RIAAT - A Software Tool for Probabilistic Cost and Risk Analysis

RIAAT
Risk Administration and Analysis Tool

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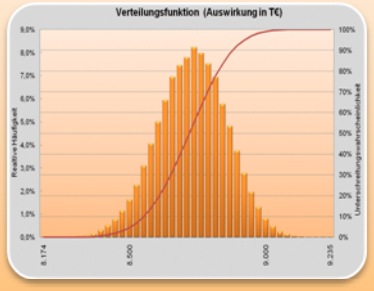
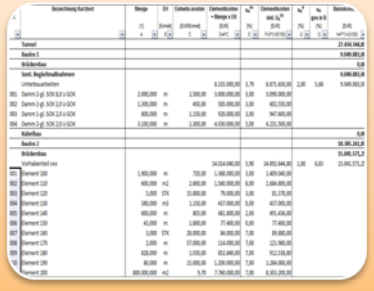
Overview

1. Introduction
2. Modeling uncertainty
3. Structuring the Risk-Management-Process
   ➔ software supported
4. Example (risk scenario)
5. Summary



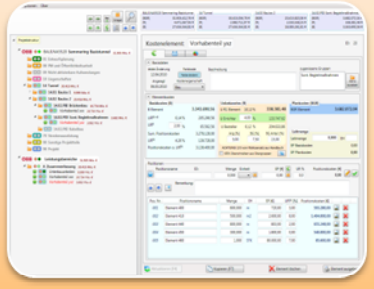
Risk Management

- Risk analysis → probabilistic
- Process moderation
- Workshops



Cost Management

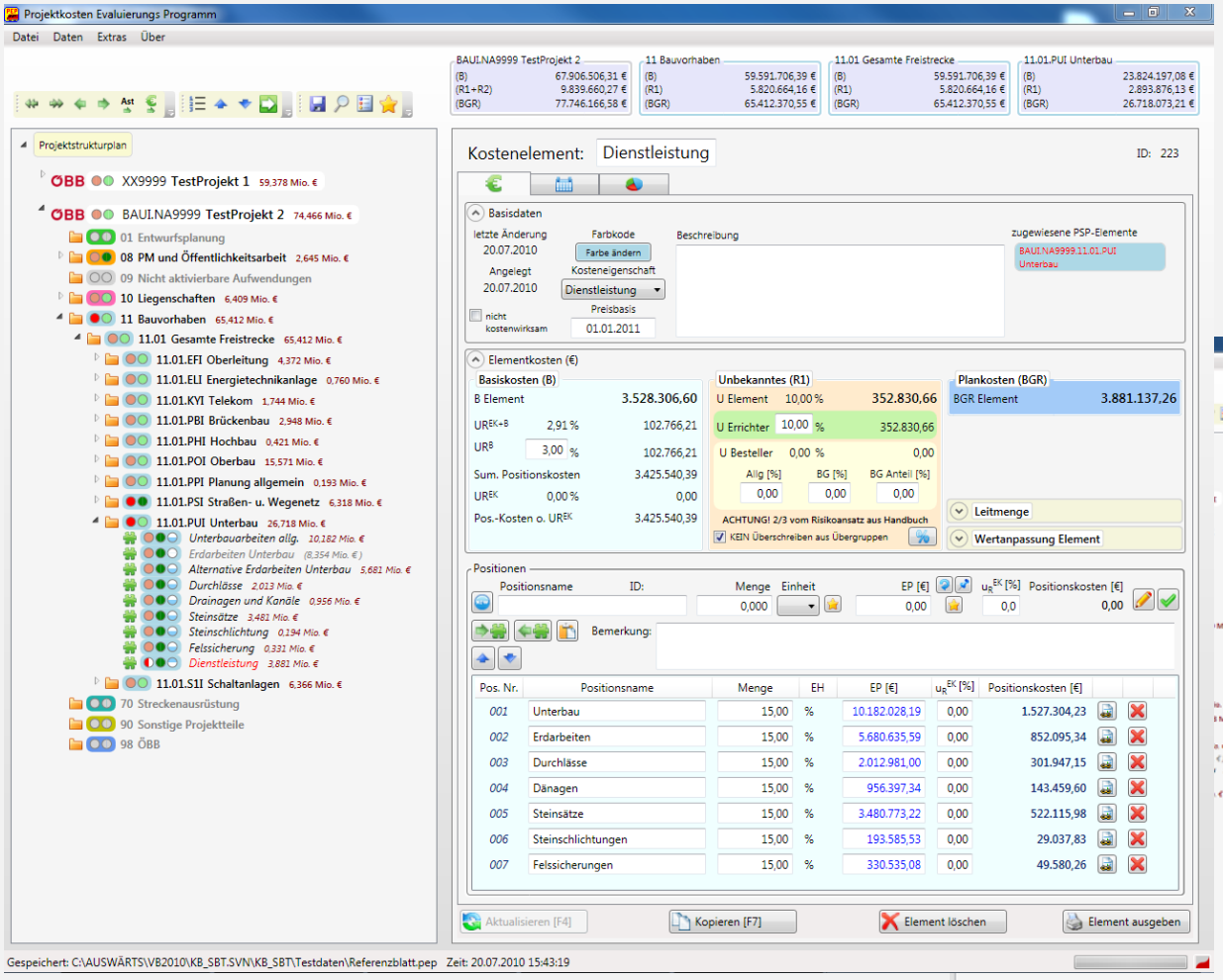
- Verification of planning costs
- Cost controlling
- Cost estimation (also probabilistic)
- Investigations of variants



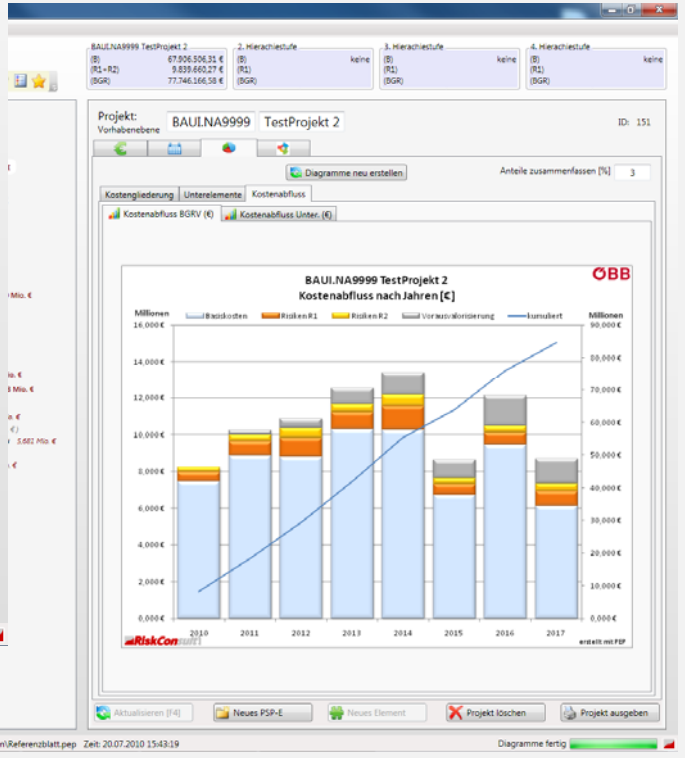
Software Development

- Individual solutions for major projects
- Controlling tools
- Implementing guidelines

PEP
Project Cost Estimation Program



- **Program for cost estimation**
- **Used by Austrian Federal Railways (ÖBB)**
- **Applied:**
  Semmering base tunnel (27km long tunnel)
  Summerauerbahn (Linz – Czech border)



1. Introduction

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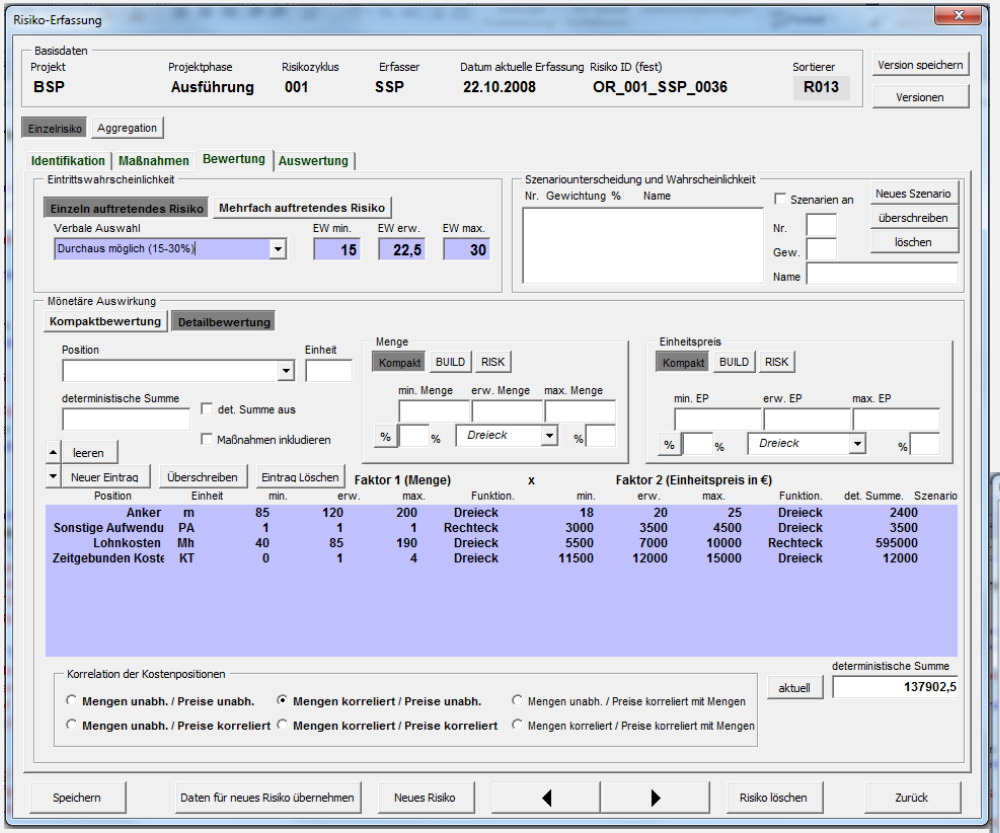
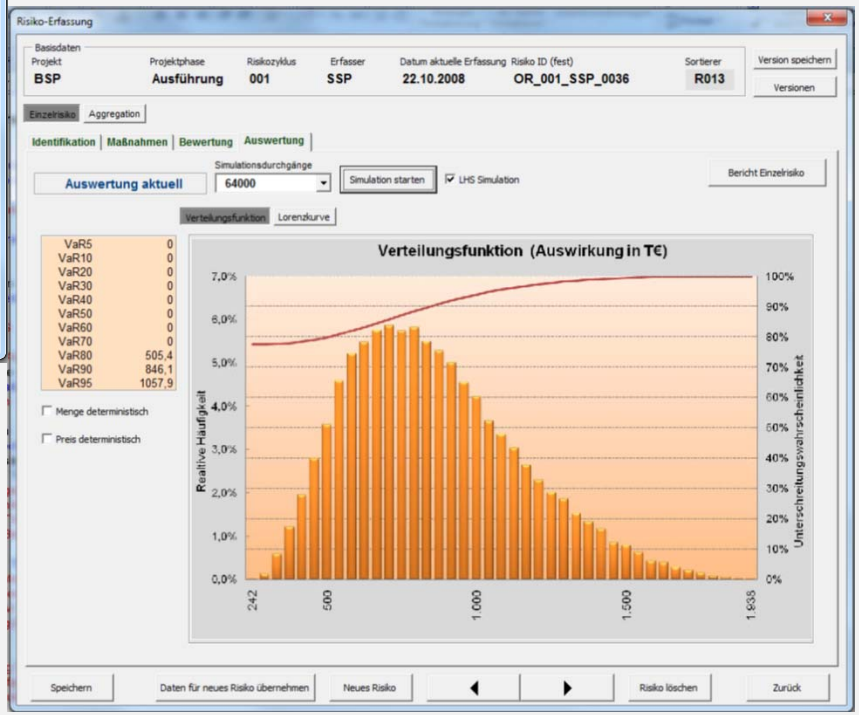
- **Program for probabilistic cost and RA**
- **Applied:**
  - **Koralm base tunnel – RA cost estimation stage (32km long tunnel)**
  - **Hydro-electric power plants**
    - Spullersee
    - Tauernmoos
  - **New rail corridor lower Inn valley (TEN 1) RA – construction stage**
  - **other projects**





Risk assessment:

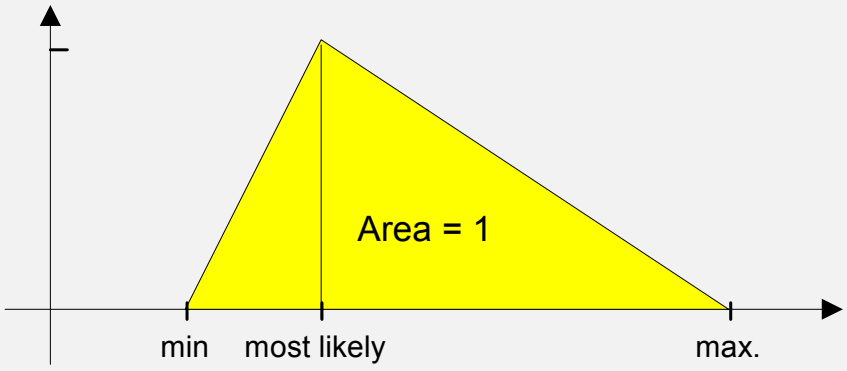
- **Probability of occurrence (in %)**
- **Financial consequences (e.g. in €)**

➔ **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: The triangle function is easy to determine and offers flexibility in its shape

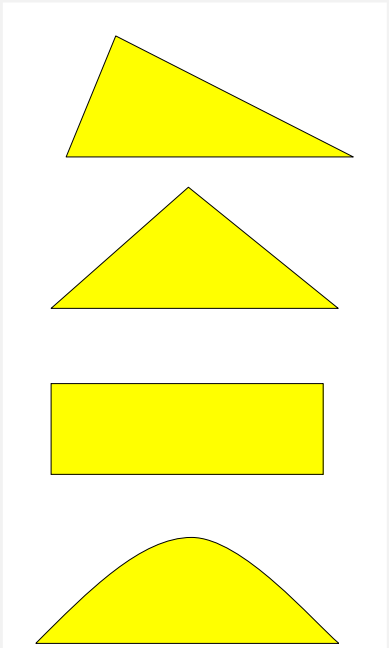


Advantages of triangle function:

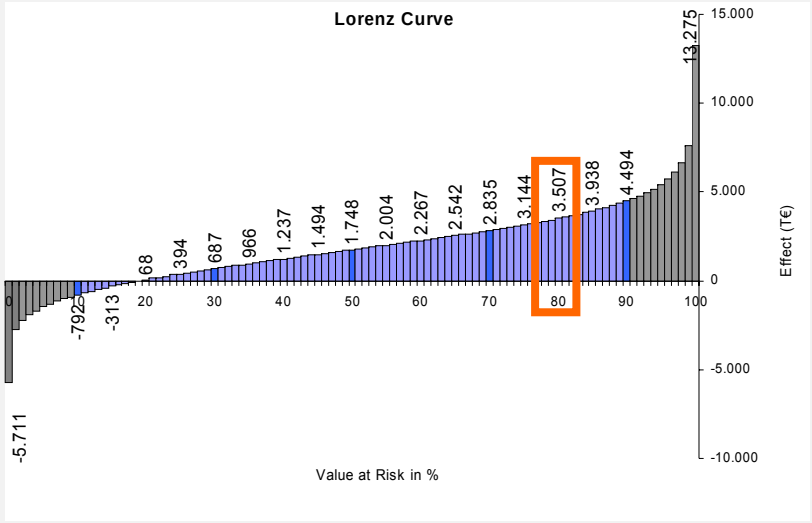
- ✓ **Three point estimate (minimum, most likely, maximum)**
- ✓ **Exact definition of min. and max.**
- ✓ **Easy handling of asymmetric shapes**
- ✓ **Requires no additional and complex input parameters (e.g. stand. deviation)**

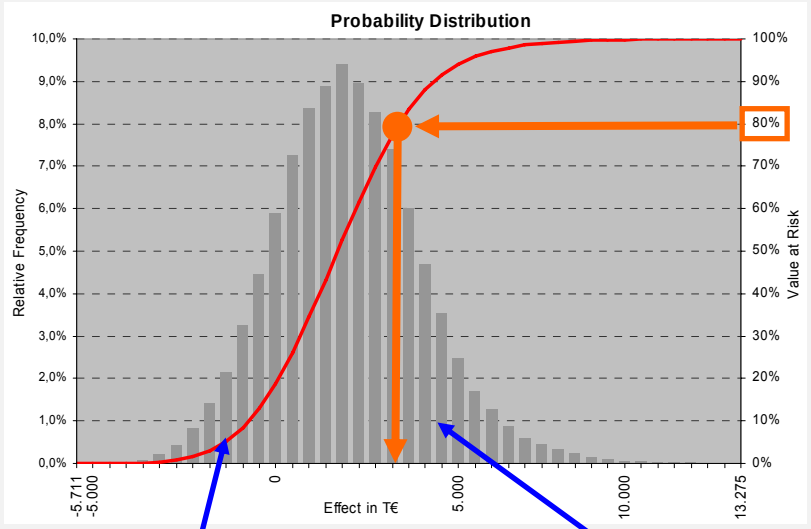
Aggregation of distributions density through simulation
(Monte-Carlo-Simulation, Latin Hypercube Sampling)

Input:
probability distributions



... other distributions





Distribution function

Distribution density

Result:

Probability distribution which displays the overall risk potential.

Example:

Cover 80% of the risk potential

Choose Value at risk (VaR) 80

Software support is necessary!

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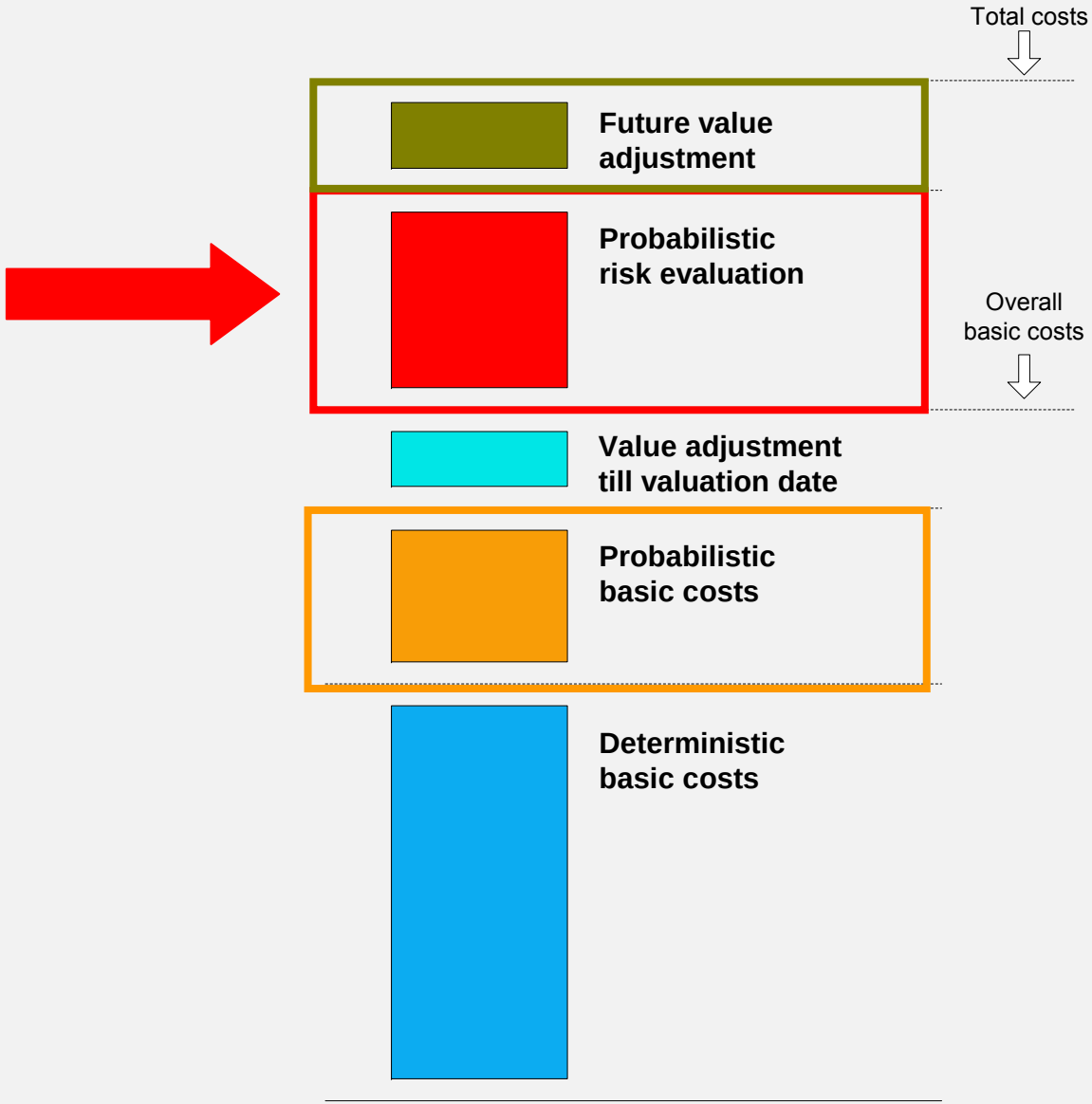
Cost structure of an infrastructure project



Risk management process supported by

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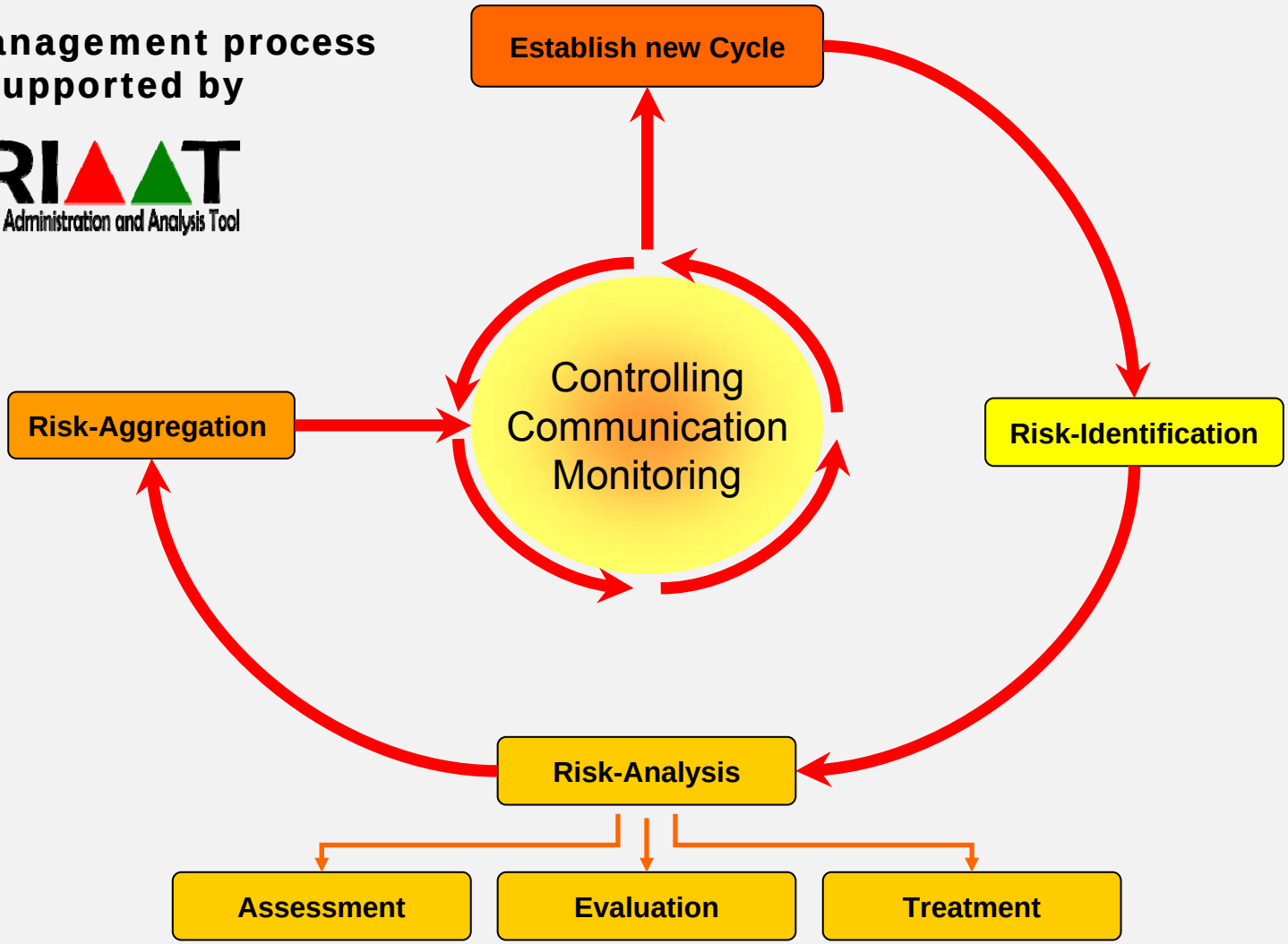
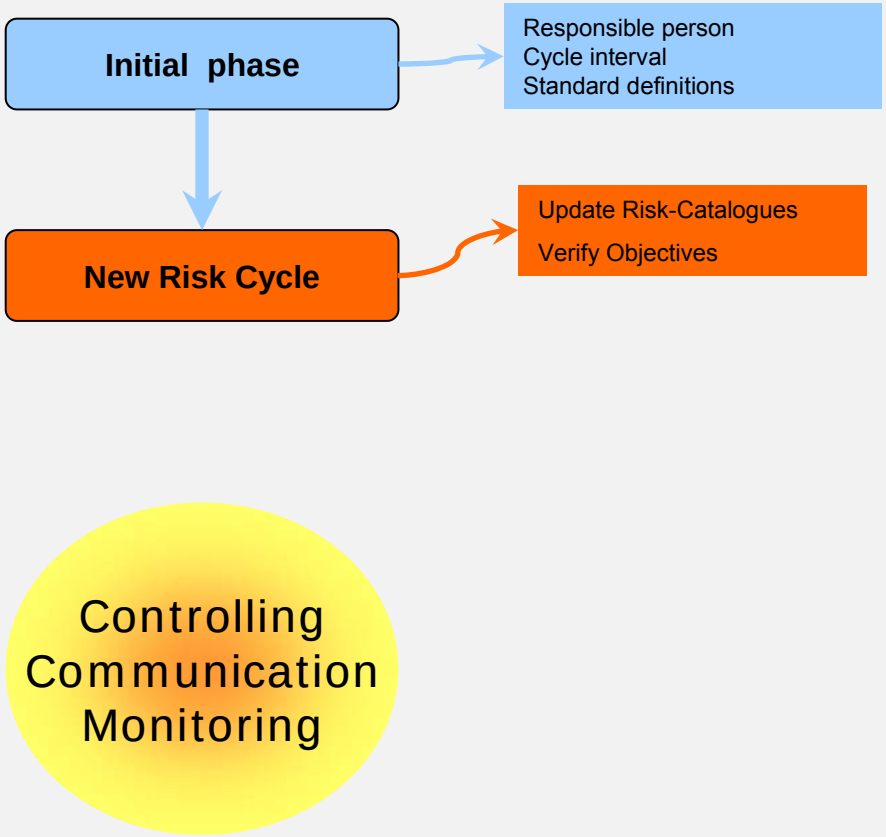


3. Structuring the Risk-Management-Process



Risk-Catalogues

- Differentiate risks
- Support Risk-Identification
- Aggregate similar risks to get a specific risk-potential

Different types of catalogues to identify and classify risks:

Themes

- Ground risks
  - Excavation pits
    - Deformations of drilled piles
    - Batter stability
  - TBM tunnelling
    - Driving problems TBM
    - Tubbings
    - TBM burying
    - TBM deadlock
  - NATM

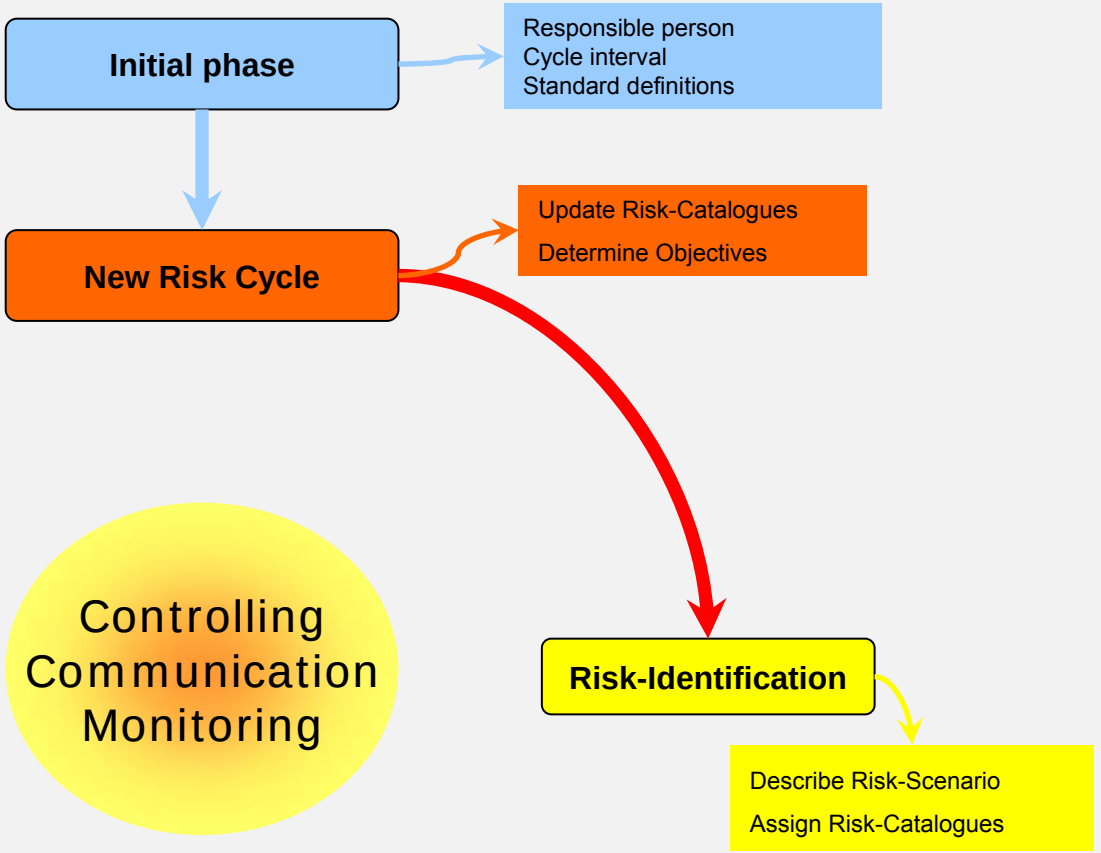
Geological

- Geological sections
  - North tube
    - N01
    - N02
    - N03
  - South tube
    - S01
    - S02
    - S03

Spheres

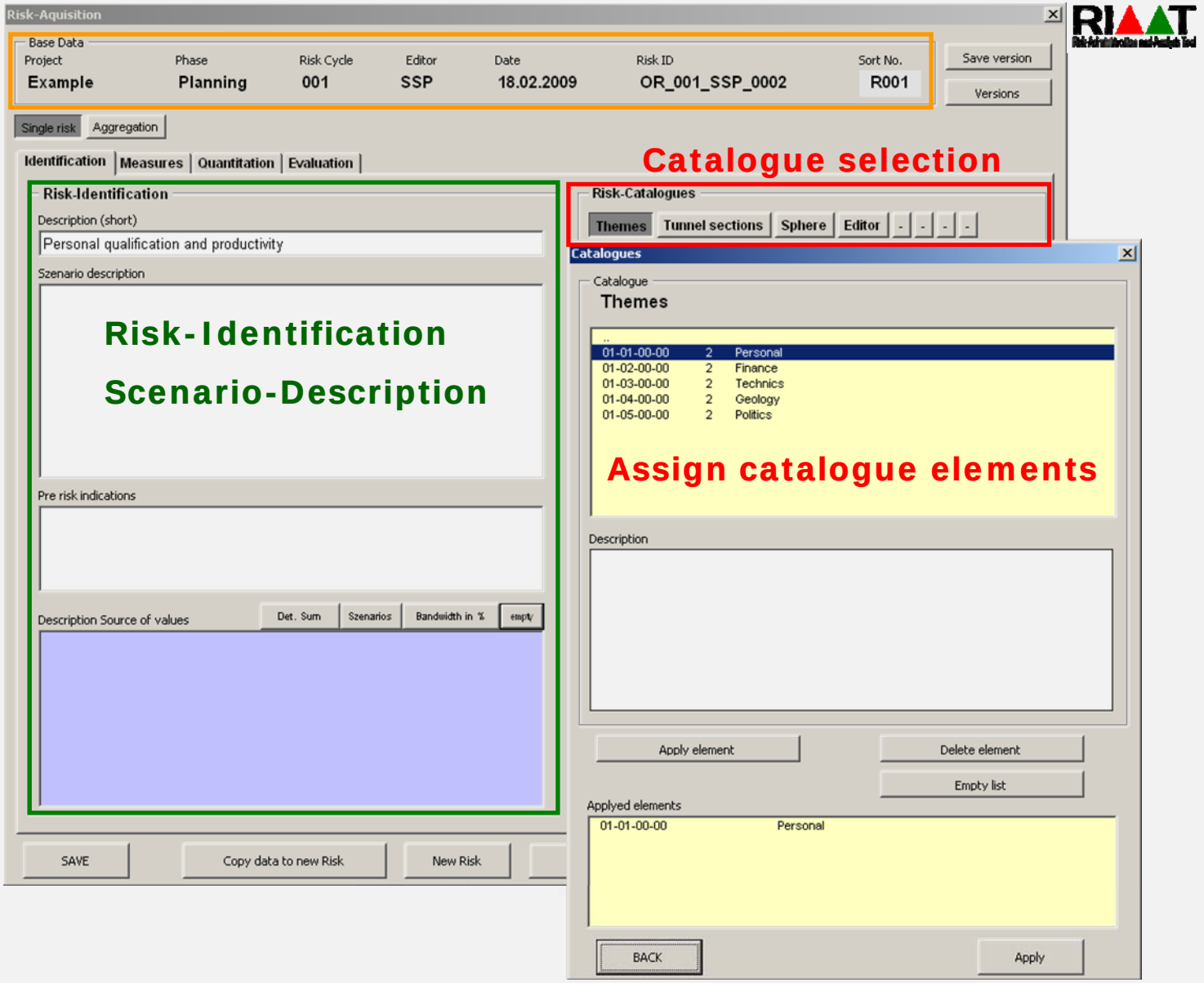
- Owner
- Client
- Contractor

3. Structuring the Risk-Management-Process



Risk-Identification

Project data



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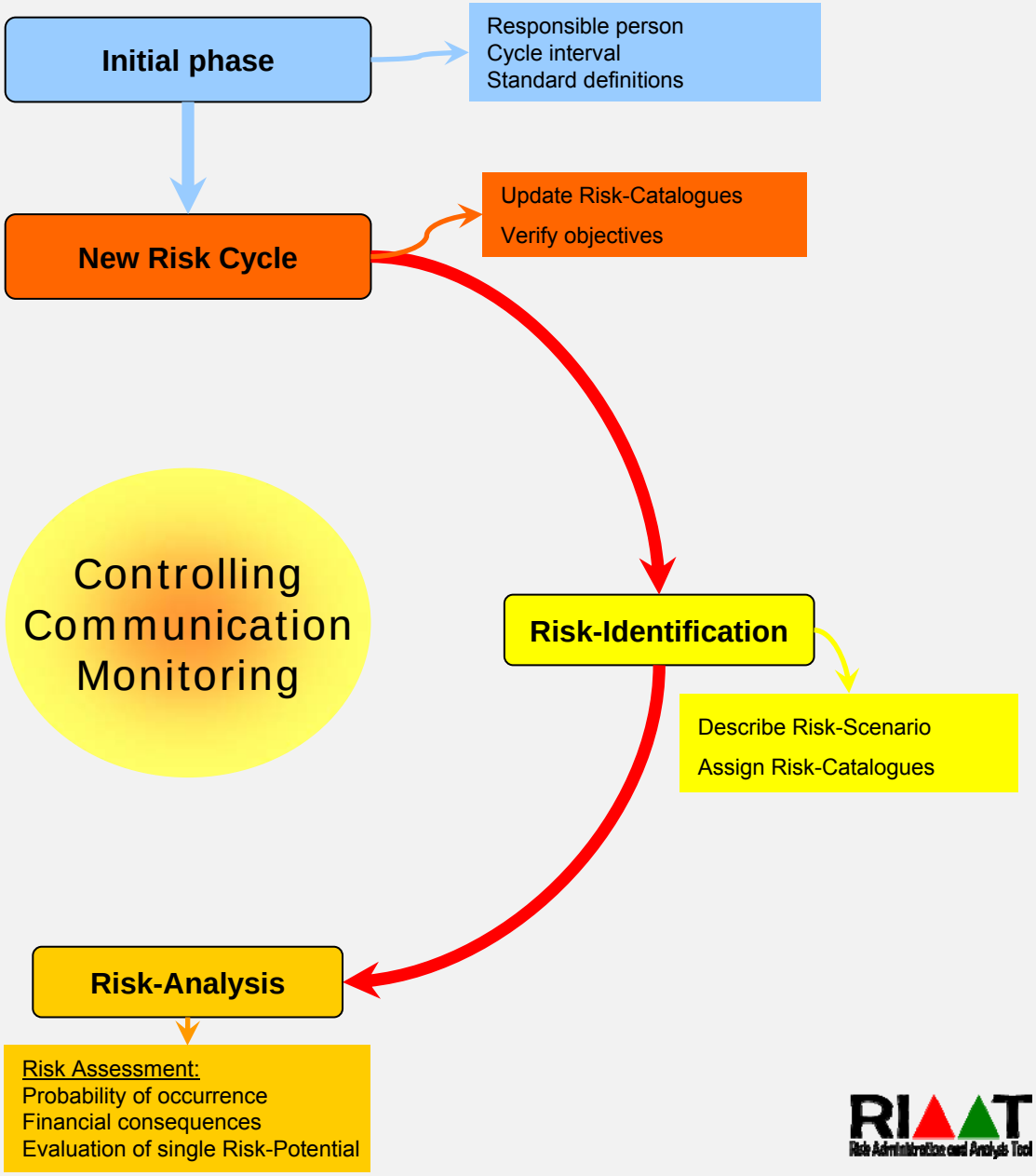
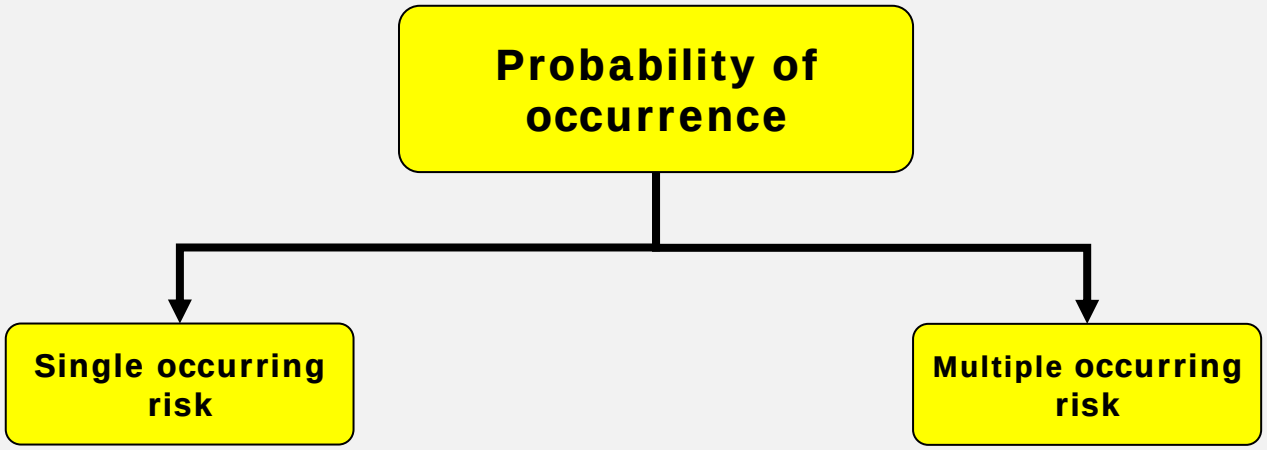
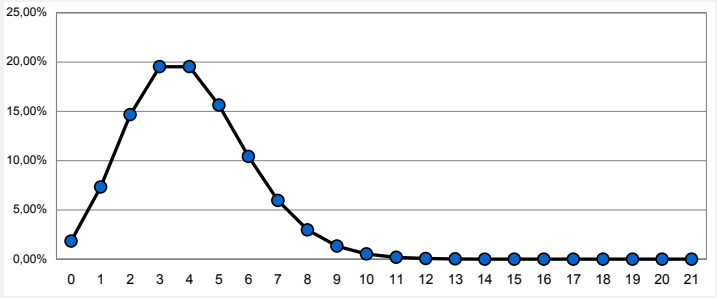




Input:

Standard value for probability between 0 and 100 %

Example: Poisson distribution l=4



Events of similar nature can occur within a section several times at different locations.

Examples:

- **cave-ins in tunnelling (e.g. 4 times in 1000m)**
- **replacement of defective segments of lining**
- **correction of surface imperfection in road construction**

Input: average rate of event occurrence

Poisson distribution to calculate the possible scenarios

Output: probability for possible number of events

3.a Details of Risk-Analysis

Financial consequences

several cost elements possible

1st Factor quantity

2nd Factor price

Distribution densities

3-point-estimate

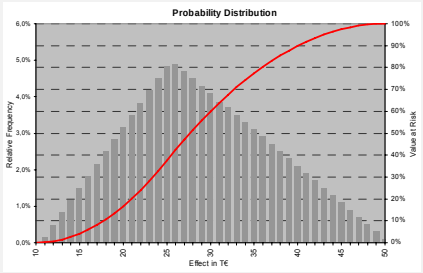
BUILD

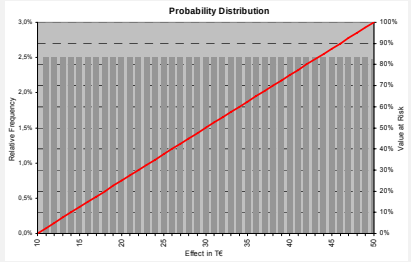
(minimum, most likely, maximum)

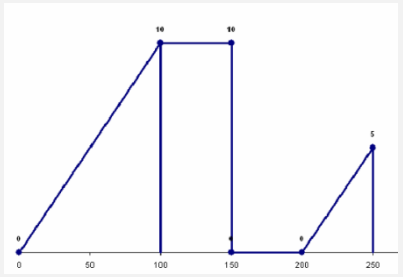
➔ Triangle, Beta-PERT, Uniform

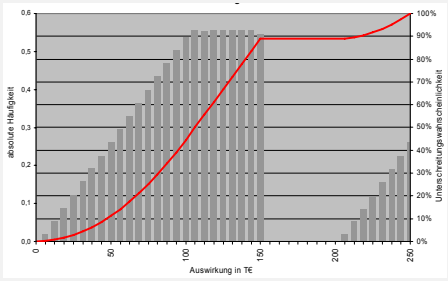
Offers more flexibility

Free in modeling distribution densities





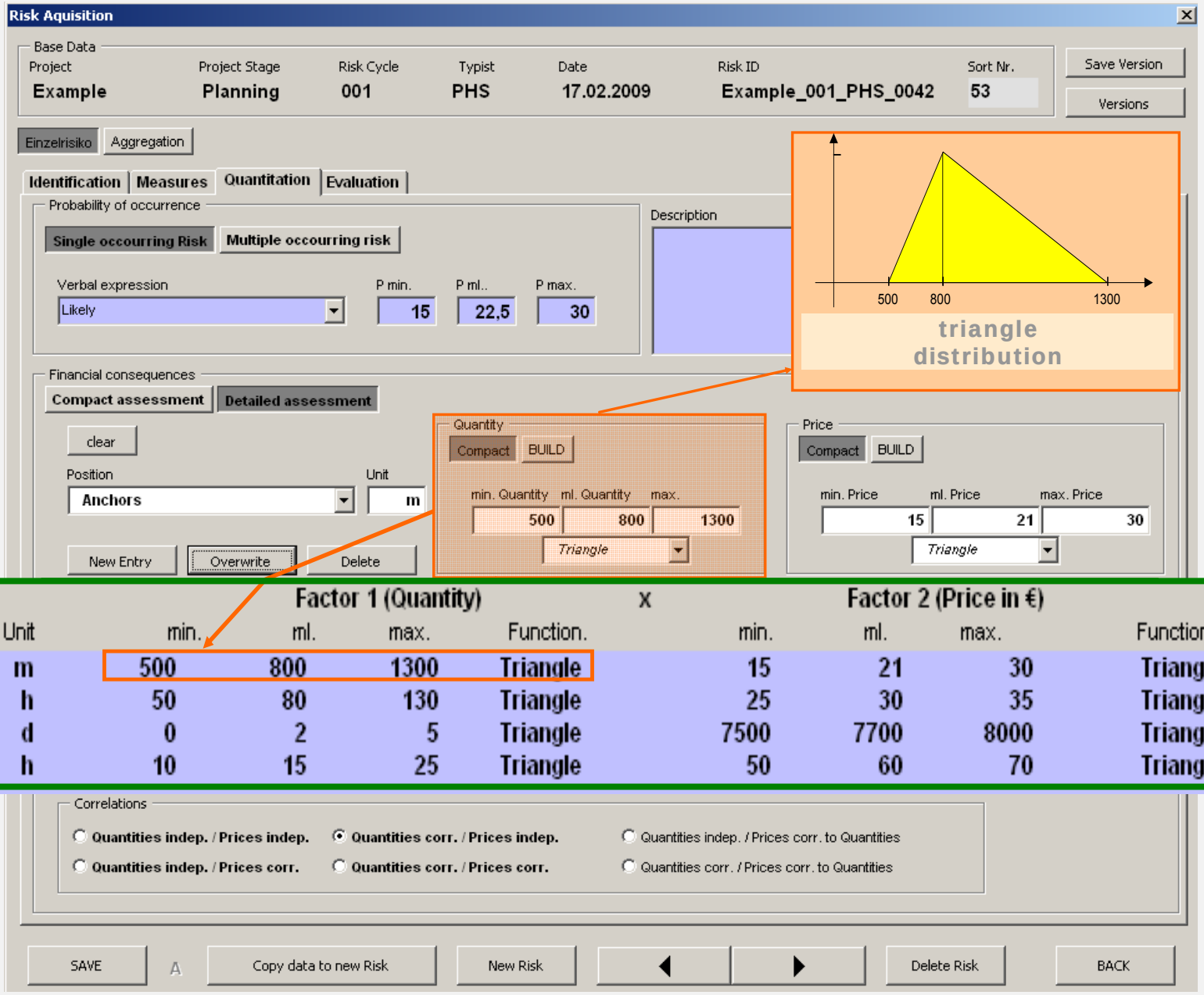




3.a Details of Risk-Analysis

Example:

Deformations of drilled piles



Position	Unit	Factor 1 (Quantity) min.	ml.	max.	Function.	x	Factor 2 (Price in €) min.	ml.	max.	Function.
Anchors	m	500	800	1300	Triangle		15	21	30	Triangle
Labour	h	50	80	130	Triangle		25	30	35	Triangle
Running costs of site	d	0	2	5	Triangle		7500	7700	8000	Triangle
Planing costs	h	10	15	25	Triangle		50	60	70	Triangle

3.a Details of Risk-Analysis

Risk Report

Project	Token	Project stage	Cycle	Due date cycle	Typist	Date	Risk-ID	No.
Example	Example	Planning	001	22.07.2008	SSP	22.07.2008	OR_001_SSP_0013	R012

Description (short)	Type	Status
TBM deadlock	SINGLE RISK	OK

Risikobeschreibung inkl. möglicher Auswirkungen und Folgen

TBM deadlock causes a standstill in tunnelling. The consequences will include time extension and additional costs.

Risk-Identification description (verbal)

Kataloge und Zuordnungen

Catalogue Group	01-05-01-00 Project Risks / Technical Risks / Ground Risks
Sphere	Client
Event sector	M11
Contract section	1-K

Catalogue assignment

Classification

Measures

Employing experienced personal		Earlier perception and identification of problems
Cost	80,0 T€	
Proper operation planning		Can help to deplete the risk
Cost	28,0 T€	

Measures incl. costs

Classification

Ranking (25 risks)

Iteration steps	Simulation method	Cost of measures
192.000	LHS	included

VaR	VaR in T€	Rank
VaR5	108,0	3
VaR10	108,0	7
VaR20	328,0	3
VaR30	471,0	2
VaR40	606,0	2
VaR50	740,0	2
VaR60	886,0	2
VaR70	1.057,0	1
VaR80	1.271,0	1
VaR90	1.587,0	1
VaR95	4.646,0	1

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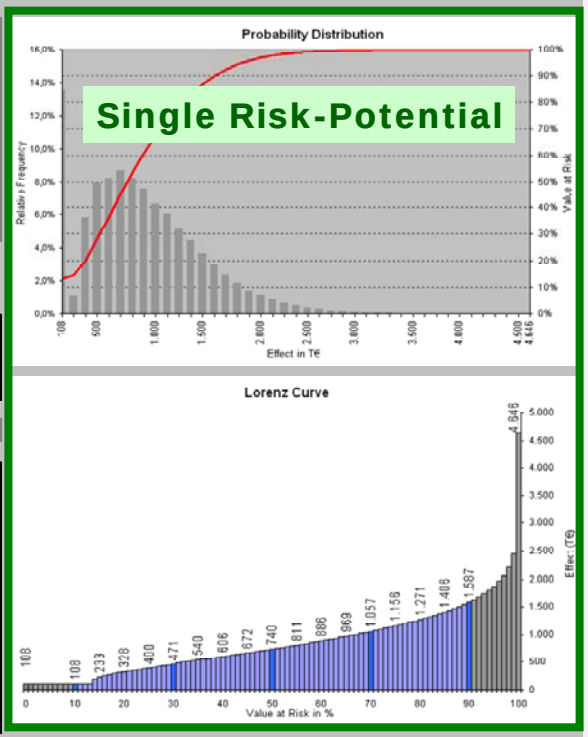


Single Risk-Potential

Probability of occurrence

☐ Single occurring risk	Probability of occurrence t (verbal)		minP	erwP	maxP
X Multiple occurring risk	Section	expected occurrence	P [%]
	5,8km	2	86,5

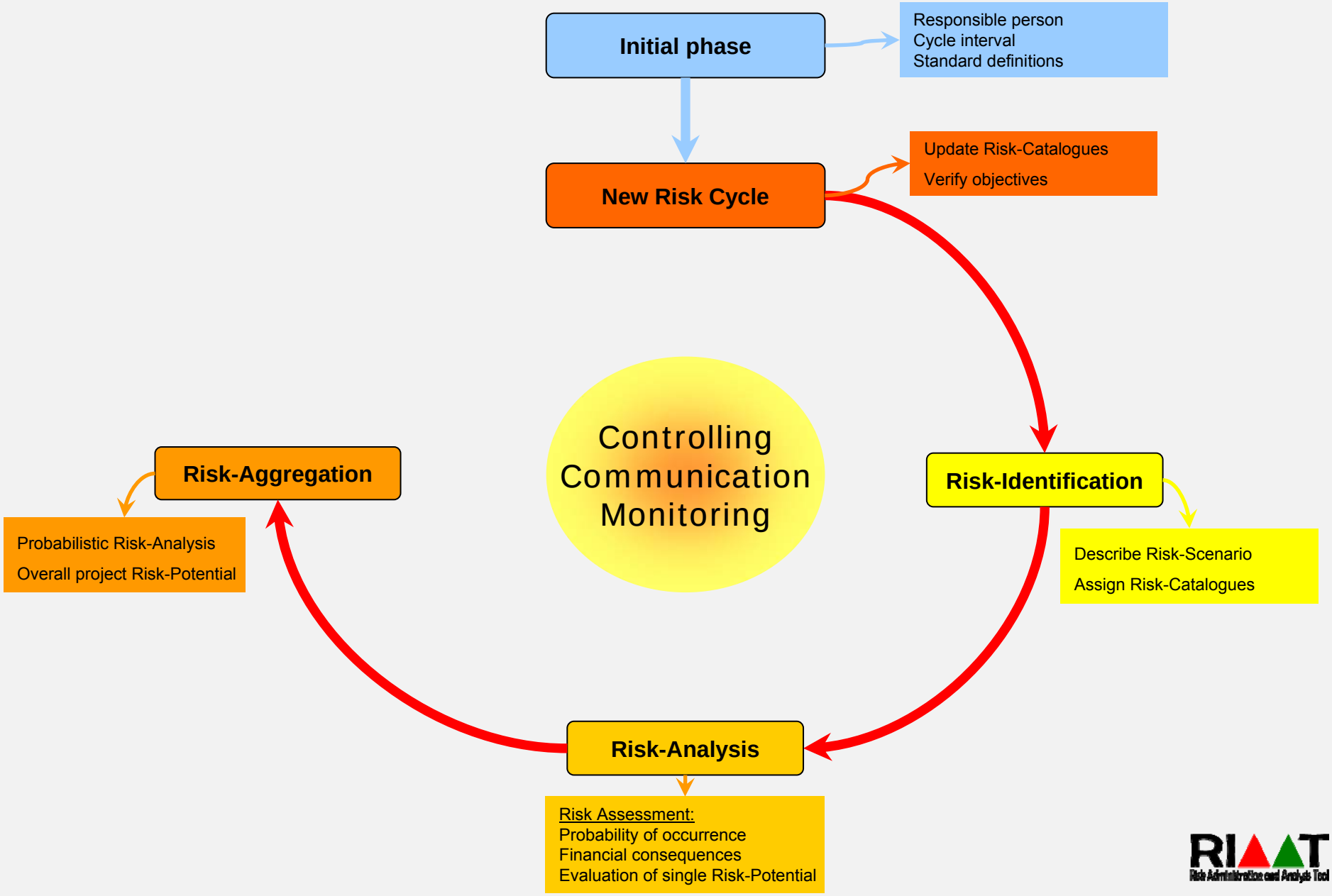
Financial consequences

	Quantity				Price in €			
	Function	min.	ml.	max.	Function	min.	ml.	max.
Running costs of site [d]	Triangle	2	12	45	Triangle	11.500	12.000	13.000
Labour costs [d]	Triangle	2	12	45	Uniform	5.700	6.000	6.500

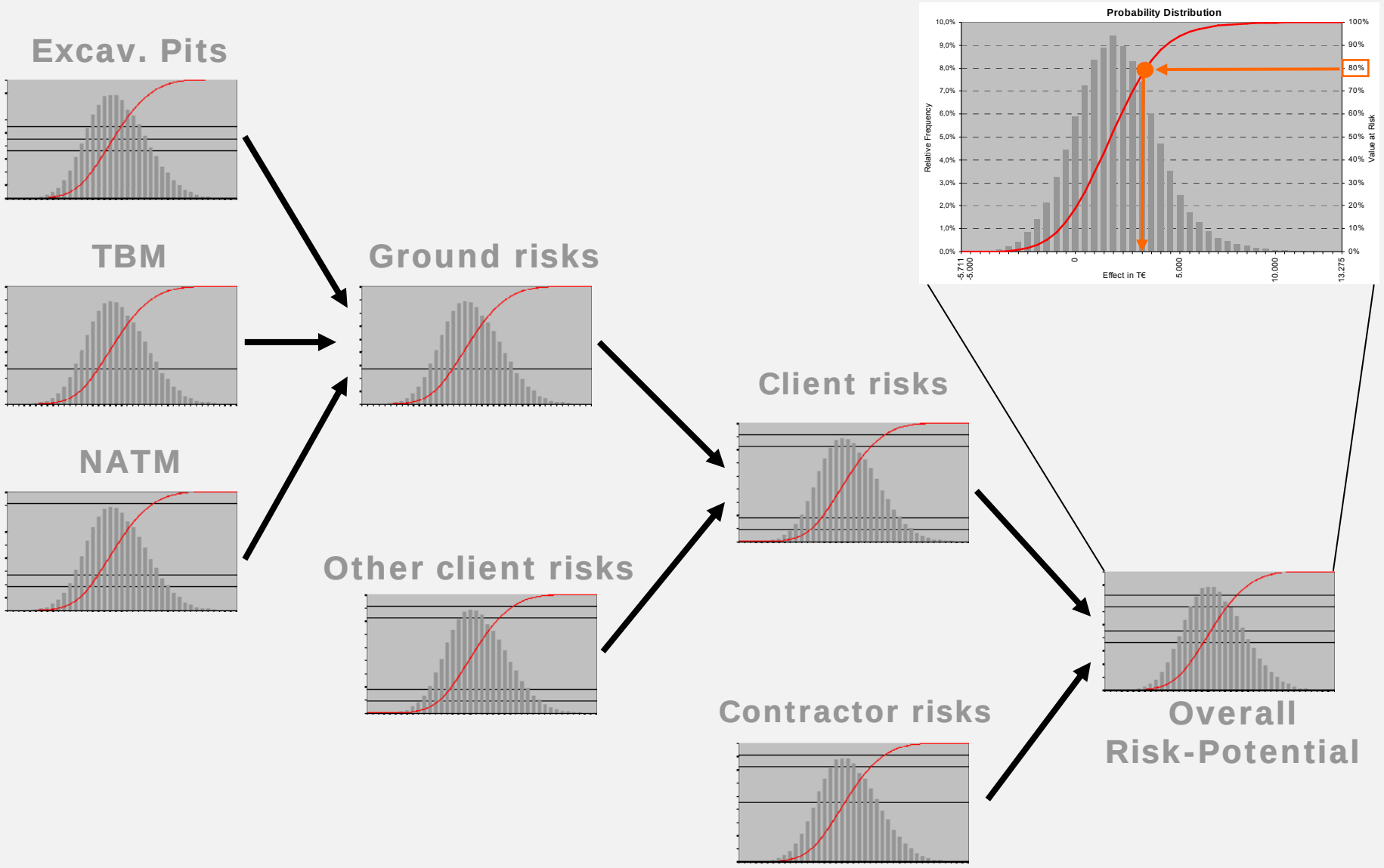
Risk-Assessment

Correlation: Quantities correlated, Prices indep.

3. Structuring the Risk-Management-Process



Aggregation to overall Risk-Potential



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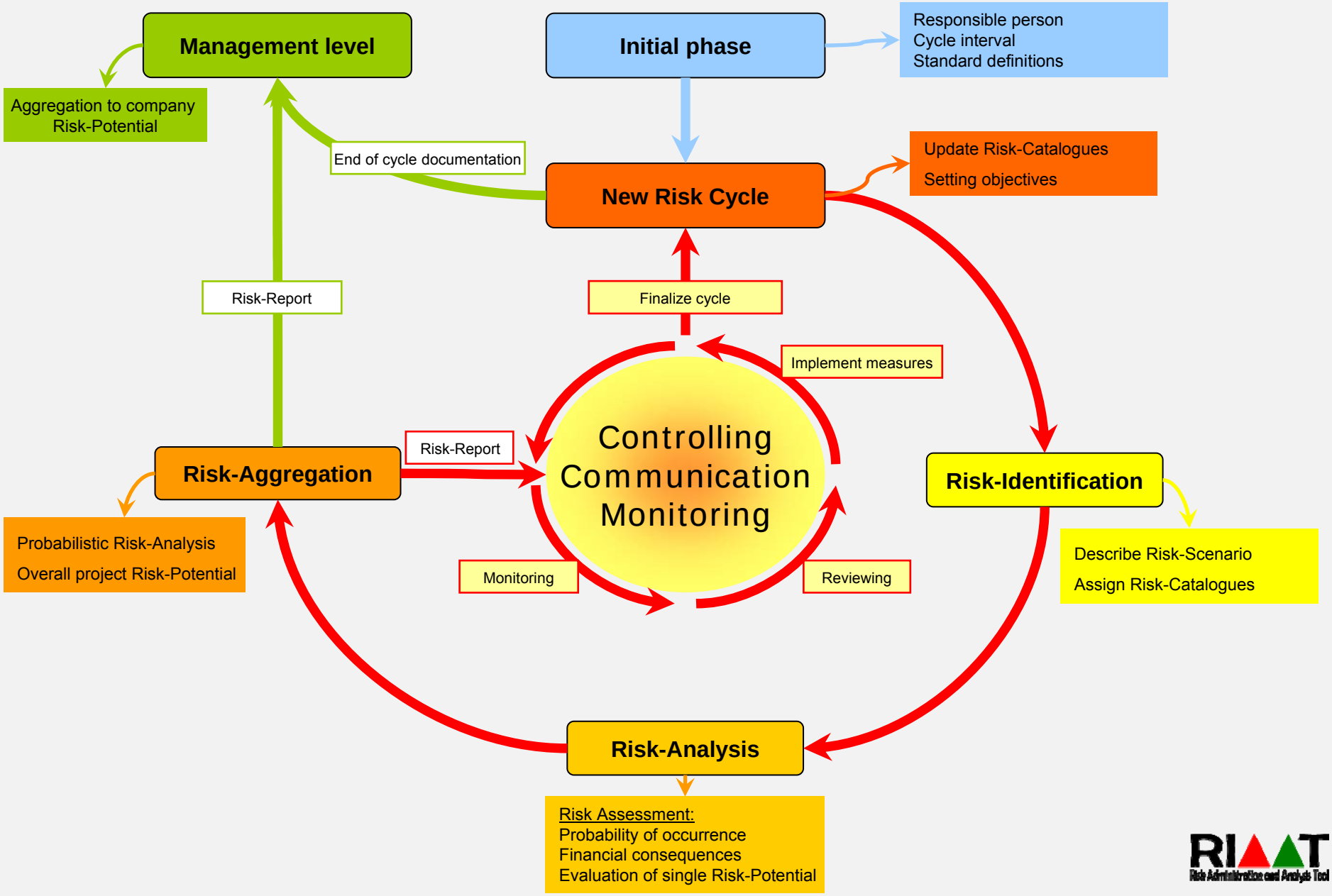
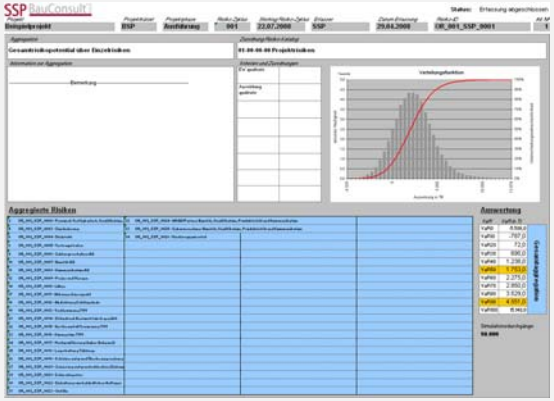
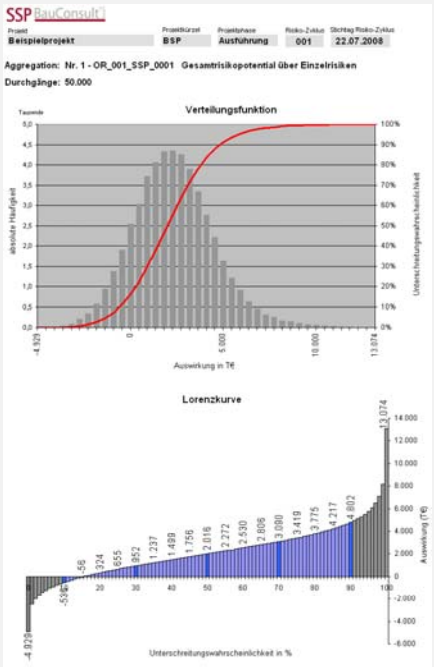


3. Structuring the Risk-Management-Process

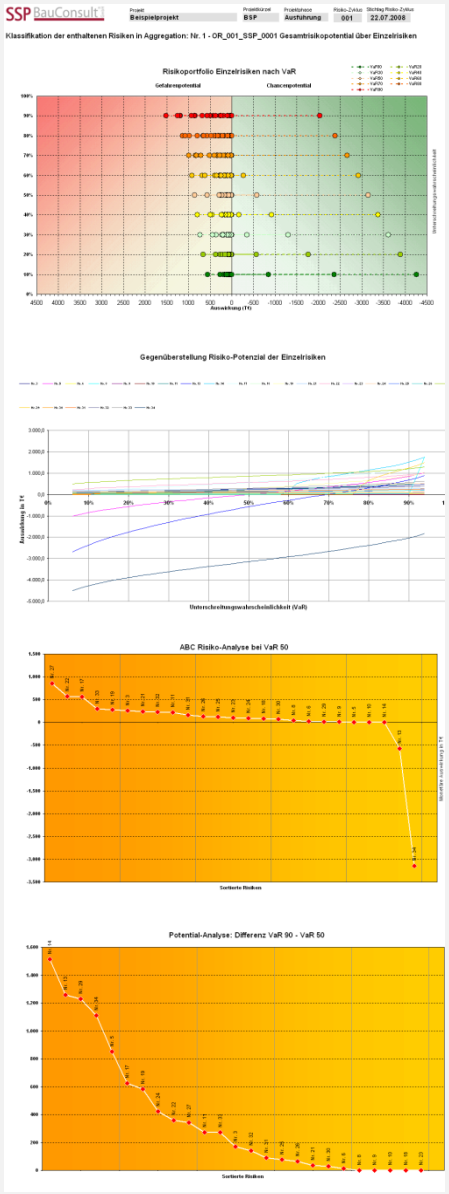
Risk catalogues



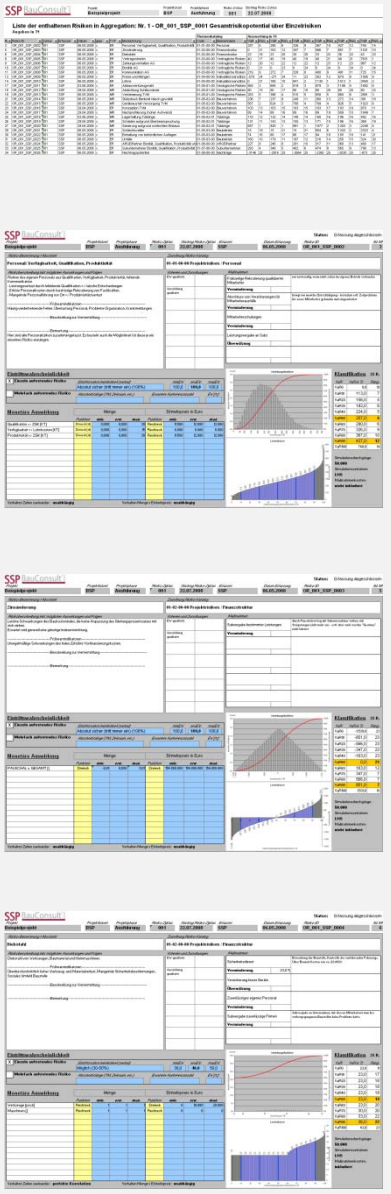
Risk-Potential



Classification



Single risk report



Event Tree Analysis

Scenario:

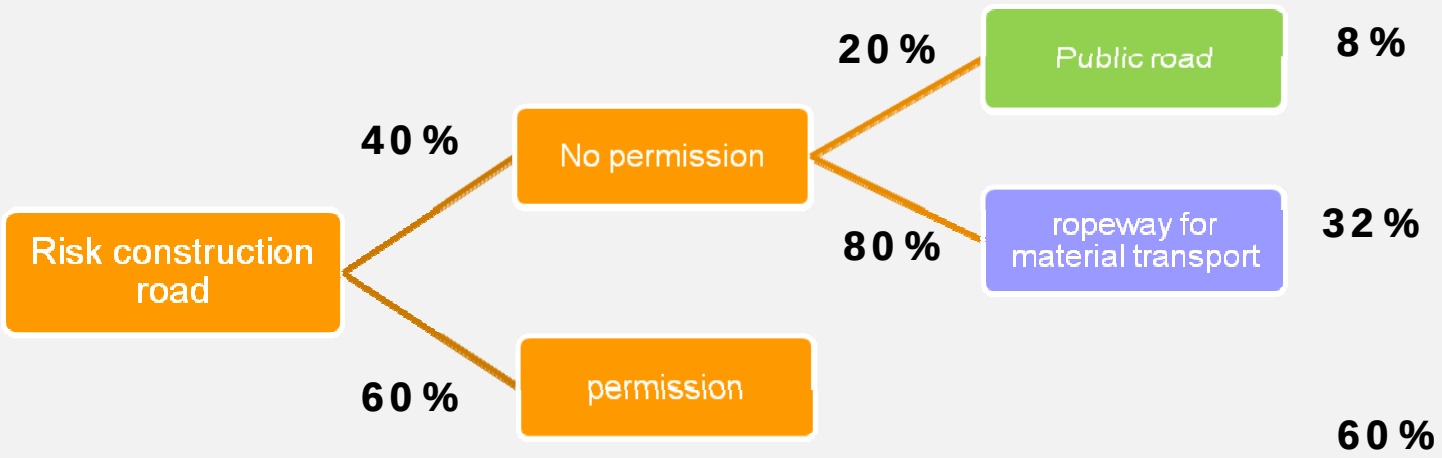
•construction road to a reservoir of a hydro-electric power plant
•40% risk that the construction road will not be permitted (nature reserve)

➔ in this case (risk does occur) → 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 ropeway for material transport
   most expensive scenario

The hole scenario can be modelled by an event tree.

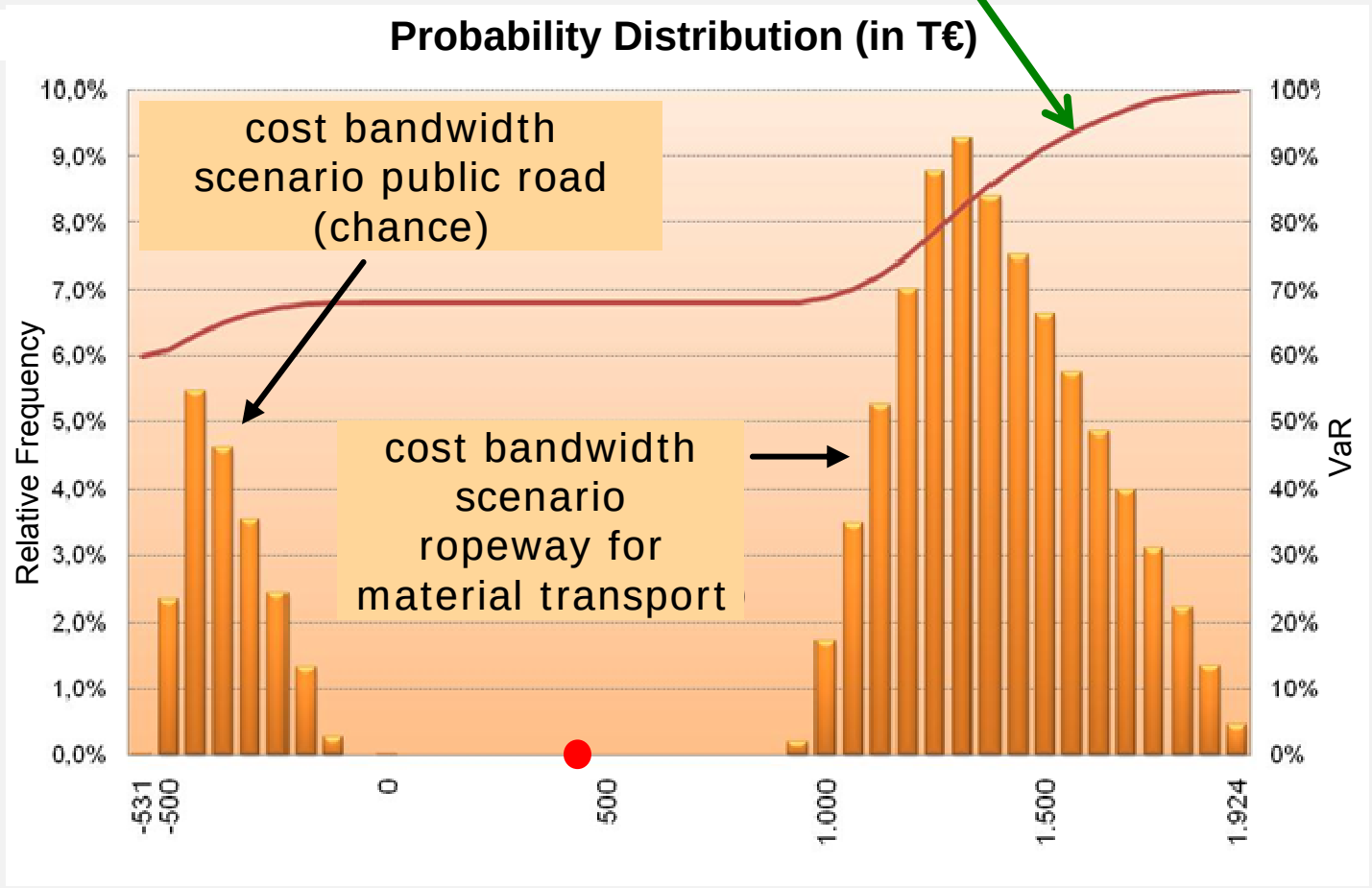


The costs of the construction road are estimated with 1.000.000 €.
If there will be no permission the costs for the construction road can be saved in the first step.

Omitted construction road	8%	-1.000.000	-1.000.000	-1.000.000
Extension of public road		467.500	550.000	880.000

Omitted construction road	32%	-1.000.000	-1.000.000	-1.000.000
ropeway for material transport		1.912.500	2.250.000	2.925.000

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€ + 425.000€ + 0€

461.000 € → won't occur in reality

Probabilistic Risk-Analysis:

- **Modeling of reality: better by distributions densities than by a deterministic figure**
- **More information is transported if a range of values is not condensed into a single figure**

Support through software Tool: RIAAT **provides**

- **Standard for project structuring**
- **Standard for risk assessment und analysis**
- **Risk aggregation "Bottom-Up" ➔ form project to company level**
- **Standard for structuring risk reports**
- **Revision control**

RIAAT
Risk Administration and Analysis Tool

- **Developed particularly for the needs of construction projects**
- **Practically proofed**

Applied in major projects:

- **Koralm base tunnel – RA cost estimation stage (32km long tunnel)**
- **Hydro-electric power plants**
  - Spullersee
  - Tauernmoos
- **New rail corridor lower Inn valley (TEN 1)**
  RA – construction stage