AUSTRIAN
SOCIETY FOR
GEOMECHANICS

ÖSTERREICHISCHE
GESELLSCHAFT FÜR
GEOMECHANIK

Guideline for the Cost Determination for Transportation Infrastructure Projects

Taking relevant project risk and uncertainty into consideration

2016

GUIDELINE

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Taking relevant project risk and uncertainty into consideration

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Review

This guideline was made available for review to all members of the Austrian Society for Geomechanics. All contributions were considered and the results were made available to the reviewers.

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1 Preface

1.1 Objectives

Transportation infrastructure projects are distinguished by long timeframes and project phases and a high number of participants and stakeholders. They are influenced by factors that are difficult to predict – such as the availability of financing, the legal environment, the political context, public pressures, and the unique character of the project itself.

Project costs must be determined based on these "framework" conditions and a sufficient knowledge of the project environment – which can change during the implementation of the project.

Project costs are dependent on many factors, such as the status of authorizations, environmental requirements, the level of planning contracting procedures, and the rate of progress of the project's implementation. Dealing with unknowns and risks requires an expert determination during the planning and implementation phases of potential risk costs as well as consideration of cost-impacting factors that, while not yet specifically identified or quantified, have historical precedents. Allowance for these factors should be included, based on experience and historical data.

This guideline provides the basis for an appropriate project cost determination, which is necessary for cost stability and achievement of project objectives. Under these guidelines, an individual cost evaluation of each specific project is required and a proactive approach to cost determination by planners and contracting authorities is extremely important. The successful management of a project depends on a sufficiently precise description of the project's scope and context (which also establishes the basis for the cost estimate).

The aim of this guideline is to describe a process that can provide a sufficiently complete and clear representation of the expected costs of a project, or elements of a project, based on the state of knowledge as the project evolves from initiation through planning, development, preliminary design, tendering, and awarding of contracts.

The graphics presented in this guideline are intended for easier understanding of the concepts and processes presented. They are conceptual in nature and need to be modified to be specific for each project application.

1.2 Scope and Limits

This guideline can be used for tunnel construction (cut and cover and mined tunnelling), infrastructure projects (airports, railway stations, bridges), and individual project elements (e.g., trenches, access roads, etc.).

The systematic approach used in this guideline is also appropriate for other major projects such as power plants and similar projects, including corrective maintenance work.

This guideline governs cost determination in the planning and design phases. Cost monitoring in the construction phase, and actual costs as the project is executed, are not within the scope of this guideline.

This guideline only addresses those costs and risks that are part of the contracting authority's (owner's) sphere of influence or responsibility, including potential effects (impacts) caused by risks that are part of the contractor’s sphere of influence but that need to be included in cost estimates by anticipating them in the planning and design phases. In addressing risk, it is normal to assign some risks to specific “risk owners” who are part of the contracting authority's sphere of influence and to assign responsibility for other risks to the contractor, through the contract documents, or to insurers or other third-parties, if and as appropriate.

The determination of the following costs and associated risks are not part of this guideline and, where necessary, should be considered separately: subsequent costs such as operating costs, maintenance costs, and, where pertinent, any dismantling or remediation costs at the end of the structure’s life cycle time; financing costs; income tax; cost contributions from third parties; grants by the European Union (EU); or subsidies.

2 Principles of Cost Determination

2.1 Project Content and Delimitation

The project content describes the measures to be implemented and the facilities to be constructed to achieve the project's quality, functional, cost, and schedule objectives.

The project content must be defined physically and time-wise. As work is done and the project develops, the project content will become more precisely defined – resulting in more detailed project element definition and more detailed cost estimates.

2.2 Project Phases

The project should be divided into phases such as those listed in Table 1.

For each project phase, milestones should be defined for completing project elements and for cost de-termination. Methods for cost and risk assessment should be defined that are appropriate for that phase.

Table 1: Example Project Phases

	Project Initiation Phase	**Project Development Phase**	**Preliminary Project Planning and Design Phase**	**Project Approval Phase**	**Tendering / Contracting Phase**	**Construction / Execution Phase**	**Final Project Phase / Contract Closeout**
Activity	Conceptual Planning	Basic Planning	Preliminary Design	Project Documents advanced to secure "Approval to Construct"	Contract Documents Published for Bidding / Tender	Project Execution and Construction	Close out Contracts, Final Payments, Formal Acceptance
Project Milestones	Project objectives, Project start / Project Completion	Product Requirements, Document Purpose and Need	Basic Project Characteristics Defined	Submission to Authorities for Approval to Contract	Transition from Design to Construction	Award / Notice-to-Proceed	Project Completion
Cost Calculation Milestones		Cost Framework Defined, Preliminary Estimate	Update and Advance Cost Estimates	Update, Cost Estimate for Approval	Owner's Tender Cost Estimate	*Not subject of this guideline*	
Costing Methods		Benchmark Method	Benchmark and Element Method	Method according to the planning status: Element Method	Item Method		

Project Initiation Phase

Based on the defined purpose and need, project objectives, general characteristics, and an initial cost estimate are defined using conceptual planning.

Project Development Phase

In the project development phase, the product requirement documents are drawn up, including detailed performance, quality, cost, and schedule objectives. This phase includes, for example, requirements and location analyses, cost-benefit analyses, feasibility studies, and project conceptualizations. The benchmark method is normally used for cost determination and to define the cost framework.

Preliminary Project Planning and Design Phase

During preliminary planning and design, various routes and project alternatives are evaluated with the aim of deciding on one possible solution or to narrow the alternatives for approval. The method used for cost determination may be the benchmark or element method (these methods are defined later in this document).

In general, there is a significant increase in information in this phase, which may lead to a significant reduction in the "mark-up" or contingency for unknown risk costs in this and the subsequent phase (see Figure 6).

Project Approval Phase

The project approval or authorization phase may be divided into two steps. The first includes the draft and authorization planning documents that are to be presented to the authorities for approval. These documents may be required by environmental, roadway, railway, and water related laws.

In some cases, the contracting authority may require design to be completed to a high level in this phase for evaluation by the contracting authority.

The second step includes verification and acceptance of the documents by the authorities.

The approval phase ends with granting of authorization to proceed by the authorities. Cost determination is updated based on the accepted approval documentation. Should cost-related conditions of approval be imposed (e.g., a lower probable cost is required), it may be necessary to revise the scope of the project and re-work the cost estimate.

Tendering/Contracting Phase

The tendering/contracting phase includes finalization of the tender documents, which are structured based on the type of contract to be awarded (e.g., fixed price, contract with functional tender specifications, use of shared contingencies or allowances, etc.). Conditions resulting from previous authorization procedures and requirements are included in the tender documents. Bids are submitted by contractors and these offers are evaluated on specified acceptance criteria (e.g., best-value, alternate technical concepts, compliance with contractual performance requirements related to incentives and penalties). The tendering phase may begin during the project approval phase and ends with the signing of the contract.

Construction Phase

The construction phase begins with the signing of the contract and notice-to-proceed to the successful contractor. This phase includes mobilization, final design of elements, drafting of pertinent construction documentation, and construction of structures on the basis of the con-tract documents. In this phase, costs are regularly monitored, with changes and adjustments to account for local conditions and scope or site condition changes during the implementation of the contract. This phase ends when the contracting authority accepts and takes over the completed work.

Final Project Phase/Contract Closeout

The final phase of the project includes closing-out of all contracts, final invoicing, analysis and reconciliation of accounts, final payments, formal acceptance, benchmarking, and "as-built" documentation of the project.

2.3 Cost Structuring Options

The cost structure to be used is based on the project's structure, configuration, and phases.

A Work Breakdown Structure (WBS) is recommended that separates the project into definable elements and units used for cost estimating and controlling (tasks, partial tasks) or work packets that can be used as a basis for further project planning and management of such tasks. The work breakdown structure should show all essential relations between project elements.

The work breakdown structure can be organized using different approaches:

- By construction phases: Construction phases are finite, time-related, or logical segments of a project. They are not necessarily ordered in sequence and can be parallel or overlapping (for example, modules such as partial and complete construction, construction lots).
- By objects: A function-oriented organization of the elements in the work breakdown structure shows the individual parts and construction groups based on the similarity of the pertinent objects (such as at-grade areas, bridges, tunnels, auxiliary systems, or structures).
- By organisational function: A function-oriented organization of the elements in the work breakdown structure may be based on participants (e.g., building trades, specialized subcontractors) or technical categories of the project (e.g., land acquisition, systems, new construction, expansion, operations).

To integrate these in the work breakdown structure and cost structuring, cost groups can be assigned to such elements. These cost groups may, for example, include the following:

- Project Management
- Land Acquisition
- Design
- Monitoring
- Service Providers in the Construction Phase
- Construction
- Equipment and Systems
- Environmentally Relevant Measures
- Commissioning
- In-House Services
- Public Relations

For a further subdivision of these cost groups see Appendix 10.1.

The work breakdown structure must be clear, sufficiently precise, and comprehensible in order to be updated on an on-going basis.

2.4 Dealing with Uncertainty

If costs are predicted using a deterministic approach (by single numbers for project elements or in total), there is no allowance for, or quantification of, uncertainty. It is almost certain, however, that so-called "exact values," predicted deterministically, will not materialize exactly during construction. For a variety of reasons, there will always be differences between results and predictions. To take these differences into account, a range of values (using distributions) should be considered.

In such a distribution (e.g., a range of costs), the deterministic value will correspond to the modal value (see Figure 1). To represent such ranges, Figure 1 shows, for example, a triangular distribution, which takes into account the lower probability of occurrence of marginal (upper and lower) values, as compared to the deterministic value.

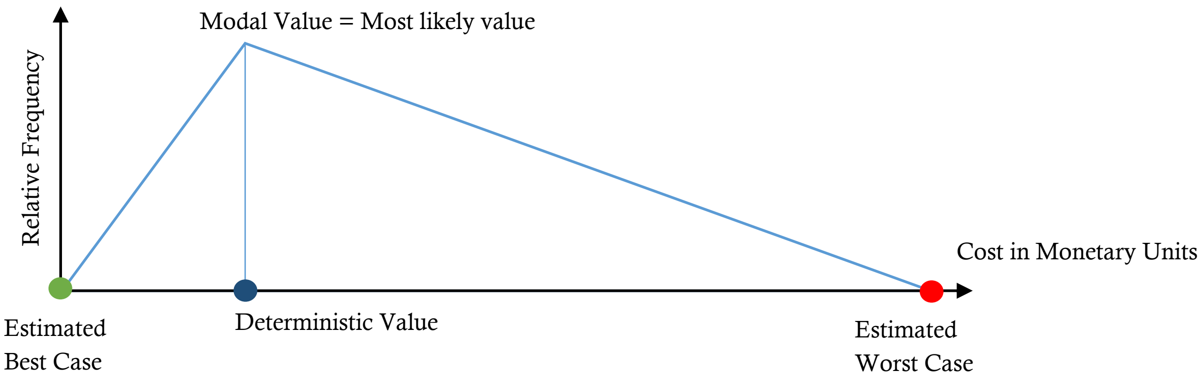

Figure 1: Adding range to a deterministic value

Figure 2 – Calculation of overall probability distribution by aggregation of cost elements shows the use of a probabilistic method. The individual cost elements are represented by appropriate distributions, in order to take uncertainty into account. The result is an aggregated probability distribution of costs that takes prediction-based deviations into account.

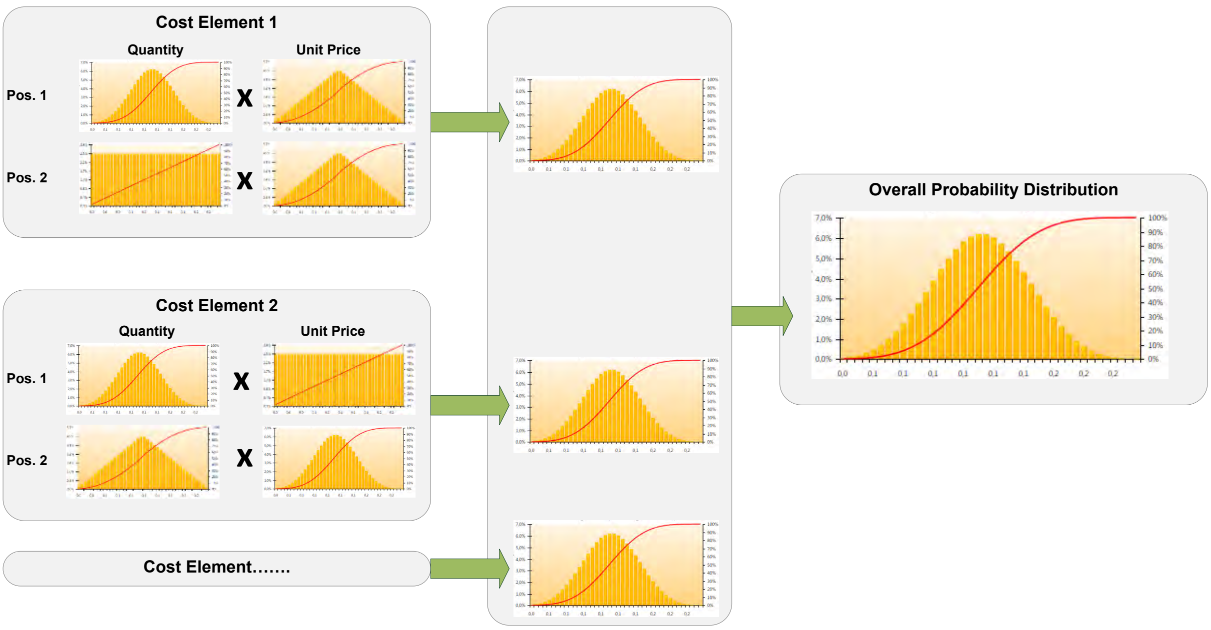

Figure 2: Calculation of overall probability distribution by aggregation of cost elements

3 Cost Components

The total project cost estimate includes the following elements:

- Base Cost (B)
- Indexation and Value Adjustment (I)
- Risk (R)
- Escalation (E)

These costs are predicated on the assumption that the project will progress in a certain (defined) manner and with a certain development of market prices as the project develops. Allowance is made for possible deviations from the expected development by adding or subtracting costs probabilistically to account for risk and uncertainty.

The build-up (summation) of project costs (B+I+R+E) over project milestone dates can be represented by the following graph, where individual cost components may be zero at specific points in time.

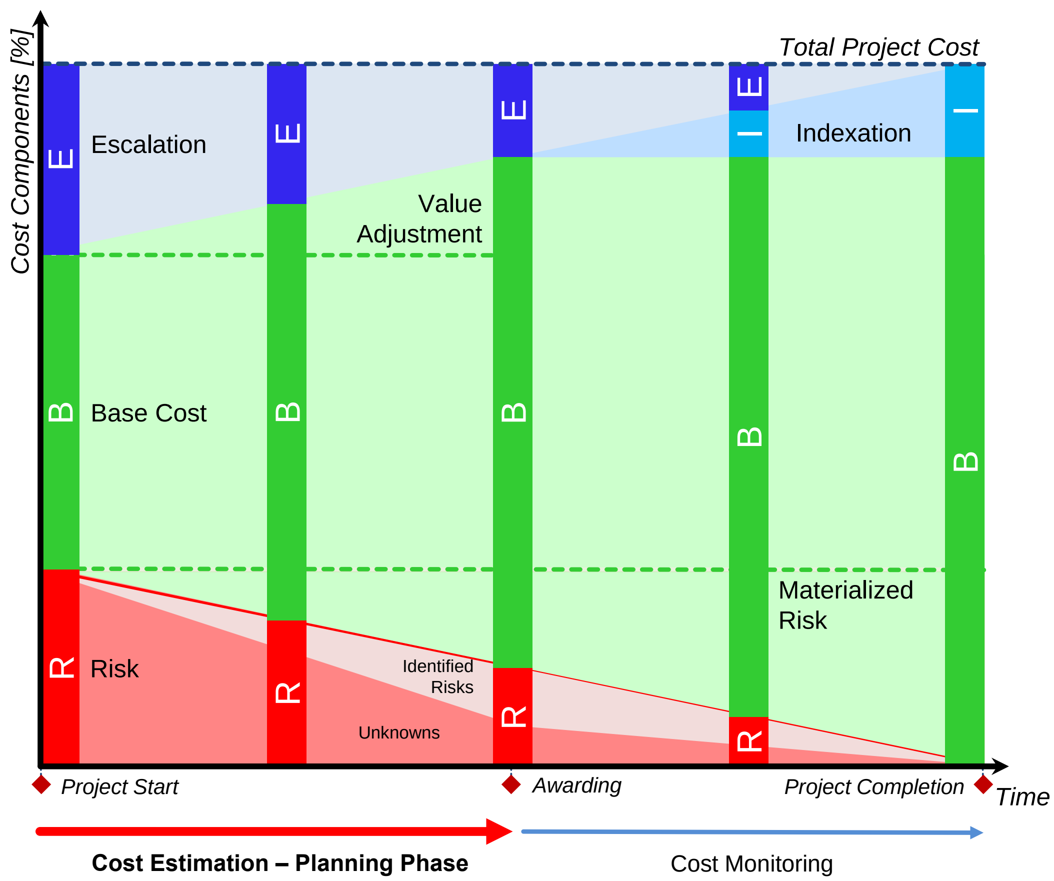

Figure 3: Schematic graph of project cost components over time/phase

3.1 Base Cost (B)

The base cost is that cost which can reasonably be expected if the project materializes as planned, with a defined content, schedule, and market situation. The base cost estimate is to be neither optimistic nor conservative and does not include price and/or quantity variability. The base cost estimate does not include contingency or the cost of potential risk events or escalation. The base cost is determined in accordance with a specific, defined base price and base date.

3.1.1 Basic Principles

The base cost generally includes all costs necessary for the design, construction, and functioning of the project, including land acquisition and development, services and works, systems, and commissioning. They include in-house and consultant services provided by the contracting authority (for possible sub-division into cost groups, see Section 3.3).

The choice of method for the determination of base cost depends on the project phase (see Table 1). The following methods can be used, depending on the level of detail required:

- Benchmark method
- Element method
- Line item method

Depending on the project structure and the progress of the project, the degree of detail for elements of the project may vary at any specific date – that is, one part of the project may already be in the construction phase, whereas the status of another part may still be in the planning, design, or tendering phase. This means that the method(s) used to determine base cost for elements at a certain reference date can vary within the same project, based on the progress of the respective parts of the project.

All three methods may not be able to take into full account certain parts of the project, based on the state of project knowledge at a particular time. In this case, contingencies must be added to allow for these unknowns (see Section 3.1.2.4).

3.1.2 Determination of Base Cost

Estimated quantities and unit costs form the basis for the determination of base cost. The following procedures are available for this determination:

- Deterministic procedure
- Probabilistic procedure

The choice of the specific procedure is to be determined by the project team and approved by the contracting authority.

In both procedures, base cost is determined from a summation of the product of estimated quantities times unit costs. In the deterministic method quantities and unit costs are single values, whereas in the probabilistic method both quantities and unit costs are defined by distributions in order to provide for uncertainties (see Section 2.4).

Unit costs are usually based on historical values, taken from comparable completed projects or from a price database. For parts of a project for which reference values are not available, reasonable estimates must be used to determine costs.

3.1.2.1 The Benchmark Method

This method considers higher-level components of a project to which reference values can be assigned (for example, costs related to linear meters for tunnels, square meters for bridges, lump sums for demolition work) based on unit costs. Values are determined by historical experience from historical projects or cost databases.

The method can be used to determine the cost framework at the beginning of the project or for the cost estimate in the preliminary project phase. For lower level cost groups such as land acquisition, costs can be assumed as a lump sum or as a percentage.

3.1.2.2 Element method

This method considers typical elements of a project, to which reference values can be assigned (for example, square meters for final lining, linear meters for tunnel excavation classes) and is based on unit cost.

For the smallest unit, there is differentiation between generic elements in the preliminary project phase and detailed elements in the authorization and subsequent phases. The distinction between generic and detailed elements is context-dependent.

3.1.2.3 The Line Item Method

This method considers line items from a bill of quantities (such as cubic meters for final lining concrete, each for rock bolts). It is based on unit costs from comparable projects or experiential values and can be used for cost quotes in the tender phase.

In drafting the bill of quantities, provision for risks for items such as force-account works, downtime days, and excavation disruptions should be considered and categorized as risk costs when determining overall costs.

3.1.2.4 Contingencies (For Undefined Elements)

Additional amounts for contingencies are included for those components of a project that are expected to be realized, based on current knowledge of the project, but have not yet been described in detail and whose costs cannot be specifically determined.

Adding contingencies allows for a sufficiently complete base cost to be determined even though there are unknown elements due to an incomplete project definition at a particular time. The amount of contingency to be added is dependent on the level of project definition and the type of project. As the project advances and more details are available, contingency costs may be replaced by known estimated values plus provision for risk costs.

3.2 Value Adjustment and Indexation (I)

3.2.1 Basic Principles

Value Adjustment is used to take into account a real market price development from, or related to, a certain reference date, which was previously included in Escalation. The Value Adjustment is a component of the initial escalation (E) (see Figure 3).

Two components should be distinguished:

- Before an active contract award, in which case a value adjustment is applied, and
- After a contract becomes active, in which case indexation is applied.

If costs are determined before a contract is signed, changes in price caused, among other factors, by inflation plus market factors (the interaction between demand and supply) will be considered in value adjustment.

With signed (active) contracts, price adjustments are generally planned for and made based on contractually stipulated cost indexes or agreed-upon inflation related to project-specific commodities. In contracts with fixed pricing, the cost component for indexation is zero.

3.2.2 Determination Value Adjustment

Value adjustment covers price fluctuation for contract services that have not yet been awarded, which occurs between the reference date for the related base cost and the current reference date ("cut-off date"). Value adjustment for the base cost is calculated from the reference date to the base cost per the current reference date ("cut-off date") (see Figure 3).

Costs may vary in proportion to market price fluctuations (price indices).

3.3 Risks (R)

3.3.1 Basic Principles

Predicted project costs must include provisions for risks that may occur, appropriate to the status and character of the project.

Risks are the combination of probability and consequence and may be either threats (negative consequence) or opportunities (positive consequence). The ability to characterize risk (quantification of probability and consequence) improves with increasing knowledge of the project as well as the experience of the project team and involved experts.

If risks actually occur during project development and/or construction, in principle the associated cost components can be added to the base cost and removed from the estimated risk cost (since the risk has occurred). The same approach applies also to opportunities.

Since risks are treated on a probabilistic basis, normally a one-to-one correspondence of actual (realized) risk costs to the estimated risk costs will not exist. This means that, while a specific risk that has occurred can be "retired" from the risk register, the overall risk profile (the sum of future estimated risk costs) should be reduced conservatively.

3.3.2 Structure of Risk Evaluation

A structured risk evaluation is a basic process for estimating potential risk costs. Risk costs are divided into identified risks and mark-up for unknowns[1]:

Identified Risks + <u>Mark-up for Unknowns</u> = Risk Costs (R)

Identified risks include, based on the phase of the project, all characterized individual risks. The completeness of the identified risks depends on the level of knowledge of the project and the scope and quality of the risk analysis.

Unknowns can be divided into:

Unidentified Risks + <u>Unidentifiable Risks</u> = Unknowns

The completeness of **unidentified risks** depends on the knowledge of the project and the scope and quality of the risk analysis. **Unidentifiable risks** cannot be identified using risk analysis and therefore only become known when such risks actually occur.

Three methods are used to determine risk costs:

- Benchmark method
- Risk identification and characterization
- A combination of the two

The choice of method is up to the project team and contracting authority and can be made on the basis of the following aspects and considerations (these are listed as examples – other factors are also possible):

- Size of the project (quantified by predicted project costs)
- Complexity of the project and its environment
- Uniqueness, lack of precedent or comparative projects
- Public perception of the project (opposition or support)
- Available data (knowns vs. unknowns)

If using the benchmark method, the total risk costs are determined as a lump sum without distinguishing between identified risks and unknowns.

If using an individual risk evaluation, risk costs are determined from the sum of all identified risks plus a certain amount (allowance, contingency) for unknowns that is added to the risk costs. The resulting amount is then added to the base cost to give the total estimated project cost. More information and an example of the methods are included below.

[1] Please note the possibility of considering separate cost mark-ups by the contracting authority according to Section 0.

3.3.3 Process Sequence

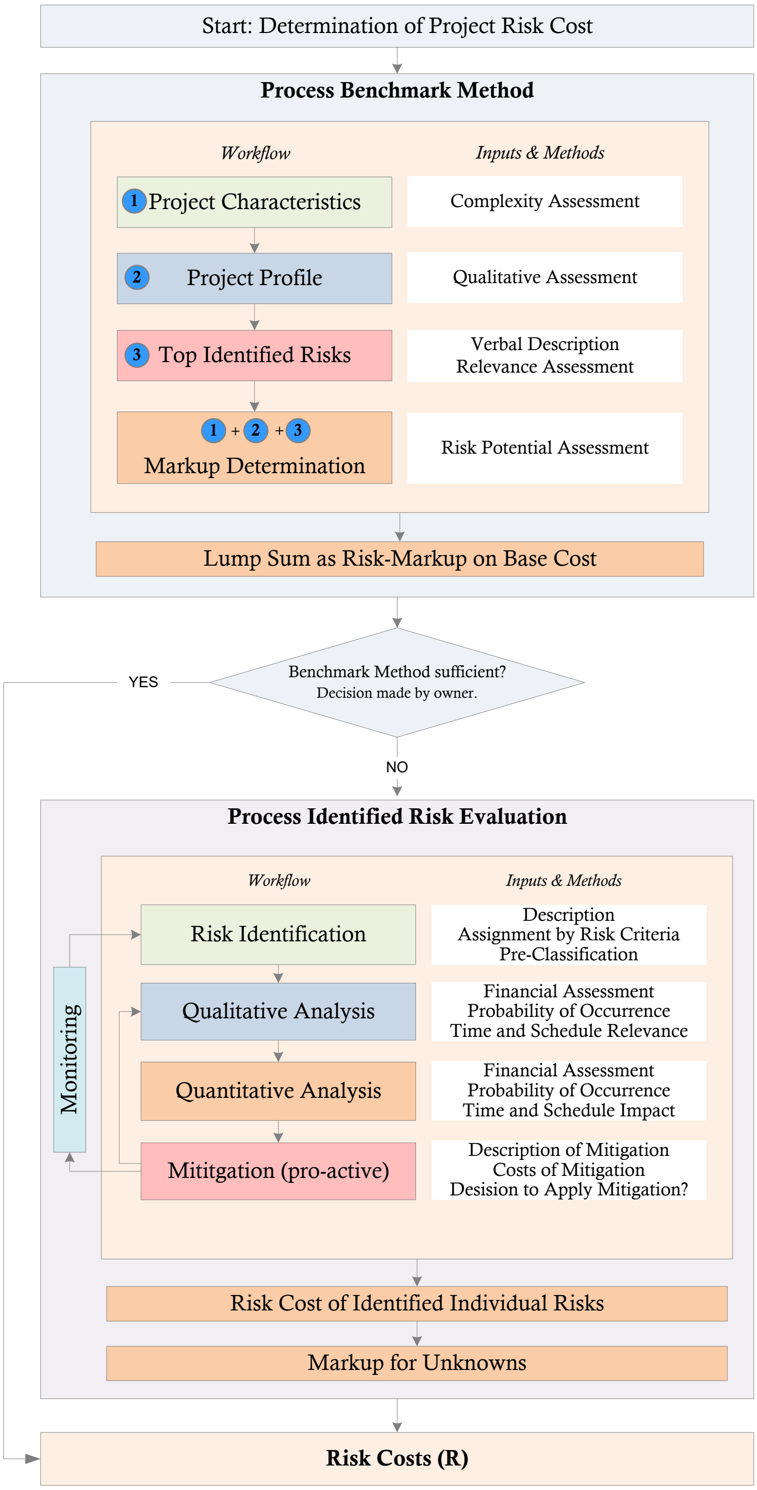

Figure 4: Sequence of steps in determining risk costs for the project

It is recommended that this process be organized in a structured manner with an expert cost/risk moderator and that the process be executed as follows:

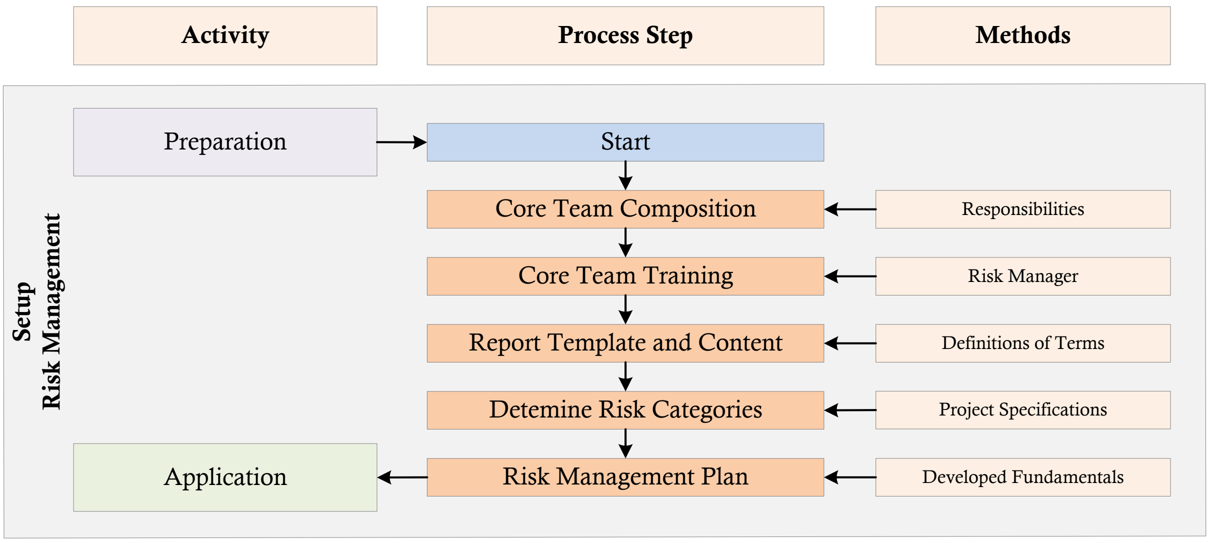

Figure 5: Preparation of the Risk Identification and Characterization process

3.3.4 Risk Breakdown Structure

The following list of risks is divided into categories in order to support administration of the risk identification and characterization process. The following structure follows from an evaluation of risk causes (triggers) to ensure that duplicate risks are not included.

Table 2: Classification and Structuring of Risks

Abbr.	Category	Typical Description	Examples
PD	**Planning Development**	The development of project detail in the planning stage with no change of project scope.	Advancing design of project elements with increased understanding and definition.
CO	**Cost**	Updated estimation of cost with unchanged project scope.	Obtain cost quotes for the E+M cost of a power plant.
RE	**Real Estate**	Cost and/or schedule changes caused by changes or updates in real estate acquisition.	Delays as a result of prolonged processes or required authorizations for real estate acquisition, which is necessary for the project. New considerations of official real estate acquisition requirements.
AU	**Authorizations**	Changes in the requirements for, or processing of, authorization procedures.	Delays in obtaining approvals. Consideration of new official requirements.
CT	**Contract**	Contract modifications	Deviations (changes) in the contract, that are necessary, in order to achieve authorized project
01	***Contract modifications***	Additional specifications or requirements, which do not appear in the contract, but are necessary to complete the project.	Missing work in bill of quantity.
02	***Quantity deviation***	Quantity deviations from the initial contract with no changes to project scope.	Amount of excavation is more than planned
03	***Contract disputes***	Different interpretations of contract by client and contractor.	Type of ground is different that planner by owner and/or anticipated by contractor.
04	***Process optimization***	Changes required for optimization of contracted services with no change of project scope.	Alternative excavation support system, value engineering required changes.
05	***Changes in design***	Changes to design requirements with no change of project scope.	Mistakes or errors in planning or design services.
06	***Compliance with requirements or agreements***	Contract compliance.	Compliance with official requirements and agreements, that were known at the stage of planning/design but were not implemented in the
CH	**Change Order**	New or changed requirements for the project ordered by the client.	Changes in project scope or schedule or conditions, compliance with third-party needs.

Table 2: Classification and Structuring of Risks (Continuation)

GC	**Ground Conditions**	Changed requirements, originating from unknown or insufficiently known underground conditions.	For example: -changes of soil classifications -ingress of water, additional flows -cave-ins
01	*Changed conditions*	Conditions are different than planned or assumed.	Differences between predicted and actual underground conditions, soil types, quantity of water
02	*Design assumptions*	Differences between planned and actually occurring ground or support system behavior.	Changes to shotcrete or reinforcing required in construction under the observational method.
03	*Unforeseen events, circumstances*	Occurrence of unforeseen underground conditions.	Gases, ingress of water, collapse, running sands, high abrasivity.
MF	**Market Forces**	Changes in prices and/or costs, that originate from market forces such as limited availability of labor or materials.	Inflation + escalation, general market conditions, economic conditions, changes in costs or fees, tracking errors, limitations on competition, difficulties in awarding contracts.
FU	**Funding**	Risks due to difficulties in funding or obtaining authorizations, deviations from planned financing models.	Rising interest costs due to short-term financing (supplementary financing) or due to amended foreign currency loans, reduced revenues.
PE	**Project Environment**	Environmental or project context changes, which affect the progress of the project or project costs.	Differences between contractual partners, contractor deficiencies, owner issues, internal/management risks.
01	*Third party costs*	Expenses or requirements relating to local residents or municipalities.	Additional measures (protection against dust, noise, etc. - not required by regulations), public events, citizens' initiatives, demonstrations, educational events, information material.
02	*Basic infrastructure*	Changes in basic infrastructure elements.	Road closures, restrictions of transit at local areas, power and water supply.
03	*External interfaces*	Changes of contract and/or project interfaces, which may not be in the client's sphere of influence.	Changes in authority, responsibilities, deferrals to other projects, changes in laws or regulations, new interpretations of regulations.
04	*Law, regulations, requirements*	Changes in laws, regulations, requirements.	Laws/guidelines/standards/provisions/official requirements.
05	*Adjacent Structures*	Deviations in extent, quantity and/or quality, between assumed and discovered conditions, of buildings or adjacent structures.	Neighboring houses that are in danger of damage or collapse
06	*Safety, Security*	Additional measures required to avoid incidents that endanger the public or construction site safety.	Thievery, vandalism, security services, health and safety requirements on the construction site
IN	**Internal**	Changes as a result of internal changes to project (e.g. management).	
01	*Staff*	Personnel resources and management.	Staff turnover, staff reduction, changes in staff deployment; issues with staff qualifications, staff availability.
02	*Organization*	Organizational management.	Clarity of organization, definition of roles and responsibilities, issues with internal and external communication, management of scope and schedule.
CN	**Contractual**	Contract Changes	Changes in costs or schedule or requirements, associated with project participants and new requirements, not necessarily arising from changes to
01	*Interface*	Interface requirements that are in the client's sphere of influence.	Organizational interfaces with contractor or third parties which impact cost or schedule.
02	*Contractor*	Suitability, capability	Qualifications, quality of execution, potential insolvency, technical, economical and financial performance issues, reliability and authority.
FM	**Higher forces, Force Majure**	Effects of higher level forces or Force Majure to an extent that is more than usually expected in planning or design.	Earthquakes, flood, avalanches, war, extraordinary weather conditions, storms, environmental disasters, strikes, labor disputes.

3.3.5 Benchmark Method

The benchmark method is a fast way to determine risk-related contingency costs, in terms of a lump sum amount added to the base cost. It is a function of the impact of construction and other conditions and is related to the project phase. There is no breakout or assessment of individual risks.

It is advisable to use the benchmark method with an expert moderator and to develop a spreadsheet – for an example, see Appendix 10.2.

From a qualitative point of view, the following aspects should be considered:

1. Project Complexity

   Note: The complexity of a project depends on the quantity of interacting components. Other relevant factors are the number of contractors, the number of the project participants, the previous experience of project participants, the project context, and timing. Complexity should, ideally, be defined jointly by the planner or engineer and the contracting authority.

2. Project Profile

   - Project base conditions
   - Project context
   - Maturity of planning
   - Approvals required
   - Construction sites
   - Contractual partner(s)

3. Definition level for identification and characterization of risks without quantitative evaluation

These aspects are used and considered for a qualitative assessment of potential risks for the project or parts of the project, often stated as a percentage of the base cost.

The ranges for added contingency (lump sum cost increase over base cost) for risks, including identified, quantified risks and unknowns, are shown in Figure 6.

In Figure 6 the approval phase is differentiated into two phases (also see Table 1) in order to determine the benchmarks. This differentiation can be used in a two-step authorization procedure.

3.3.6 Risk Identification and Characterization of Individual Risks

In the single risk assessment method, multiple phases are evaluated, focusing on the identification, characterization, and management of individual risks specific to each phase. This method is based on the principles of ISO 31000.

The following sequence is recommended:

- Identification of individual risks using a risk fact sheet.
- Classification of the identified risks according to Table 2.
- Pre-classification of risk scenarios according to section 11.3.
  This classification will help to decide whether each risk should undergo further analysis.
- Qualitative evaluation of risks without taking mitigation measures into account (as an example, see Figure 15).
- Based on the results of the evaluation, mitigation measures can be defined and risks are then re-evaluated for a revised probability of occurrence and impact. The cost of such mitigation measures, if implemented, will be taken into account in the base cost.
- Once the qualitative risk analysis is complete, a decision can be made as to whether a quantitative risk evaluation is required. The option of analysing and defining risks using a range approach (as described in Section 3.3) provides the basis for the probabilistic approach. It is up to the contracting authority whether to use a deterministic or probabilistic method for quantitative risk assessment. If at a given point in time a quantitative analysis is not feasible, the process stops with the qualitative documentation of the risk. Risks can then be quantified at a later date.
- Even with this method, not all individual risks can be identified. Therefore, an additional mark-up for "unidentifiable risks" should be added.
- Results from the individual risk fact sheets should be aggregated.

In quantitative analyses, the probability of occurrence is given as a percentage and the financial impact is expressed in monetary units (costs). In general, deterministic and probabilistic methods differ as follows:

With deterministic analyses, risk is the product of the estimated probability of occurrence [p] and the impact [I]. The product is the predicted value for risk costs. With multiple risks, the total risk is the sum of the single predicted values of the risk costs. The predicted value of the risk costs is calculated using the following formula:

$$R_{Ges} = \sum p_i * A_i$$

When using probabilistic methods, the financial impact of risks is more realistically assessed using probability distributions. Computer simulations to model the probable outcome, such as the Monte-Carlo Simulation, are needed for this method.

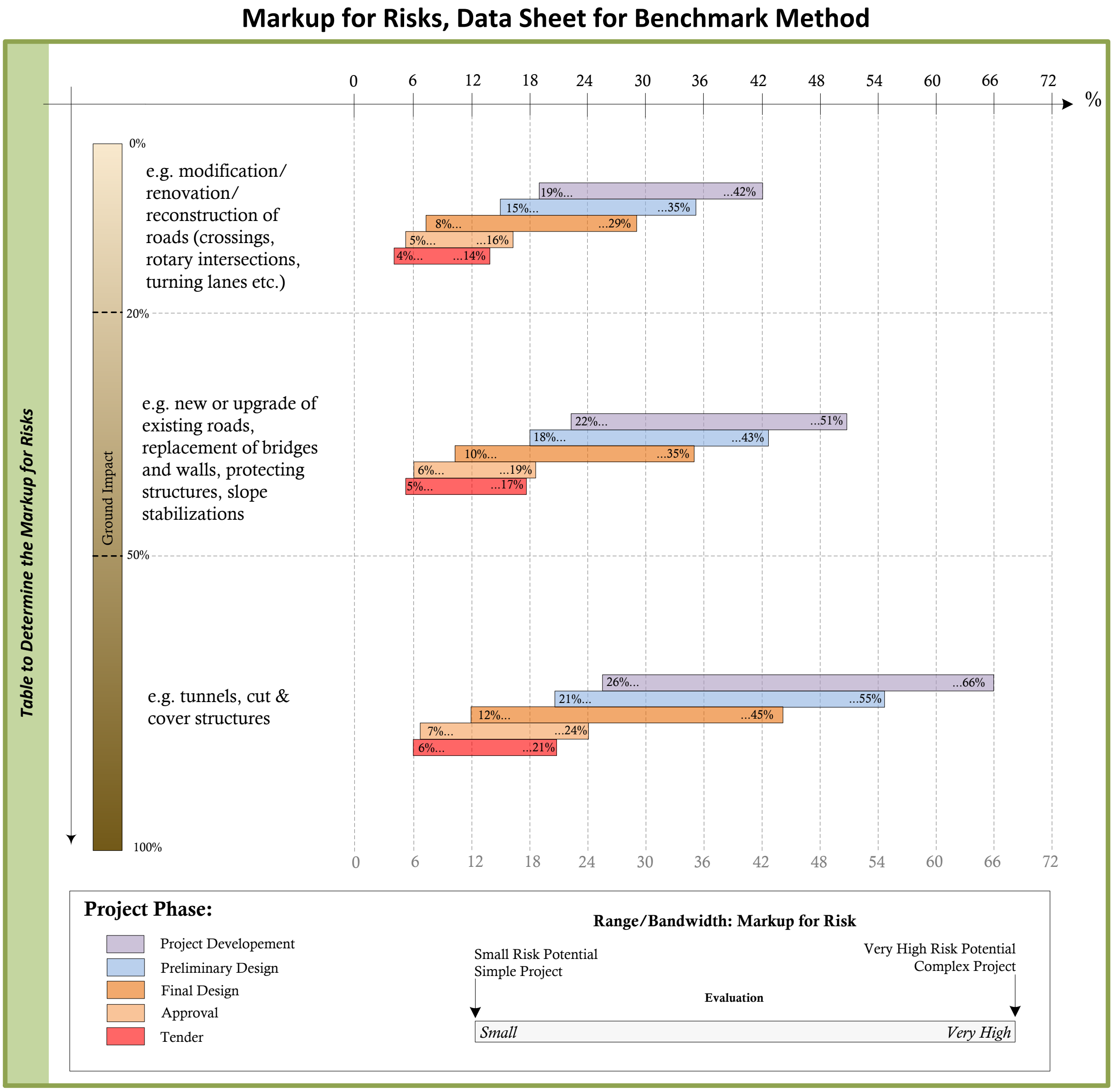

Figure 6: General Ranges for added Contingency by Project Phase

Table 3: Comparison of deterministic and probabilistic methods

	Deterministic Method	Probabilistic Method
Input	Indication of a single value for probability of occurrence and for impact of each risk.	Risk analysis requires an input value for the **probability of occurrence** and, for example, **three values for the impact** (minimal, expected, and maximum). This takes into account an "uncertain" prediction in the risk evaluation.
Result	A simple sum of the predicted values of the single risks (impact times probability of occurrence) gives the predicted value for the total risk, but not the most probable risk cost.	Simulation methods deliver the range of the total project risk as a probability distribution.
Statement	The result is a single number that gives no information regarding cost certainty.	The resulting probability distribution delivers a prediction for a certain risk. By using the probability of not exceeding a certain value within the given distribution, defined by the contracting authority, a predicted level of cost certainty can be determined.

3.3.7 Risk Mark-ups by Contracting Authority

Based on specific benchmarks, considerations, and experience of the contracting authority, it may be necessary to define certain separate contractor-specific cost increases to be added to the risk cost.

3.4 Escalation (E)

3.4.1 Basic Principles

Since transportation infrastructure projects generally take a long time to be realized, the cost increase due to escalation is of significant importance.

Cost indices for escalation are a methodical approach that takes into account assumed future market fluctuations from a specific cut-off date until the end of the project. Unlike value adjustment (I), these costs consider market price developments as of a certain cut-off date as cost indices for escalation (E).

Consideration of escalation is meant to give the best possible estimate of future price fluctuations on the construction market (such as construction or producer price indices) for not yet awarded services and, on the other hand, for the future development of contractors' internal costs (such as construction cost indices), while taking into account the various cost groups (land acquisition, tunnel construction, etc.).

If projects or parts of project are delayed, escalation will vary. If indices are increasing, delays will lead to higher estimated total BIRE project costs.

3.4.2 Determination Escalation

Determining escalation (E) requires a schedule of deliverables for services to be provided, broken down into project phases, and a market assessment for each phase.

In long-term projects, escalation (E) can be determined by using a constant percentage for all cost groups for the annual variation, to be applied to both value adjustment and indexation. This is because over the long term it can be assumed that costs and prices, which differ only by the profit margin plus risk mark-ups and by productivity, will neither converge nor spread. The percentages are to be applied to the planned future costs using a compound interest calculation. The appropriate percentages should be added to the predicted project costs (BIR).

The definition of the percentage is up to the contracting authority, which can define the percentage on the basis of the escalation (inflation/deflation) rates of the last years.

4 Aggregation of Cost Components

The determination of total estimated project costs (BIRE) requires the aggregation of the cost components of Base Cost (B), Escalation (E), Risk (R), and Prospective Value Adjustment (I). The type of aggregation to be used is dependent on the methods used to determine the individual cost components.

BIRE = B + I + R + E

If all cost components have been calculated in a deterministic manner, they are added together arithmetically. The result (BIRE) is then a deterministic value whose probability of occurrence cannot be predicted. Therefore, no quantitative statement can be made as to the degree of cost certainty.

If at least one cost component – for example, risk costs – has been determined using the probabilistic method, the aggregation should be carried out according to the rules of the probabilistic method. Estimated project costs and cost certainty can then both be assessed, based on the resulting probability distribution of the aggregated cost components (BIRE). The cost certainty mentioned in this context (Value at Risk or VaR) refers only to those cost components that were determined probabilistically.

For a probabilistic estimation of cost components, the contracting authority can choose a specific probability for budgeting, considering the likelihood of cost over or under runs.

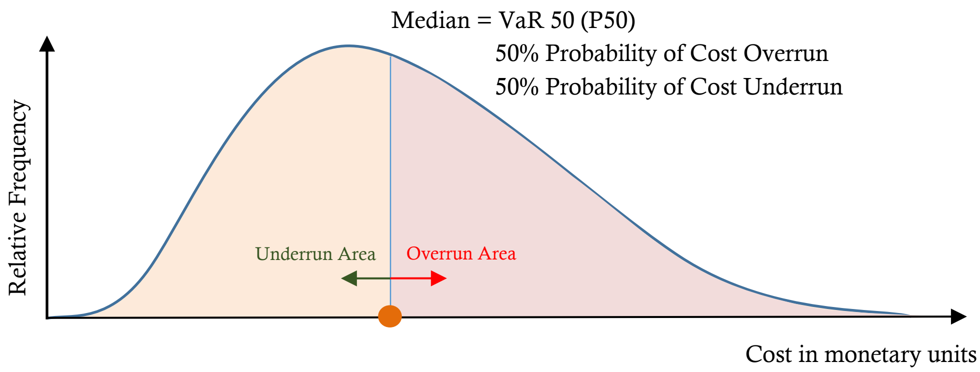

Figure 7: Representation of median value (50% probability of underrun, 50% of overrun)

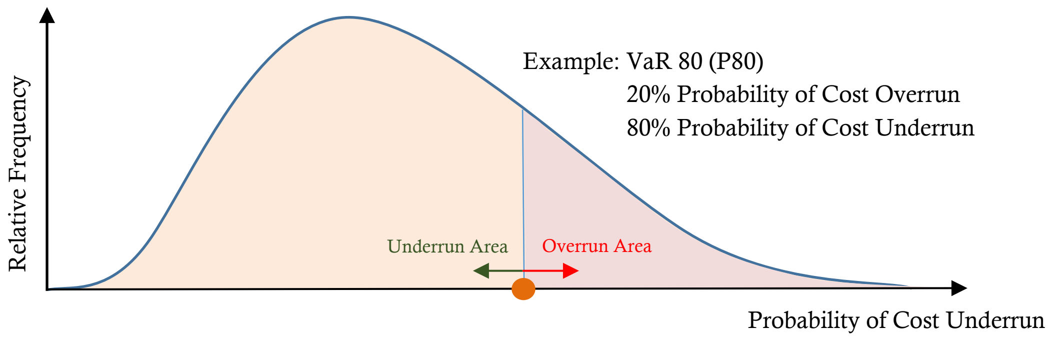

Figure 8: Representation with an 80% probability of underrun and 20% of overrun

5 Cost Management

During the construction phase, cost management requires periodic checks of the estimated project costs. Cost prediction as a whole must be updated taking into consideration the results of the tender procedures and the changes in the services required during execution. Project costs, then, consist of the actual costs for services that have already been delivered and predicted costs for services yet to be performed, an appropriate risk provision, and the costs pursuant to the prospective value adjustment for escalation until the end of the construction phase.

Cost monitoring in the construction phase, and the actual costs as part of project costs, are not the object of this guideline.

6 Final Accounting

Once the project has been completed and after all final invoices have been accepted, the total project costs (actual, out-turn costs) will be determined and defined.

The result is the basis for the subsequent management and amortisation of the infrastructure and is used to assign a value to the infrastructure in order to obtain cost benchmarks.

7 Bibliography

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8 List of Tables

9 List of Figures

10 Annex

10.1 Checklists for Further Breakdown of Cost Groups

1 Project Management

- Project auditing
- Project direction
- Project guidance

2 Land Acquisition

- Assessment property acquisition, land acquisition, servitudes
- Expropriations
- Reimbursement for spoil
- Drawing up of agreements
- Drawing up of partition plans
- Use of land in the prospection phase
- Land acquisition
- Expert opinions concerning hunting, forestry, fishing, impacts on wildlife
- Expert opinions and authentications
- Expert opinion on pecuniary damages e.g. water rights
- Notary's fees
- Property acquisition
- Attorneys' fees
- Servitudes
- Costs for trustee services
- Agreements with infrastructure owners (companies)
- Agreements with fire fighters
- Agreements with municipalities
- Agreements with private companies
- Agreements with transport carriers
- Registration in land registry after final topographic measurements

3 Planning Services

- Planning of construction works
- Basic planning of construction works
- Preliminary planning of construction works
- Draft and approval planning of construction works
- Tender planning of construction works
- Executive planning of construction works
- Survey and assessment of construction works once built
- Documents for subsequent work concerning construction works
- Conceptual planning of equipment and outfitting systems
- Basic planning of equipment and outfitting systems
- Preliminary planning of equipment and outfitting systems
- Draft and approval planning of equipment and outfitting systems
- Tender planning of equipment and outfitting systems
- Executive planning of equipment and outfitting systems
- Survey and assessment of equipment and outfitting systems once built
- Documents for subsequent work concerning equipment and outfitting systems
- Conceptual planning of environmentally relevant measures
- Basic planning of environmentally relevant measures
- Expertise for tender procedures
- Altitude model data
- Preliminary planning of environmentally relevant measures
- Draft and approval planning of environmentally relevant measures
- Tendering planning of environmentally relevant measures
- Executive planning of environmentally relevant measures
- Survey and assessment of environmentally relevant measures once built
- Documents for subsequent work concerning environmentally relevant measures
- Expert opinions as prescribed by §31a
- Construction management as prescribed by §40
- Runoff calculation
- Acceptance tests
- Aerodynamics and tunnel climate
- Airborne Laser scanning
- Accompanying architectural planning of structures
- Tender preparation and offer evaluation
- Geological documentation, consulting, planning and elaboration
- Calculations in construction physics
- Preliminary construction planning
- Requirement analyses
- Calculation of power consumption in the operational phase
- Calculations for operational management
- Calculations of capacity utilisation rate
- Database for requirements of notifications
- Consulting services in cement technology
- Work regulations for technical systems
- Economic assessment
- Evaluation archaeological artefacts
- Evaluation of war relics
- Geomechanical expertise (soil mechanics)
- Geomechanical laboratory tests (soil mechanics)
- Database for hydrogeological, geological, ventilation measurement values etc.
- Detailed analyses for subsoil modelling
- Documentation requirements of notifications
- Simulations of breakthrough errors
- Obtaining basic data
- Analysis of earthquake intensity
- Local enquiries (e.g., fish, macrozoobenthos, phythobenthos, flora, fauna)
- Elaboration of design principles
- Elaboration and adaptation emergency folder
- Geomechanical expertise (rock mechanics)
- Geomechanical laboratory tests (rock mechanics)
- Geomechanical special procedures on fault rocks
- Forest ecology planning
- Geodetic basic data
- Geo-information systems
- Geophysical prospection of fault zones
- Geotechnical experts
- Elaboration of an overall time schedule
- Total economic evaluation
- GPS reference network test

- Hydrogeological documentation, consultancy services, planning and elaboration
- IOP-tests
- Cadastre data
- Acceptance documents
- Cost for tender procedure or public order publication
- Cost calculations
- Cost verifications
- Prescribed costs due to authorization procedures
- Laboratory tests
- Life-Cycle-Cost calculations
- Analysis of aerial photos
- Disposal plan for spoil
- Nature conservation planning
- Ecological planning
- Orthophotographs
- Planning management
- Planning and construction coordination
- Swelling test
- Regional economic assessment
- Reproduction of planning documents
- Risk analyses for the construction and operational phases
- Risk analyses cost determination
- Safety plans
- Simulated calculations (e.g., ventilation, smoke extraction, electrical fire, evacuation)
- Software developments
- Static calculations and construction planning
- Morale analyses
- Tunnel and surface seismology
- Route planning
- Tectonic and structural geology analysis
- Structure design services
- TSI evaluation per phase
- Experts on tunnel construction
- Tunnel safety concept
- Analysis of the influence of alternating current on gas pipelines
- Analyses concerning water resources
- EIA expert fees
- Variant analyses
- Transportation analyses
- Expertise on Transportation safety
- Transportation assessment
- Economic assessment
- Water balance management
- Central project folders

*Note: Evaluation must be done per phase and system and/or measure

4 Monitoring

- Waste analysis
- Waste chemical analyses
- Asphalt testing
- Accompanying surveys during construction
- Preparatory construction work surveys
- Accompanying geotechnical testing during construction
- Concrete testing
- Monitoring of streets, real estate, installations
- Borehole tests
- Borehole topography
- Chemical analysis
- Detailed survey and inventory of pre-existing structures
- Fish stock saving and fish stock survey
- Extraction of frozen ground core samples
- Geophysical measurements
- Bedload analysis
- Basic principles of spoil classification
- Hydrochemical and isotopic-hydrological analyses
- Inclinometer measurements and anchoring force measurements
- Clearance of explosive ordnance
- Climate measuring stations
- Control surveys
- Perpendicular deviation surveys
- Material testing and quality controls
- Measurement and calculation of electromagnetic fields
- Monitoring for soil management, agriculture and forestry
- Monitoring of discharge points into waters
- Monitoring of vibrations
- Monitoring of river ecology
- Monitoring of hydrogeology
- Monitoring of noise protection barriers
- Monitoring of air/dust emissions
- Monitoring of springs, wells, etc.
- Monitoring of ecology
- Level measurements
- Soil mechanics testing
- Retention samples of concrete and test structures
- Gravel testing
- Vibroscan analysis
- Concrete testing, asphalt testing

*Note: Evaluation must be done per phase and system and/or measure

5 Construction Supervision or Service Providers in the Construction Phase

- Acceptance testing of concrete, asphalt, waterproofing, etc.
- Construction management
- Construction site coordination in accordance with the Bau KG (Austrian Construction Work Coordination Act)
- Official acceptances
- Official construction supervision (water legislation, disposal site, hydrogeology, etc.)
- External accompanying inspection
- External cost management
- Geotechnical experts for in situ underground work
- Ordnance technical safety during construction
- Environmental construction supervision
- Local construction supervision for equipment and outfitting systems
- Local construction supervision for construction works
- Local construction supervision for prospection drilling
- Local construction supervision for environmentally relevant measures
- Inspecting engineer activities
- Survey services in the construction phase
- Supervisions in accordance with the water laws
- Disposal sites

*Note: Evaluation for all systems and measures

6 Construction

- Demolition work
- Waterproofing measures
- Waste disposal to external disposal sites
- Sedimentation pools
- Equipment for rest areas
- Platform equipment and outfitting
- Railway transport
- Construction site offices
- Land clearing
- Ground improvements
- Construction site communication
- Construction site set-up areas
- Construction site clearing
- Construction site security
- Construction electricity supply
- Construction electricity supply
- Structures for substitute water supply
- Plantings
- Coatings
- Signage
- Visitor centre
- Operations and ventilation building
- Operations building
- Ground markings
- Piling walls
- Bridge structures
- Roofing works
- Dam structures
- Construction for disposal sites
- Jet grouting with experimental tests
- Disposal of excavated material and concrete
- Prospection work
- Substitute water supply
- Vibration protection measures for the construction phase
- Vibration protection measures for the operational phase
- Fiber optical measuring systems
- Channel regulations
- Water treatment facilities
- Water treatment facilities
- Digging activities and laying work
- Basic cleaning
- Foundations
- Aboveground structures
- Info centre
- Info points
- Injection measures
- Injection testing fields
- Landscaping projects
- Noise and vibration protection
- Noise protection structures for the construction phase
- Noise protection structures for the operational phase
- Ventilation systems for the construction phase
- Ventilation buildings
- Construction site safety measures
- Auxiliary facilities
- Auxiliary buildings
- Emergency stop, floors, walls, doors, interior outfitting
- Superstructure
- Pilot tunnels
- Portal cuts
- Cross passages floors, walls, doors
- Tire washing facilities
- Recultivation
- Dismantling of construction works
- Holding basins
- Forestry works
- Barrier systems
- Steel structures
- Road and path network for the construction phase and the operational phase
- Road equipment
- Supporting structures
- Transformer building
- Tunnel constructions
- Tunnel coating
- Substructure
- Transportation signs
- Surveying pillars and ground points
- Preliminary works
- Preliminary works for ground-breaking
- Trench construction
- Water and brook control, avalanche barrier construction
- Access control for the construction phase

*Note: project specific

7 Equipment and Systems

- 50 Hz Energy systems
- Dismantling, upgrading and conversion of existing systems
- Axis control measurements
- Adjustment of existing software
- Lifts
- Fire Brigade Equipment
- Equipment for the surveillance centre
- Equipment logistics
- Railway equipment and outfitting
- Electrical traction systems
- Electrical systems
- Power supply systems
- Electrical grounding works
- Telecommunications
- Remote control engineering
- Ballastless track
- Radio equipment
- Building services
- Heating, air conditioning, ventilation, sanitary systems
- Communication devices
- Cooling
- Control engineering
- 20KV, 30KV, 110KV, 220KV cables
- Lighting systems
- Light mass-spring system
- fire extinguishing water supply pipes
- Ventilation systems for the construction part of the equipment and outfitting phase
- Ventilation systems for the operational phase

- Fitting and wiring works
- Network provision and network access current
- Low-voltage installation circuits
- Contact wire
- Rescue equipment
- Dismantling equipment and outfitting systems
- Switchgears
- Rails
- Cabinets for technical systems
- Security systems
- Safety installations
- Signaling and systems technology
- Signal box
- Road outfitting
- Technical equipment systems for roads
- Telecommunication systems
- Tunnel painting
- Doors
- Switch system
- Switch heating
- Train running checkpoint
- Train pre-heating systems

*Note: project specific

8 Environmentally-Relevant Measures

- Amphibian protection
- Accompanying measures
- Humid biotopes
- Ecological measures over large areas
- Ecologically functional measures
- Ecological rebalancing measures
- Protective measures for historical monuments

* Note: project specific

9 Start of Operations *

- Fire tests
- Obtainment of decree for the start of operations
- Start of operations of the entire system
- Ventilation tests
- Planning for the start of operations
- Planning of single system and whole system control procedures
- RAMS evidence
- Exercises for intervention units

* Note: project specific

10 In-house Services

- Supply of locomotive(s)
- Supply of road equipment
- Company in-house services
- Material supply
- Planning services in-house
- Look-outs
- Transportation safety measures by the highway maintenance agencies

11 Public Relations Services

- 3D-Videos
- Agency services
- Arrival plans
- Construction documentation with Webcam and orthophotography
- Construction signage
- Surveying flights
- Population polls
- Accompanying public relation services during the construction phase
- Accompanying public relation services during the construction phase -activity plan
- Supply of project information, brochures, DVDs, etc.
- Catering
- Photographic documentation
- Give-aways
- Info- and visitor management
- Information films
- Information events
- Print media insertions
- Conferences
- Fair stands
- Models
- Modelling activities
- Ombudsman
- Visitor safety equipment
- Ground breaking ceremony
- Visual aids

12 Other Items

- Construction - technical expert activities
- Hearing members
- Legal assistance during construction work
- Legal assistance for authorization procedures
- Legal assistance for tender procedures
- Legal opinions
- Expert services
- Sureties or coverage for disposal sites

10.2 Appendix to the Section "Benchmark Method"

The following two templates may be used:

- Risk Fact Sheet Project
- Diagram to determine the additional lump sum mark-up for risks

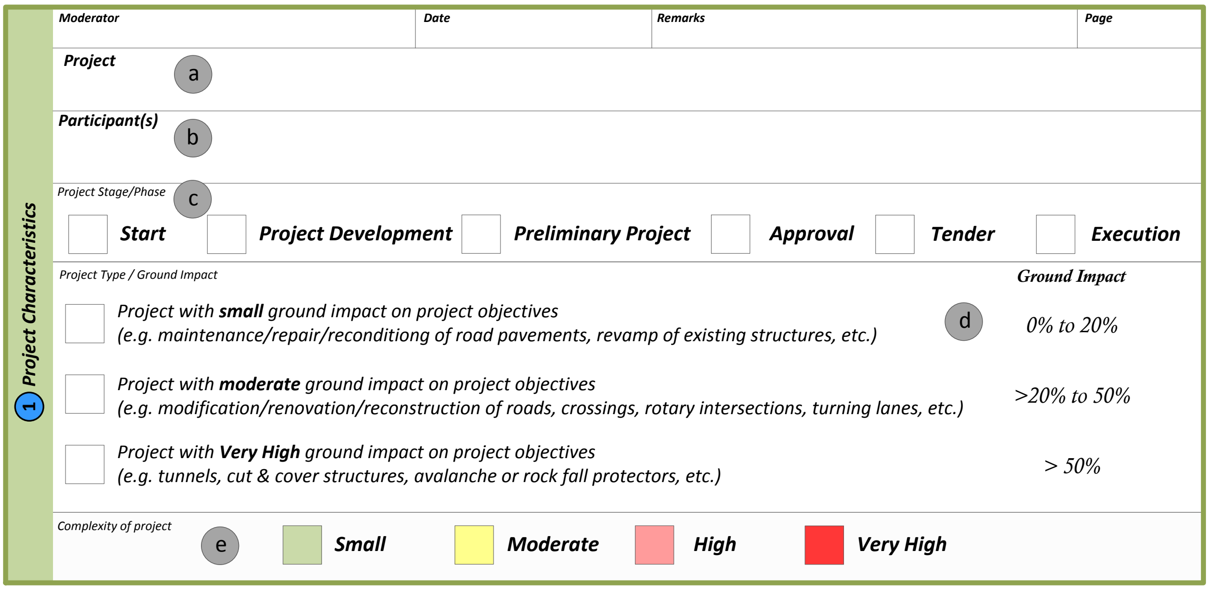

Figure 9: Data Sheet for the Benchmark Method

(a) **Project Name & Description**

(b) **Risk Team Participants**

(c) **Project Phase according to Section 3.2**

(d) **Impact of Ground Conditions**

(e) **Estimate of Project Complexity**

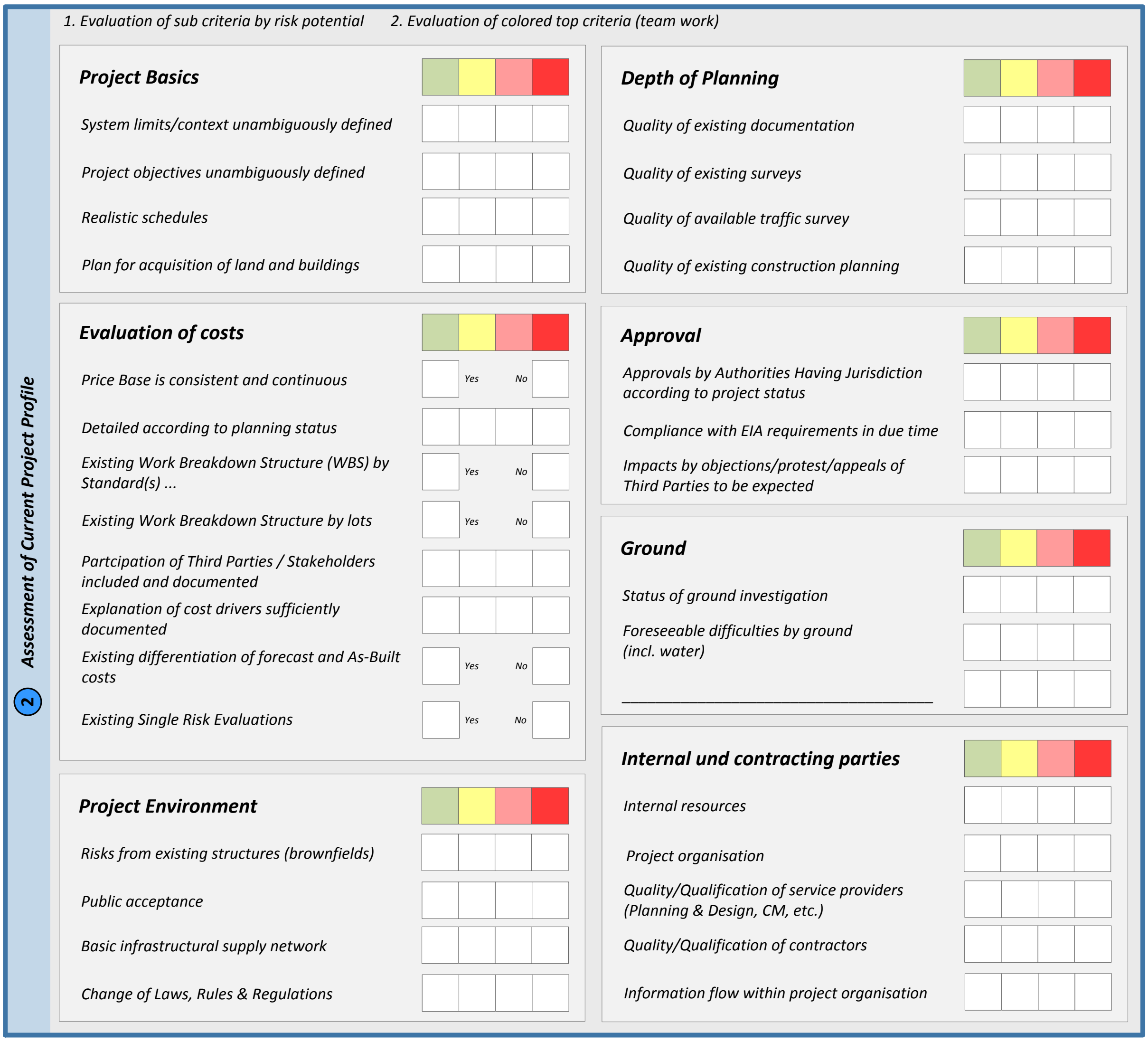

Figure 10: Data Sheet for the Evaluation of the current Project Profile

Procedure to evaluate the current project profile following certain evaluation criteria:

- 1. Step: Evaluation of the subcategories (white fields)
- 2. Step: Evaluation of the main categories following a summary evaluation of the sub-categories by the team (coloured fields)

Data Sheet for Benchmark Method

Figure 11: Data Sheet to identify Single Risks

Procedure to identify single risks:

- Brief verbal description
- Assessment of risk relevance

Note: In case of subsequent single risk analysis, single risks will be analysed and assessed with a greater degree of detail using the data sheet for single risks (10.3).

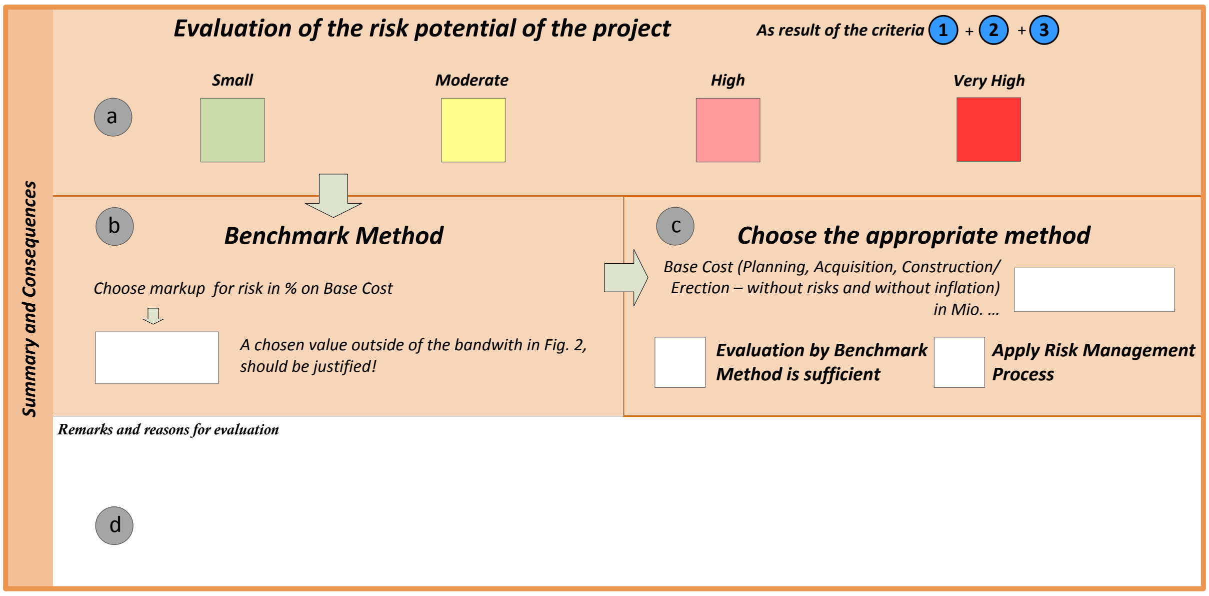

Figure 12: Data Sheet to assess the Project Risk Potential

(a) **Assessment of the project's risk potential**

together with the evaluated aspects

- Project Characteristics
- Project Profile
- Single Risks

(b) **Application of the Benchmark Method**

(c) **Decision as to whether the benchmark method is sufficient or if a method using single risk evaluation should be subsequently applied**

(d) **Reasons for the decision**

10.3 Appendices to the Section "Risk Identification and Characterization of Individual Risks"

10.3.1 Risk Identification

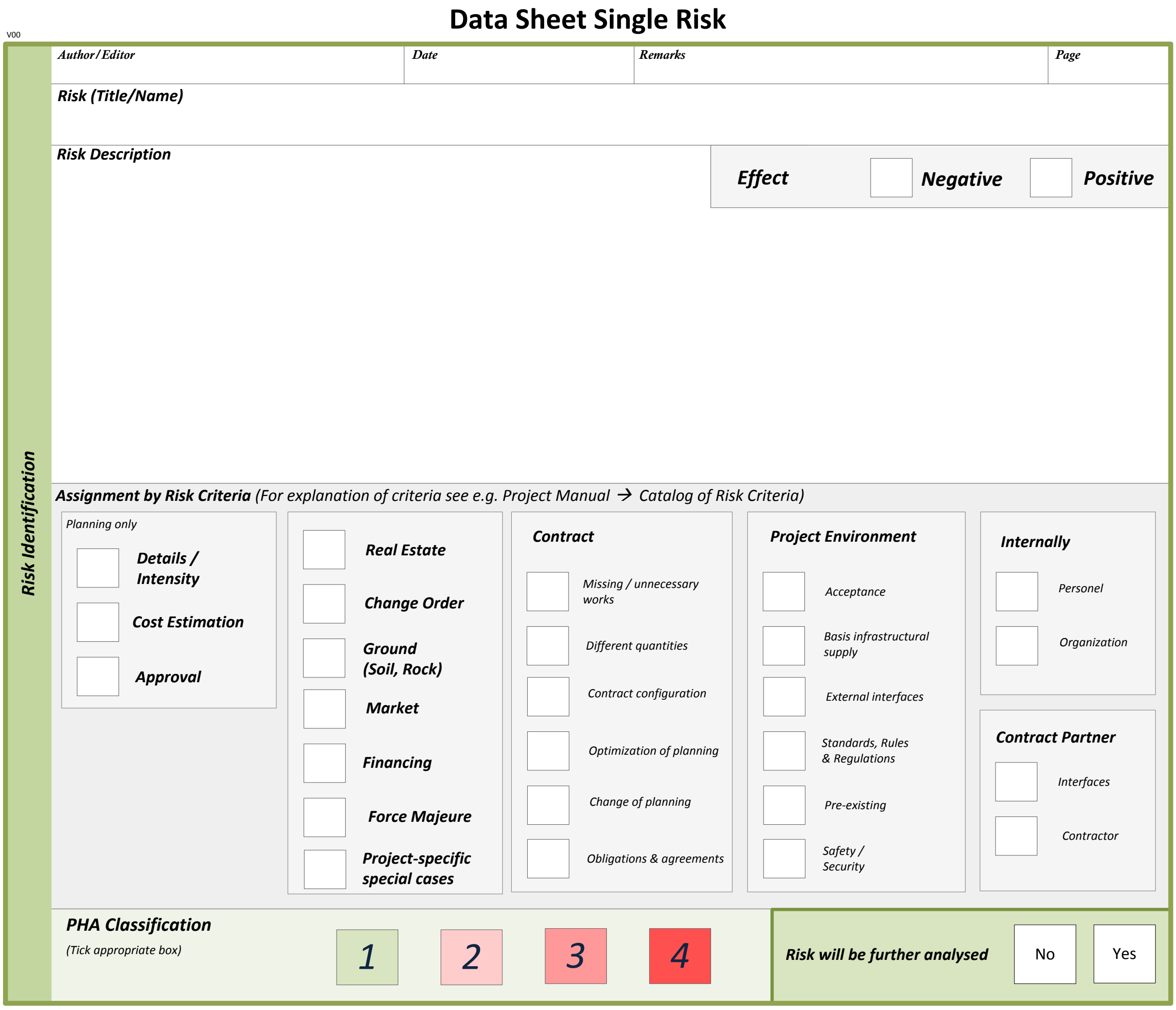

Figure 13: Pre-Classification of Single Risk

Workflow:

1. Several methods can be used for risk identification. Some recognized methods are brainstorming, 6-3-5 brainwriting method, and brainwriting pool.
2. Basic data registration: Administrators, Recorders (one or more), data and notes.
3. The identified single risks will be described verbally. Thereby, one has to refer specifically to the scenario and its causes. General descriptions have to be avoided.
4. Risk Categories will be assigned according to the table "Risk Categories."
5. Pre-Classification

The Preliminary Hazard Analysis (PHA) is a certified method (see IEC/ISO 31010) adopted specially for the classification of risks in early project phases. The aim is to identify the relevant risks. On the basis of the results, resources and further analysis methods can be applied to the relevant risks in a focused manner. The procedure can be summarized as follows:

- Listing of risk scenarios
- Classification of risk scenarios
- Decision as to which threats will be analysed in-depth as risks
- Documentation of the results

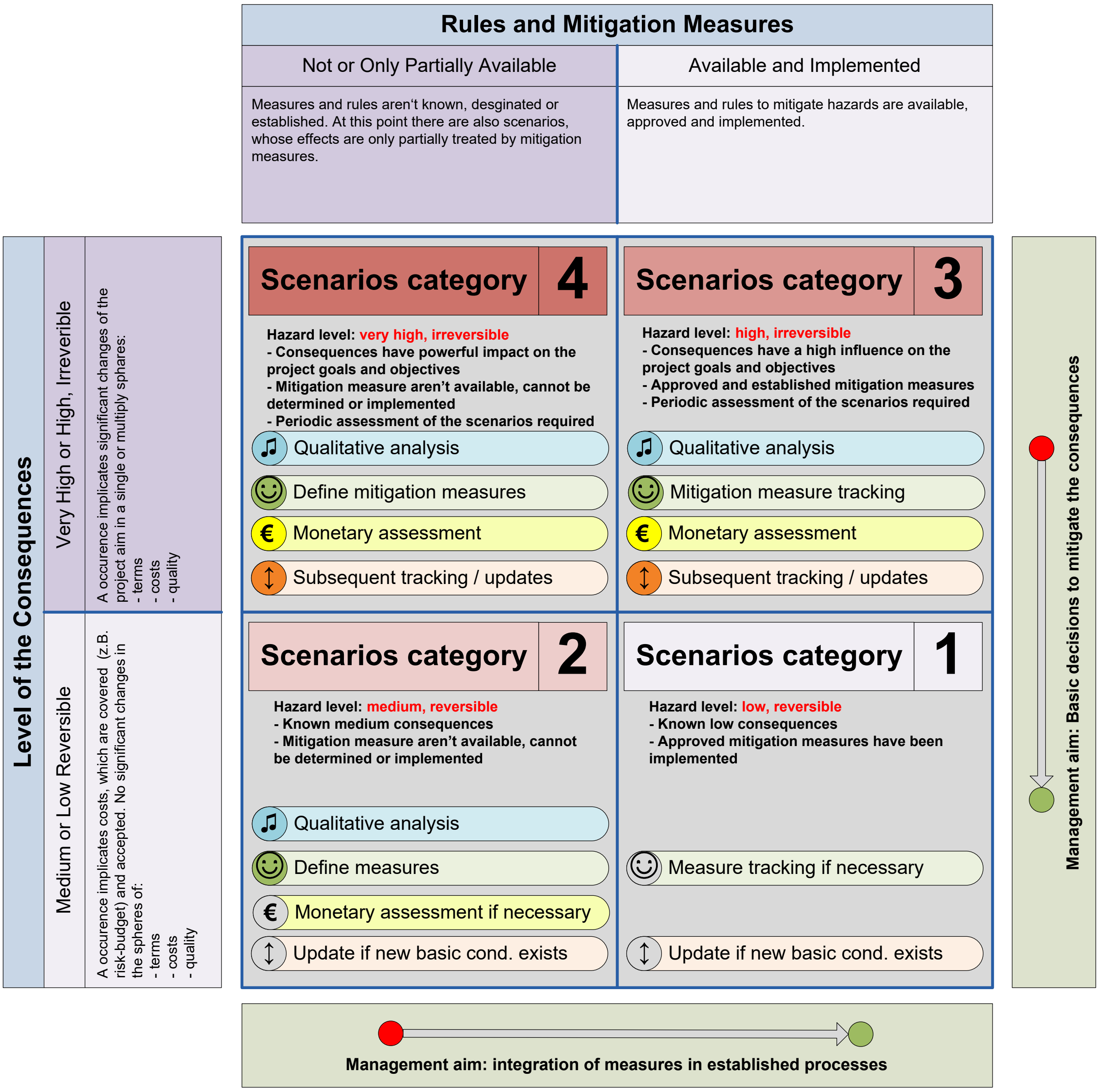

Figure 14: Classification of Risk Scenarios (Preliminary Hazard Analysis Matrix)

Based on the result of the PHA, a decision will be made whether to evaluate the risk in greater detail.

10.3.2 Qualitative Risk Analysis

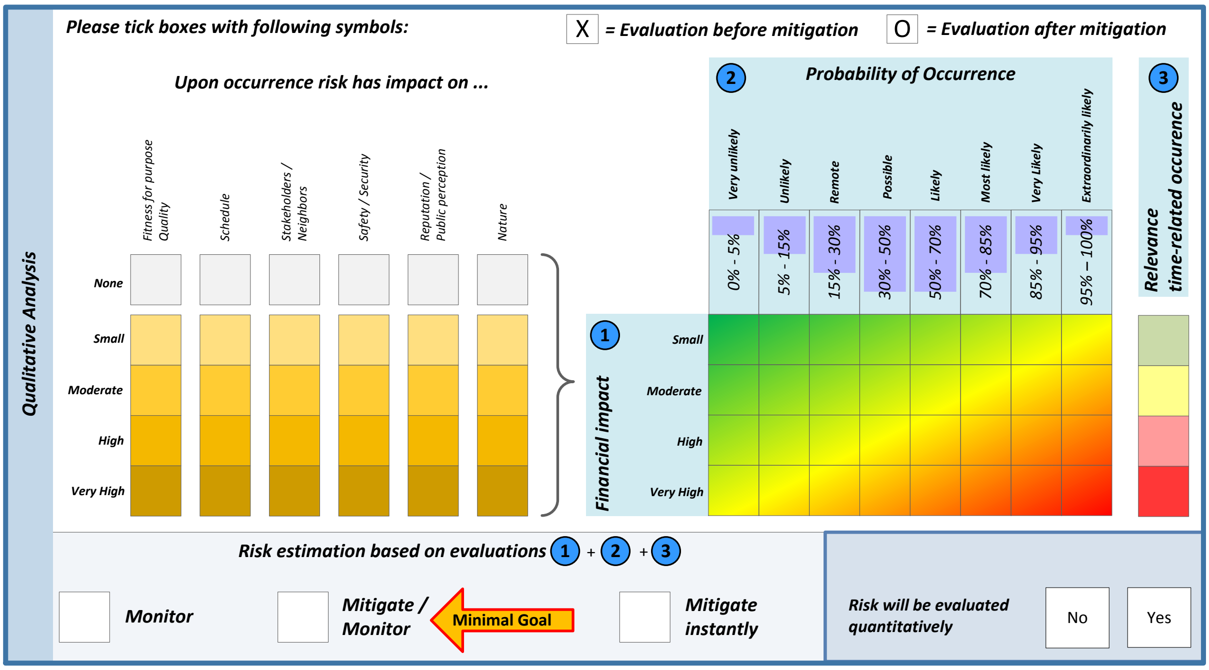

Figure 15: Data Sheet for Qualitative Analysis of Single Risks

Workflow:

1. Qualitative analysis should be done before measures are implemented. Therefore, an "X" is used to select evaluation before mitigation.
2. First of all, the implications of risk occurrence on the six categories of Fit for Purpose, Schedule, Involved Parties/Neighbouring Communities, Safety/Security, Reputation/Public Relations and Environment should be evaluated.
3. Together for all these six categories, the
   - Monetary impacts have to be evaluated and
   - Probability of occurrence has to be assessed and
   - Urgency should be evaluated.
4. From an overview of the above mentioned three evaluations, risk should be assessed as a whole as:
   - Act immediately
   - Act/Monitor
   - Monitor only
5. Once measures have been implemented (in following steps), the evaluation should be performed again in a similar way in a second walk-through. There, an "O" will be used to select evaluation after mitigation.
6. Once measures have been defined, all risks categorized as "to be handled immediately" should be lowered at least by one level.

10.3.3 Quantitative Risk Analysis

Data Sheet Single Risk

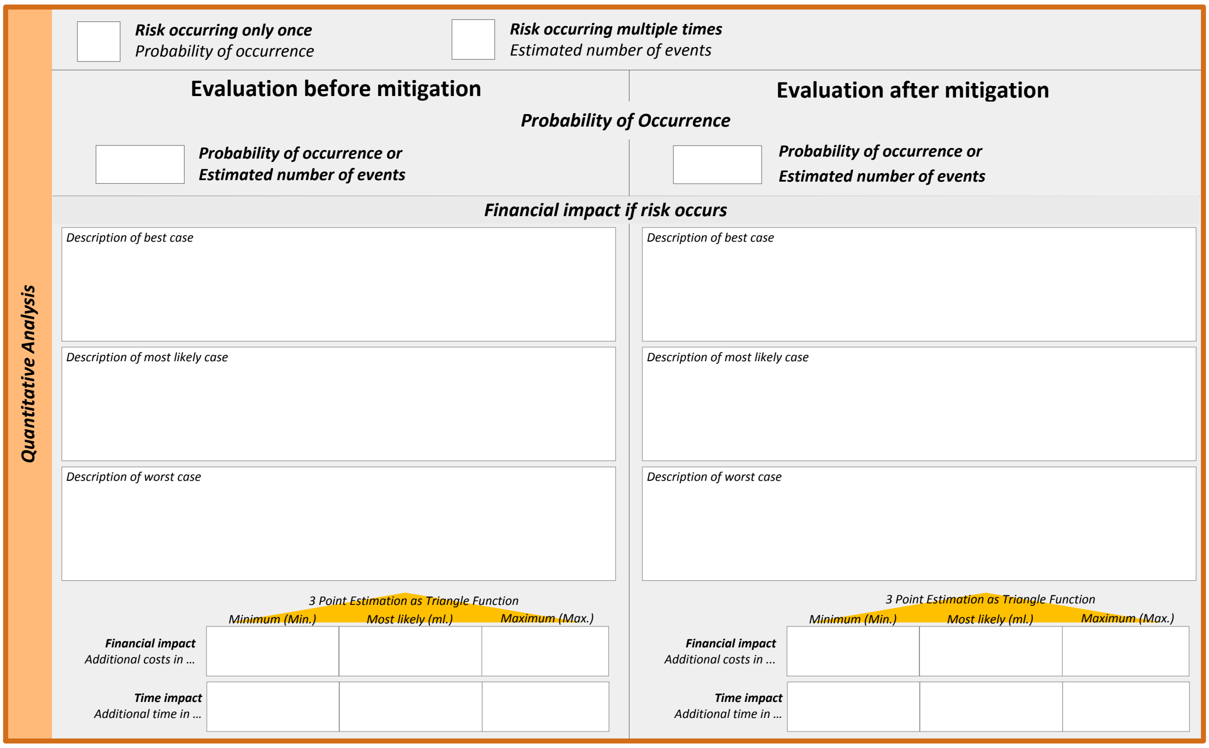

Figure 16: Risk Fact Sheet for Single Risks for Quantitative Analysis

Workflow:

1. Indicate whether a risk occurs just once or multiple times.
2. Fill in the left column: Evaluation before mitigation.
3. Probability of occurrence should be assessed. For single risks, the percentage of the qualitative analysis can be used. In case of risks occurring multiple times, the number of events should be estimated.
4. With regard to monetary impacts – in case of risk occurrence – each risk case should be described verbally (best case, expected case, and worst case).
5. After the verbal description, monetary and time impacts should be indicated using a 3-Point-Estimate (best case, expected case, and worst case):
6. Using the probabilistic method, impacts will be determined indicating three values (in currency units), for example, by a triangular distribution (minimal impact, expected or most probable impact, maximum impact).
7. Once measures have been implemented, the right-hand column, for evaluation after mitigation, should be filled in in a similar way in a second walk through.

10.3.4 Proactive Measures

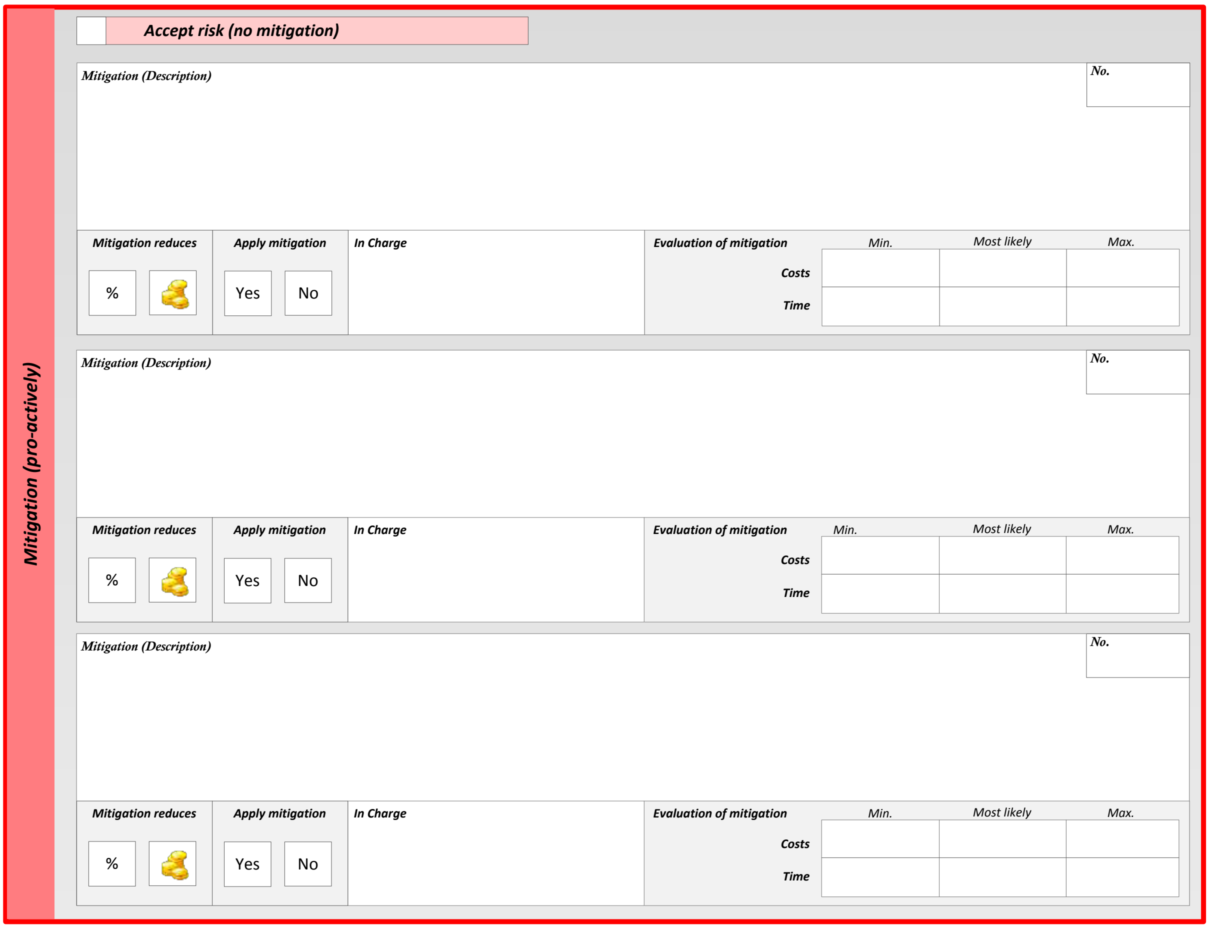

Figure 17: Risk Fact Sheet for Single Risks for Planning of Measures

Workflow:

1. After qualitative and quantitative evaluation before measures, appropriate measures have to be defined in order to minimize or completely eliminate the risk. The Risk Fact Sheet for Single Risks provides space for up to three measures.
2. The measure should be described exactly.
3. Indicate whether a successful implementation of the measure influences the probability of occurrence or the effects on timing and costs – or both.
4. Indicate whether the measure(s) should be implemented or not. In most cases this decision can only be taken at the end of the completed analysis.
5. A responsible person for each measure should be nominated. Measure updates should be documented periodically within the risk-management-process.

10.4 Definitions

The definitions used below have largely been taken out of the literature referenced in Section 7.

Allowances on Base Cost	An additional amount added to a cost estimate to cover those components of a project that are expected, based on the knowledge of the project, but have not yet been described or estimated in detail.
Base Cost (B)	The base cost is that cost which can reasonably be expected if the project materializes as planned, with a defined content, schedule and market situation. The base cost estimate is to be neither optimistic nor conservative and does not normally include price and quantity variability. The base cost estimate does not include contingency or the cost of potential risk events or escalation. Prices normally used are current values but can be stated at a specific price and date basis.
Contracting Authority	A person or legal entity who contracts, or intends to contract, with another party (the contractor) to deliver services for reimbursement and is authorized to enter into such a contract.
Contractor	Any person or legal entity with which a contracting authority signs a contract to deliver services for which they will be compensated.
Cost	Expenses that the Owner or Contractor will incur in the delivery of a project. From a general economic point of view, the evaluated and quantified use of resources to obtain goods and or services. In project development, costs are defined (as opposed to a macroeconomic cost-benefit analysis) as a monetary use of services, supplies, and goods required to implement the project. Depending on the type of entity, taxes and other fees may be included in costs.
Cost Actual	Costs recorded up to a certain date, under a cost centre or cost unit.
Cost Coefficient	The ratio of applicable cost(s) to a measurable unit of reference (such as length, base area of land, capacity, cost areas, elements, services).
Cost Components	Elements that make up a cost. These can include base cost, cost for value adjustment and indexation, cost for risk, and escalation.

Cost Estimation	The process of aggregating all relevant cost, including base cost, allowances, escalation, consequences of potential risk events, and other expected costs of a project.
Cost of Financing	Cost involved in obtaining the necessary funding for a project, but not the funds themselves.
Cost Project (Predicted)	A quantitative assessment of a likely amount or outcome in monetary terms required to reach defined project goals. Such costs can include project management, auditing, bookkeeping, project information management, planning, project-related procedural costs, expertise, construction, construction management, land management, land acquisition – whether in-house or outsourced – and cost factors for risks and escalation.
Cost, Planning	Costs estimated or incurred in the planning phase.
Cost, Preliminary	A number which defines estimated project costs determined in the project development phase.
Escalation (E)	The total annual rate of increase in the cost of work elements or sub-elements. Escalation includes the effects of inflation plus market conditions and other similar factors.
Estimated Cost	A quantitative assessment of a likely amount or outcome in monetary terms (PMI def).
Inflation	A persistent tendency for prices to increase, measured by proportional changes over time relative to an appropriate price index.
Invitation to Tender	A document, published by a contracting authority to a selected, invited, or solicited number of companies, in which the contracting authority defines services to be provided under a contract with conditions for the provision of such services.
Maintenance	Those activities to maintain or restore systems to a proper state (performance, safety, etc.). Maintenance does not imply an improvement as compared to the system when new.
Owners estimate of Project Cost	The owner's estimate of project cost defines the project cost estimated before publication for the tender phase.
Price Basis/Base	Reference point in time for the price level on which costs are based.

Project Scope	The elements of a project that are to be produced or secured to reach defined quality, cost, and time objectives.
Risk	The combination of the probability and consequences of a potential event, should it occur. Risk consequences can be positive (opportunities) or negative (threats).
Risk Cost (R)	The cost component that covers the monetary aspect of a risk. Costs can be positive (opportunities) or negative (threats).
Risks Identified	Identified risks include potential events, which have a probability and consequence (positive or negative), that are not part of the base, and which may eventuate during the project or a specific phase of the project. Risks are usually identified by experts in a risk workshop.
Unknown Risk Costs	All risk costs that are not identifiable or were not identified in the respective project phase.
Value Adjustment and Indexation (I)	A methodical approach to take into account a variation in market prices that has already occurred by a certain reference date. Value adjustment governs the pre-contract phase and indexation is used in the contract phase.
Value at Risk (VaR)	Probability of not exceeding a certain value within a distribution. That value (for example, € or $) corresponding to a specific probability within a probability distribution.
Work Breakdown Structure (Project Structure)	A framework of project elements defining important relationships between such elements that can be set up with multiple hierarchical levels (for example, based on construction steps, on structures, or on organizational functions).

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