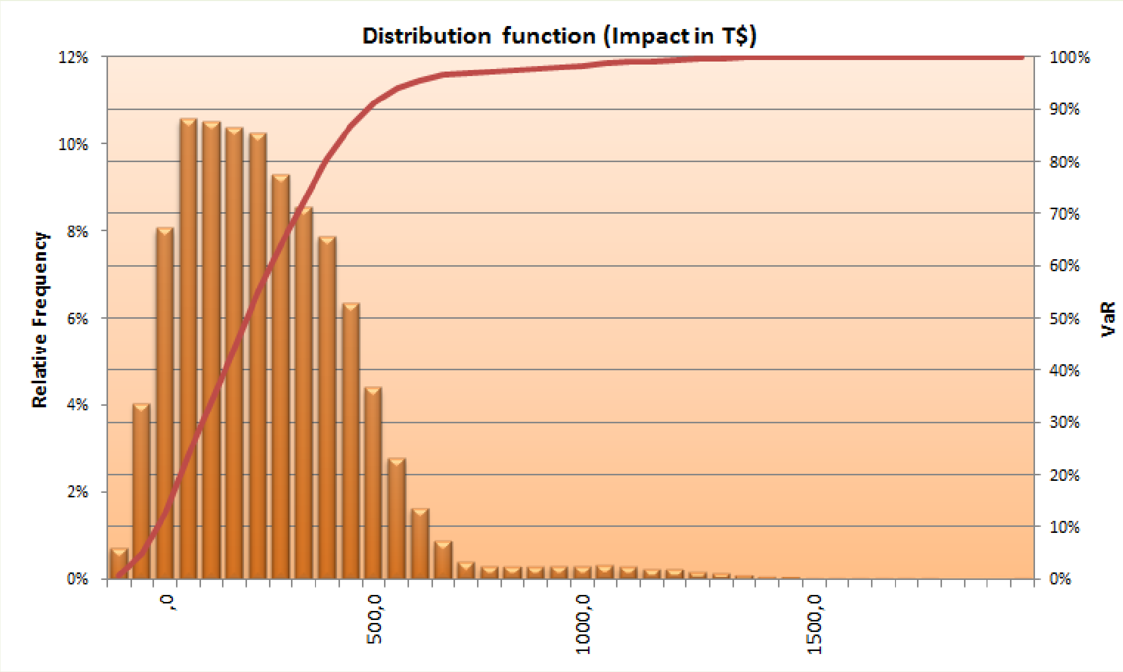
$ 164.250

Probabilistic risk analysis is a quantitative analysis method. The result it provides also illustrates the risk potential expressed in monetary units. The advantage over standard deterministic methods is that it clearly delivers more information because the result is a distribution with a bandwidth for the risk potential (incl. best case and worst case). The distribution function (red line) shows the Value at Risk (VaR) expressed in monetary units. The result derived from the deterministic calculation generally deviates from VaR50.
The probabilistic method uses simulations (Monte Carlo simulations) to compute its results. For every simulation a number of runs (maximum of 100,000) must be determined. The higher the number of runs, the more precise the results are.

Probabilistic calculation

Runs 100.000 Discrete (x)

Compute VaR

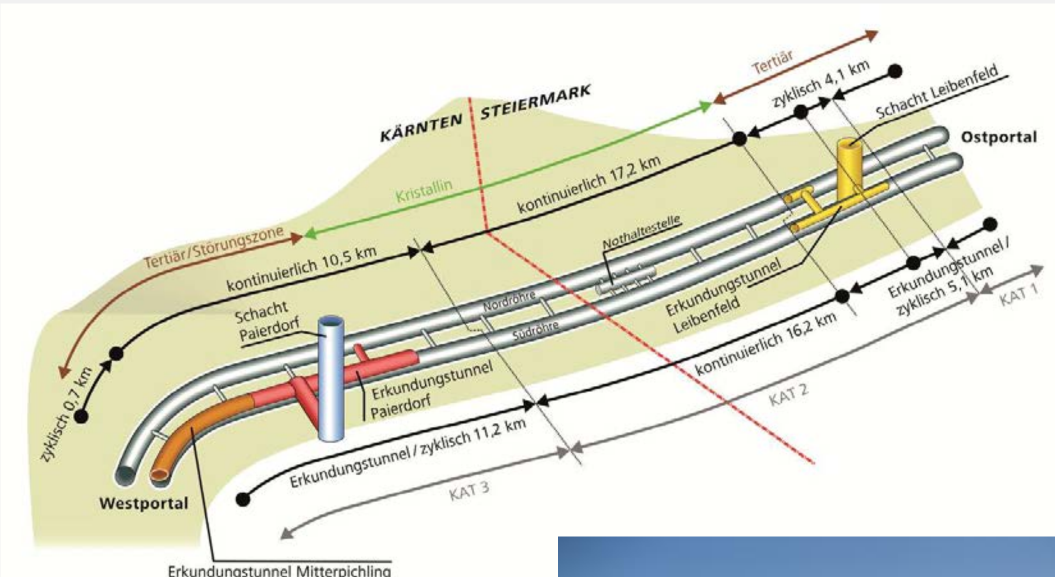


VaR0	-132.547
VaR10	9.616
VaR20	61.785
VaR30	112.229
VaR40	162.851
VaR50	214.113
VaR60	267.917
VaR70	328.252
VaR80	394.137
VaR90	487.850
VaR100	1.983.716

Contents

Koralm Base Tunnel (Southern Austria)

With a total length of 32.8 km and a maximum cover of 1.250 m the base tunnel will traverse the Koralpe mountain range. The tunnel system is designed with two single-track tubes (approx. 82 m² per tube) and cross drifts at intervals of 500 m. Excavation for the Koralm tunnel is executed by two double shield TBM's for long distances.



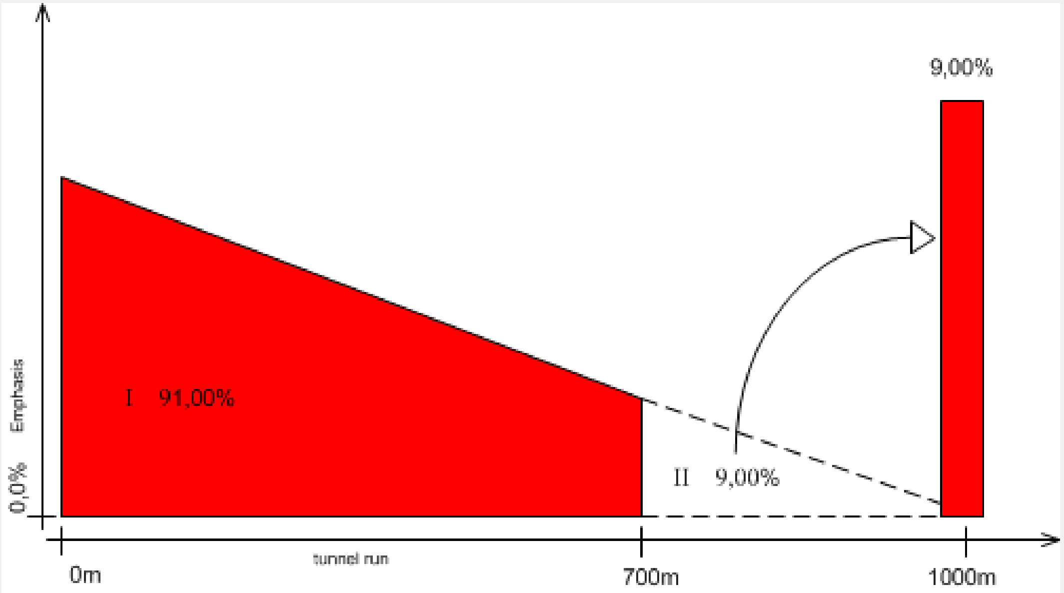
Example 1: Customized Distribution Function – The Scenario

Scenario:

A tunnel with 1,000 m of TBM excavation is designed without a final lining as a result of expected favorable geological conditions.

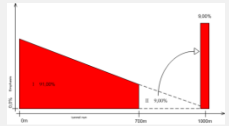
However, a final lining may become necessary in some sections if geological conditions turn out to be less favorable.

If it will be necessary to excavate 700 m or more with a final lining, final lining will be implemented for the full length of 1,000 m.

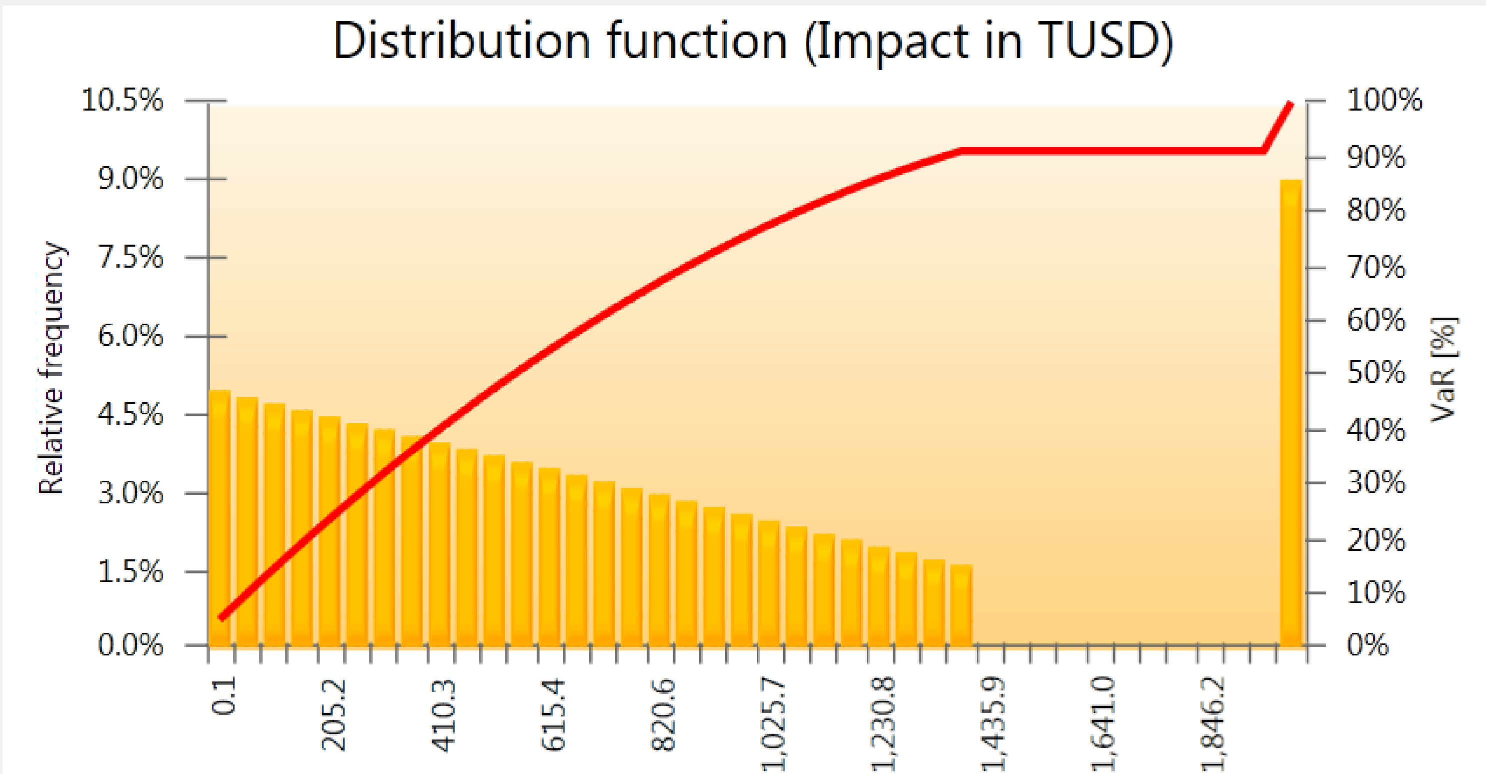


Example 1: Individual Distribution Function – Estimation and Result

The **quantity** is modeled by the individual distribution.



The **financial impact** is modeled by a deterministic value: 2,000 USD

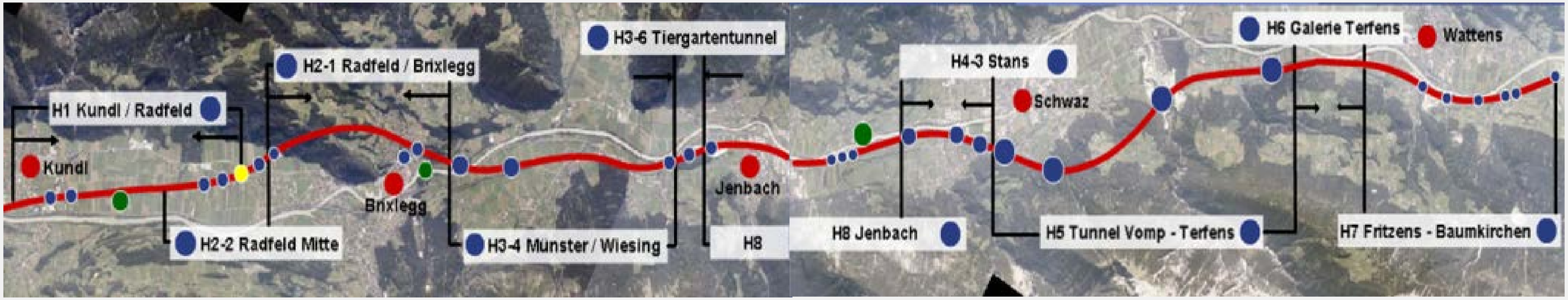


Lower Inn Valley Railway Corridor (Tyrol/Austria)

The project includes the construction section 1 (Kundl-Baumkirchen) of the Lower Inn Valley Railway Corridor.

It is part of the Brenner Base Tunnel scheme.

The railway track has an approximate length of 40 km. 32 km are underground.



Scenario:

Cyclic excavation in a rock zone comes with the danger of cave-ins.

Probability of Occurrence:

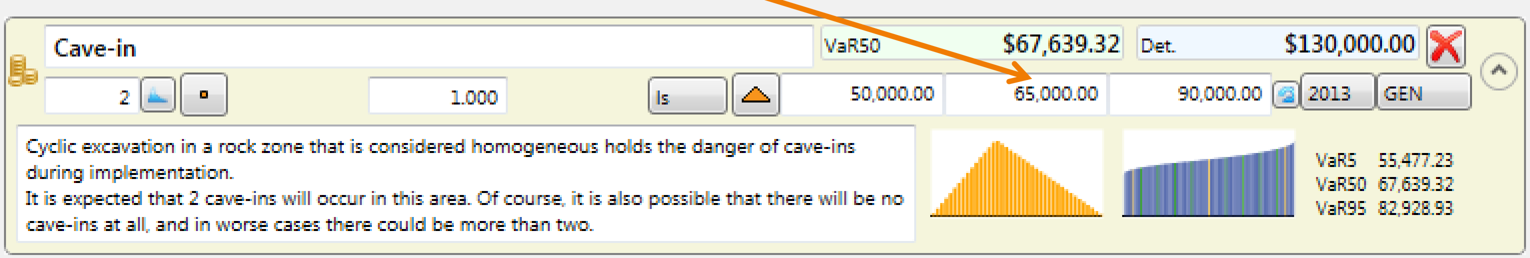
It is expected that 2 cave-ins will occur in this section.

Of course, it is also possible that there will be no cave-ins at all, and in worst cases there could be more than two.

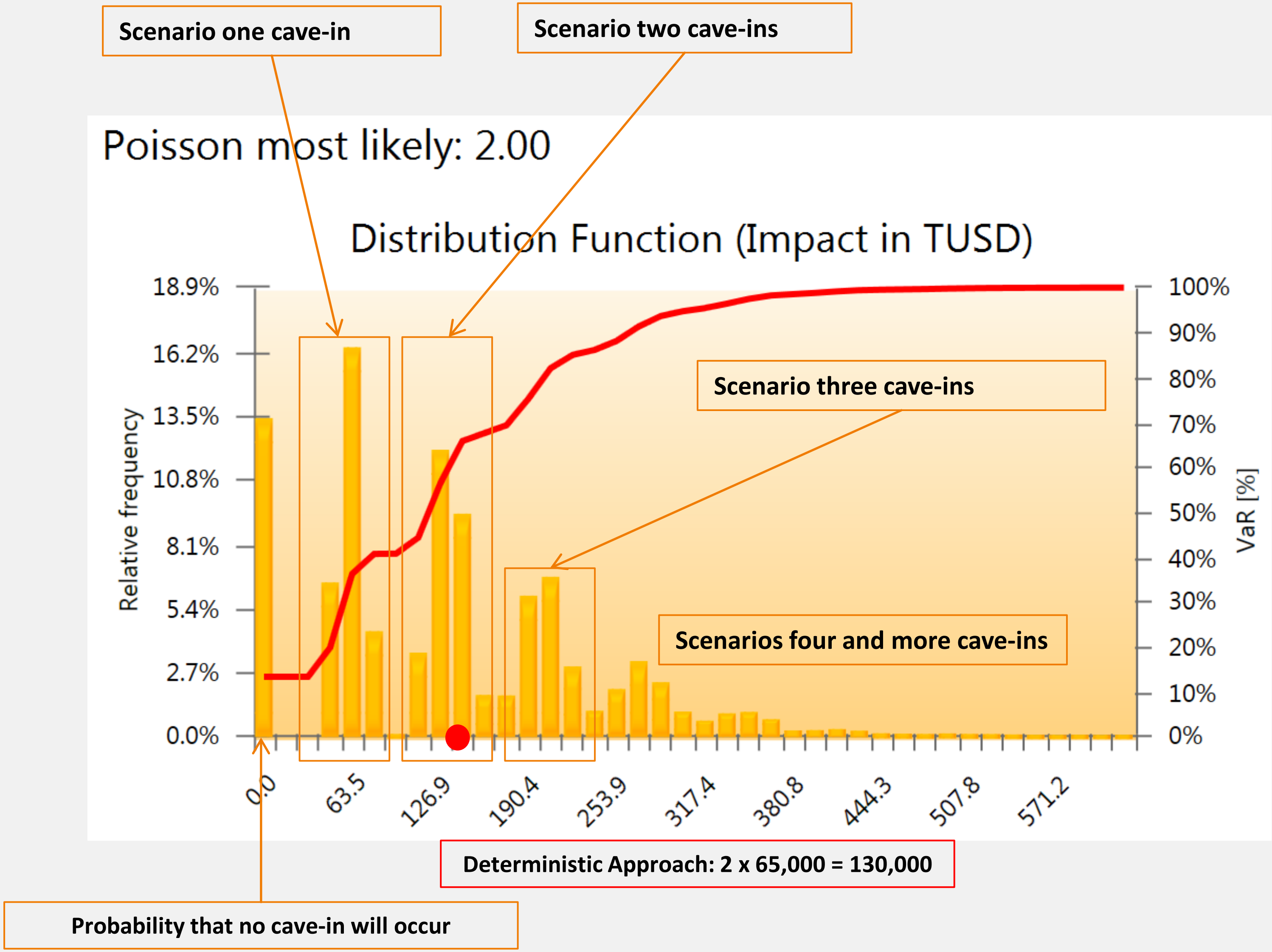
Financial Impact:

The financial impact is modeled as a triangular function with the parameters:

Min: 50,000 ML: 65,000 Max: 90,000



Example 2: Risks occurring multiple times – The Result



Hydro Electric Power Plant Spullersee (Vorarlberg /Austria)

Planned in 3 scenarios

2 surface scenarios

1 subsurface scenario

For comparison consider basic costs and risks for each scenario.

→ Ground risks
subsurface scenario

→ Production outage
surface scenario

Example 3: Event Tree Analysis – Scenario Description

Scenario:
Access road to the construction site of the reservoir

Probability of 40% that the access road will not be permitted (nature reserve)

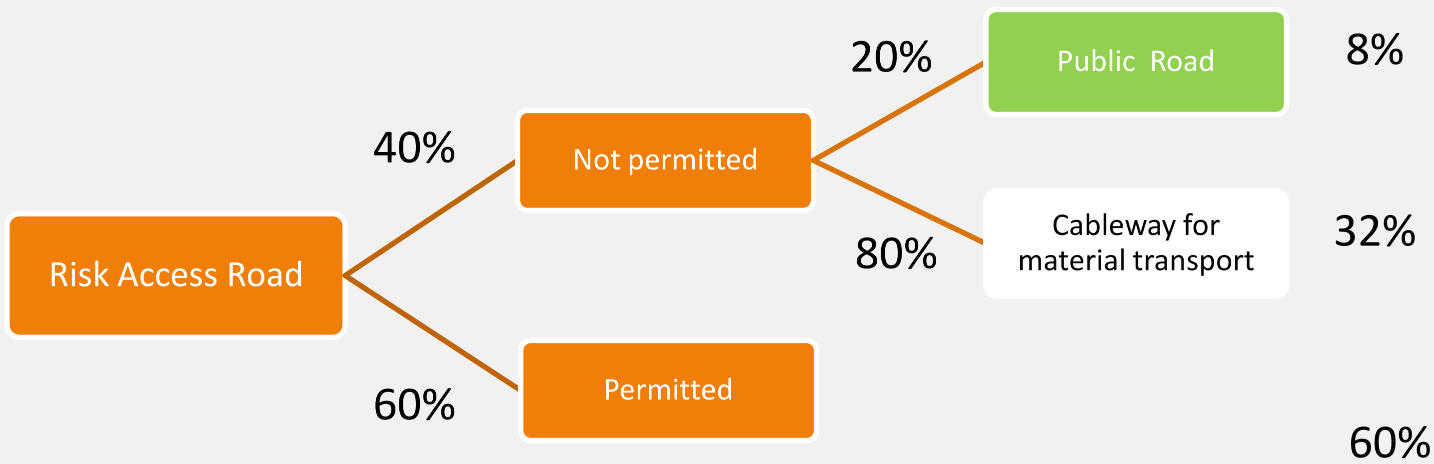
→ In this case (risk does occur) there will be 2 alternatives:

1. Extension of the existing public road to the reservoir.
   Estimated probability for permission only 20%

2. No permission for the public road => new cableway for material transport
   Most expensive scenario (80%)

The whole scenario can be modeled by an event tree.

Example 3: Event Tree Analysis – The Model



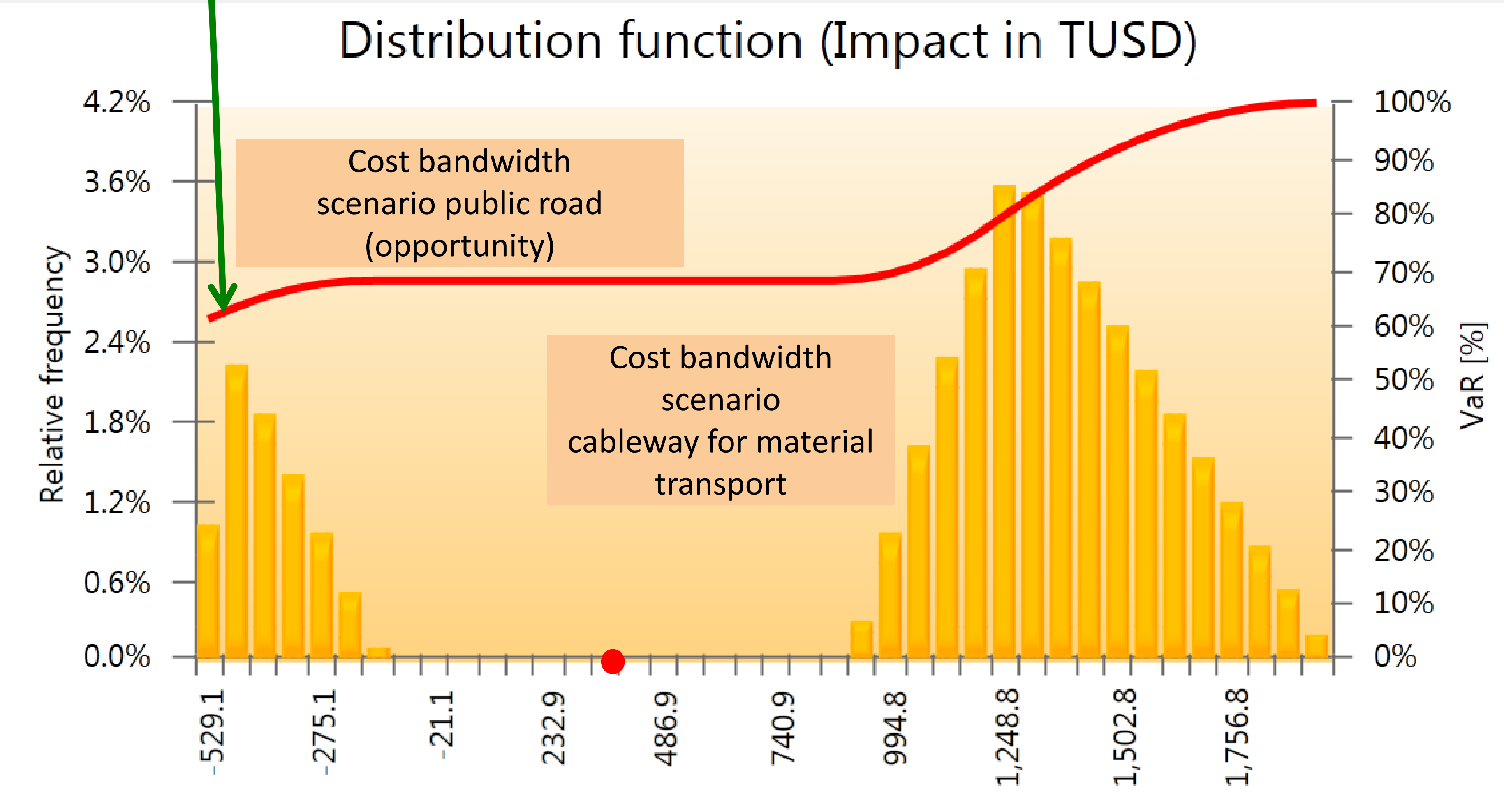
Costs for the access road are estimated to be 1,000,000.
If there will be no permission, the costs for the access road are saved in a first step.

		Min	Triangle Most likely	Max
Omitted access road	8%	-1,000,000	-1,000,000	-1,000,000
Extension of public road		467,500	550,000	880,000

Omitted access road	32%	-1,000,000	-1,000,000	-1,000,000
Cableway for material transport		1,912,500	2,250,000	2,925,000

Example 3: Event Tree Analysis – The Result

After simulation the result is a probability distribution that displays the overall risk potential.
There is a probability of 60% that the risk will not occur (see red distribution function).

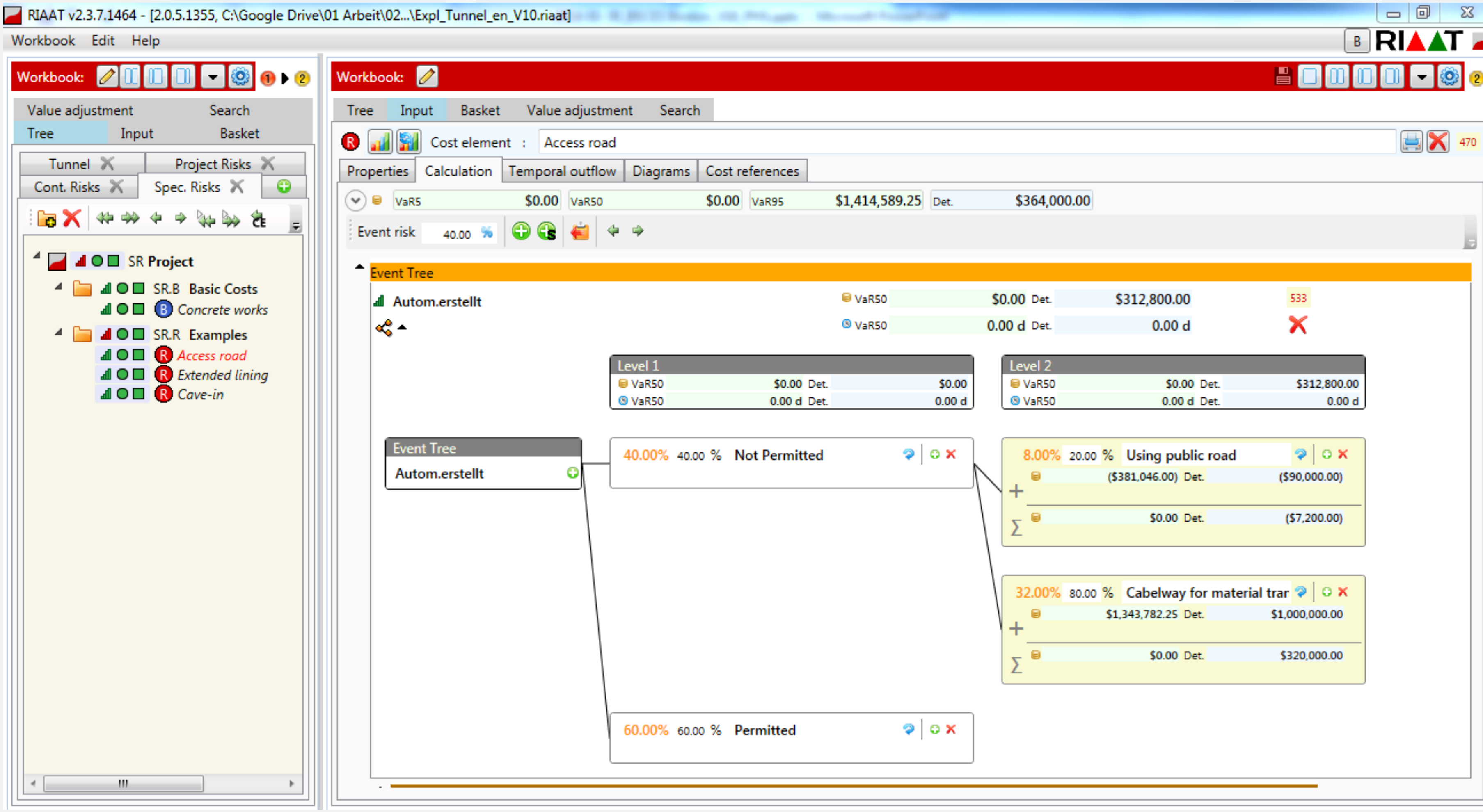


Deterministic Approach:

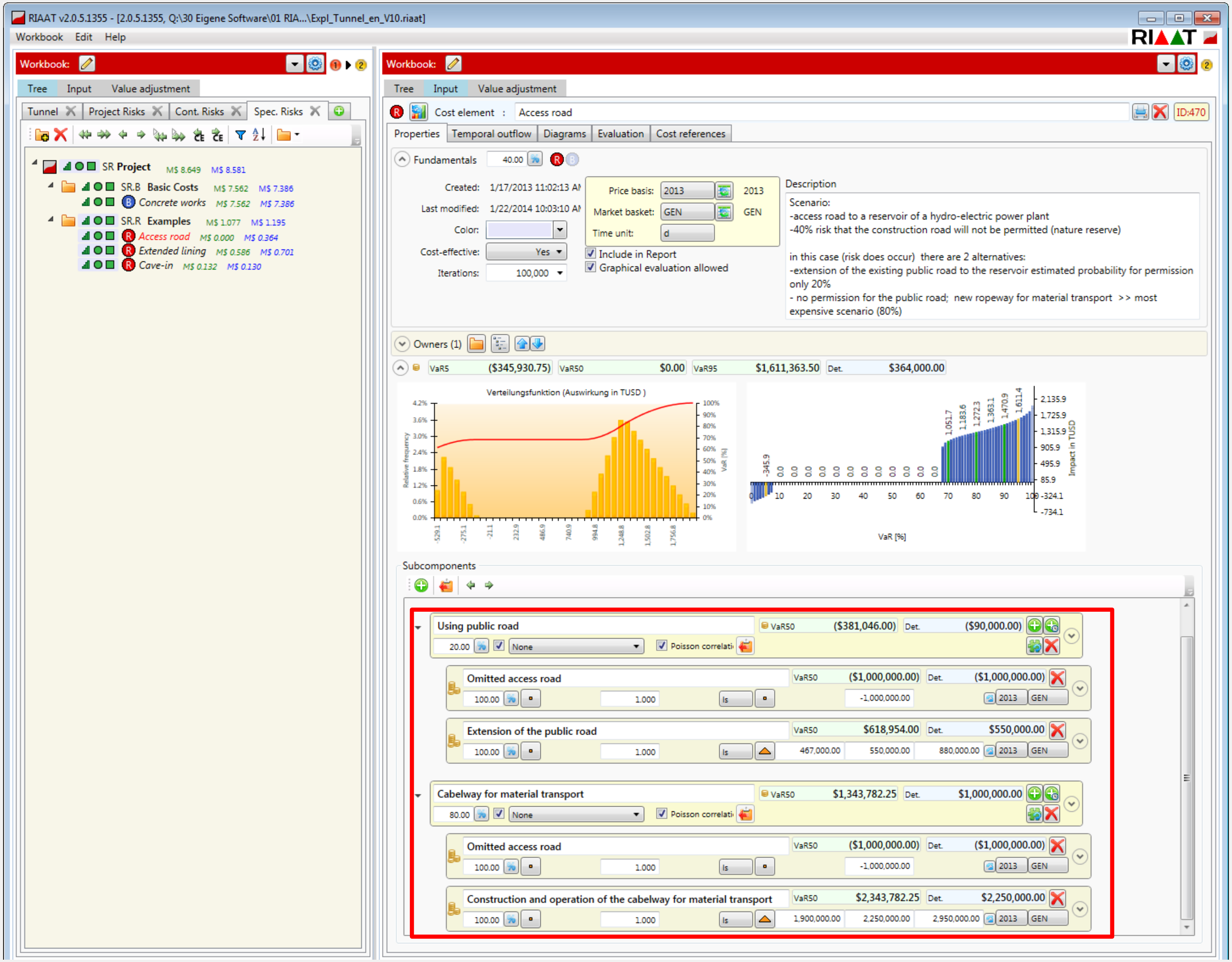
8% x (-1,000,000 + 550,000) + 32% x (-1,000,000 + 2,250,000) + 60% x 0
= -36,000 + 400,000 + 0

364,000 will not occur in reality

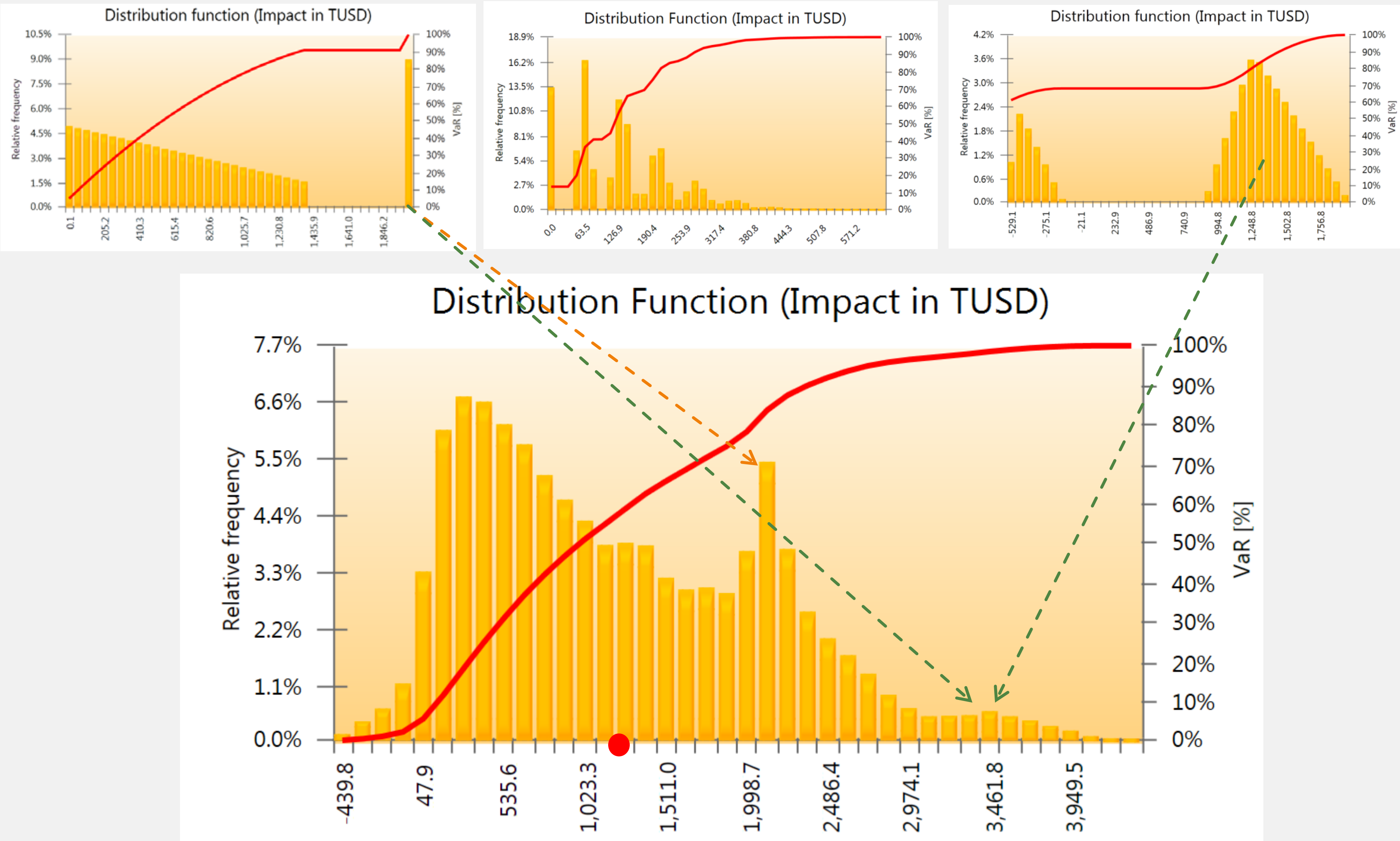
Example 3: Event Tree Analysis – Model in Graphical User Interface (GUI)



Example 3: Event Tree Analysis – The Result in Graphical User Interface (GUI)



Example 4: Aggregation - Specific Overall Risk Potential



We can't consider the real risk potential using a simple deterministic figure.

Contents

Summary

1. **Understand the Basics**

2. **Structure your project**
   - Distinguish between basic costs and risks
   - Consider uncertainty

3. **Establish a Risk Management Process**

4. **Actively moderate the Risk Management Process**
   - Do not let users go on their own

5. **Identify and analyze all your relevant & significant risks**
   - Define methods
   - Use adequate tools
   - Use a probabilistic approach

6. **Manage, monitor & control your risks pro-actively**

7. **Continually learn from current projects & Best Practice**

8. Keep in mind, RM is sound project management
   => **To let you live (and rest well) with your Residual Risks**

Thank you …

… Boston Society of Civil Engineers Section (BSCES)

… Simpson Gumpertz & Heger

… You all

Please feel free to download our presentation
from our websites (after February 4, 2014 – thank you)

Risk Management –
How Do You Control Your Risks in Practice?

Your Questions …?

Please feel free to contact us any time

if you have specific questions.

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