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Project Risk Management with openSE

Part 4

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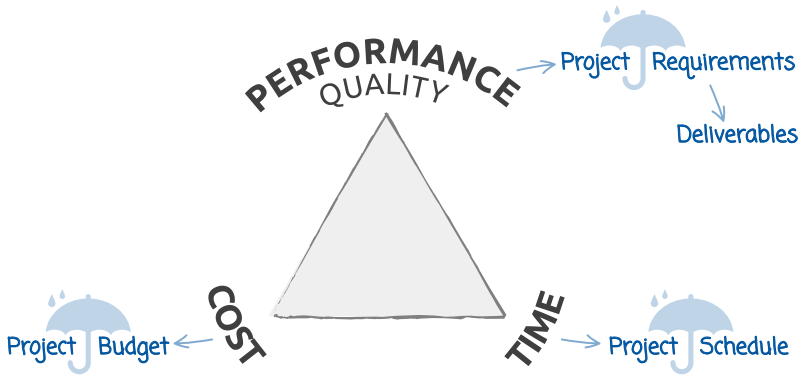
Project Risk Management

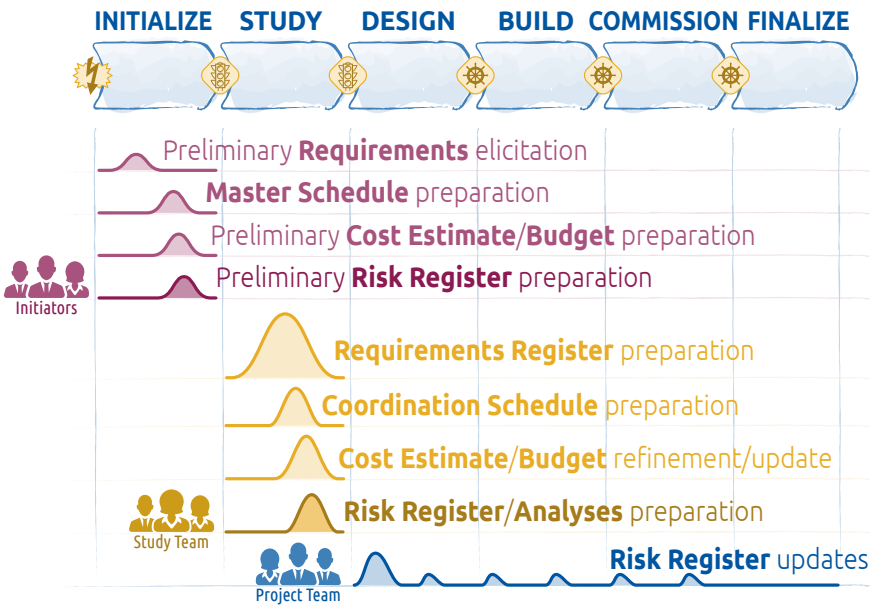
"Project triangle"



Pierre Bonnal

Project Risk Management

When and which effort?



Risk Definitions

Risk

Definition

The effect of uncertainty on objectives.

ISO 31000:2009 § 2.1

Can be seen as:

- **Threats**, i.e. with negative impact → common/regular meaning
- **Opportunities**, i.e. with positive impact → often forgotten!

Risk
Etymology

- From ancient Latin: *risicare* = reef ⇢ ***risk-snag***
- From (ancient) Greek: *ρίζα* = root ⇢ ***risk-snag***
- From (ancient) Latin: *rixa* = quarrel, brawl ⇢ ***risk-action***
- From ancient Greek: *ριζικόν* = soldier's pay ⇢ ***risk-action***

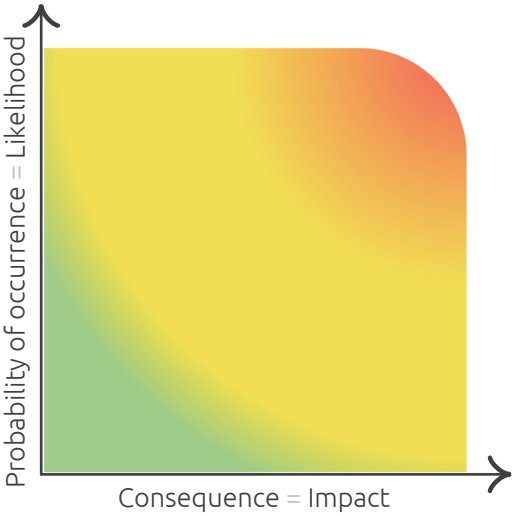
Risiko, Risiken in German

risk-snag vs. ***risk-action***

Fabio Sabelli (mars 1999) Les risques de l'économie, l'économie des risques. Le point de vue de l'anthropologue. présentation donnée lors du 7e Congrès de la Société suisse de management de projet à Lausanne, Suisse

Risk
Heatmap

Likelihood × Consequences



Risk Management

Enterprise RM vs. Project RM

ERM

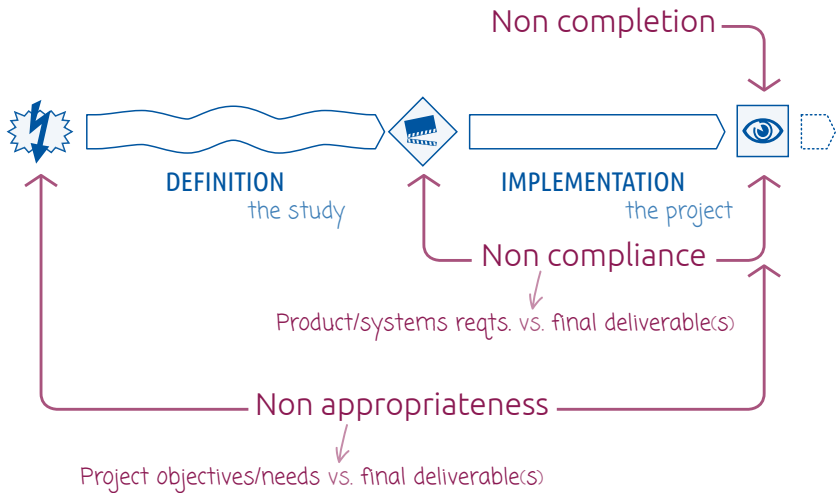
- Strategic risks
- Operational risks
- Financial risks
- Reputational risks
- Safety risks
- Environmental risks

PRM

- Technical risks
  - related to the **system/product** being developed, incl. technical **reqts.**
- Programmatic risks
  - related to the **project**: on schedule, on budget
- External risks
  - for which the project team has no real control

Project Risk Management

Concept of lifecycle



Project Risk Management
Standards and methodologies

PMBoK	Ch. 11 pp. 309–354 + *Practice Standard*
PRINCE2	Ch. 8 (4th theme) pp. 75–88
HERMES 5.1	*Rôle* pp. 54–57 + *Tâche* pp. 104–105
ISO 21500:2012	§§ 2.13, 4.2.3.8, 4.3.28, —.29, —.30, —.31
NASA Systems Engineering Handbook NASA/SP-2007-6105 Rev1	§ 6.4 pp. 139–150
INCOSE SEBoK	sebocwiki.org/wiki/Risk_Management
ECSS European Coordination for Space Standardisation	ECSS-M-ST-80C July 2008
openSE	§ IV.3.5 p. 50

Project Risk Management with openSE
3 levels of implementation

3. **Advanced** approach
2. **Intermediate** approach
1. **Simple** approach

The preferred project risk management approach shall be defined in the Project Management Plan

The ‘very basic toolbox’

Project Risk Management

The ‘basic toolbox’

SIMPLE approach

Simplified
Risk Register

→ Bullet list consisting of risk statements:

- ⟨risk⟩, *however* ⟨response⟩

examples

- Unsufficient funding, *however* initial investigations have shown that stakeholders are likely to fund this proposed project
- Unrealistic master schedule, *however* discussions in conferences and workshops have shown that one year to have an experimental setup in operation is realistic
- Technical problems with instrumentation, however according to a few interviewed experts, the solutions considered are totally feasible
- Enhanced experimental setups by other labs, *however* our scientific watch shows that this set-up will be very competitive

The ‘intermediate toolbox’

Project Risk Management

The ‘intermediate toolbox’

INTERMEDIATE approach

Regular
Risk Register

→ Spreadsheet table consisting of **risk scenarios**:

RISK SCENARIO	RISK MAGNITUDE	RISK RESPONSE

Project Risk Management

A 5-step process

INTERMEDIATE approach

1. Agreeing a risk management approach for the project ✓
   ↑ risk management planning
2. Identifying risk scenarios
   ↖ risk searching
3. Evaluating their magnitude
   ↖ risk sorting
4. Defining responses to these risk scenarios
   ↖ risk treatment or risk planning
5. Following up the risks as the project progresses
   ↖ risk monitoring

Step 1 - Risk Management Planning

Project Risk Management

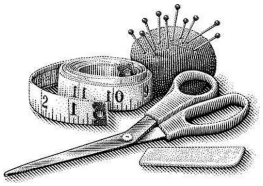
1 Risk Management Planning

INTERMEDIATE approach

Shall be discussed with Project Board

§ 3.6 of the **Project Management Plan**

⚠ Risk aversion vs. Risk appetite



Consider tailoring

Step 2 - Risk Identification

Project Risk Management

2 Risk Identification

INTERMEDIATE approach

How to identify all appropriate risk scenarios ?

Project Roadmap
Project Management Plan
Requirements Register
PBS, WBS, RACI Matrix
Project Coord. Schedule
Project Budget Document
Risk Checklists, *Vademecums*
Subject matter experts

Doc. screening
Interviews
Delphi panels
Six-hats, etc.

Risk scenario column of the **Risk Register**

Project Risk Management

INTERMEDIATE approach

3 project **risk categories**

Technical risks
↓
risks related to the **systems/product** being developed: appropriateness and compliance

Programmatic risks
↓
risks related to the **project** itself: completion on schedule and on budget

External risks
↓
"project strategic risks"
macro-economic risks
natural hazards
regulatory risks
"PESTLE-risks"

Step 3 - Risk Evaluation

Project Risk Management

3 Risk Evaluation

INTERMEDIATE approach

Project Roadmap

Project Mngt. Plan

Subject matter experts

Risk scenarios from the **Risk Register**

Risk Level Matrix
FMAC Analysis, etc.

Risk Register with magnitude columns populated

Risk Level Matrix

Probability	*P*
Very unlikely	.1
Rather unlikely	.3
Possible, plausible	.5
Rather likely	.7
Very likely, quite certain	.9

Consequences	*C*
Negligible	.05
Marginal	.1
Significant	.2
Major, critical	.4
Catastrophic, crisis	.8

Risk Level Matrix

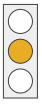
Consequences	C	on budget	on schedule
Negligible	.05	$\Delta C \approx 0$	$\Delta D \approx 0$
Marginal	.1	$1\% < \Delta C \leq 5\%$	$1\% < \Delta D \leq 5\%$
Significant	.2	$5\% < \Delta C \leq 10\%$	$5\% < \Delta D \leq 10\%$
Major, critical	.4	$10\% < \Delta C \leq 20\%$	$10\% < \Delta D \leq 20\%$
Catastrophic, crisis	.8	$\Delta C > 20\%$	$\Delta D > 20\%$

Risk Level Matrix

Consequences	C	on the project performance
Negligible	.05	Minimal or no consequence
Marginal	.1	Small reduction of the performance
Significant	.2	Significant degradation of the performance
Major, critical	.4	Technical goals cannot be achieved
Catastrophic, crisis	.8	Project cannot be completed

Risk Level Matrix

$$S = P \times C$$

$S < 0.05$		low risk
$0.05 \leq S < 0.20$		medium risk
$S \geq 0.20$		high risk

Risk Level Matrix

P \ C	.05	.1	.2	.4	.8
.9	.05	.09	.18	.36	.72
.7	.04	.07	.14	.28	.56
.5	.03	.05	.10	.20	.40
.3	.02	.03	.06	.12	.24
.1	.01	.01	.02	.04	.08

Step 4 - Risk Treatment

Generic Response Types

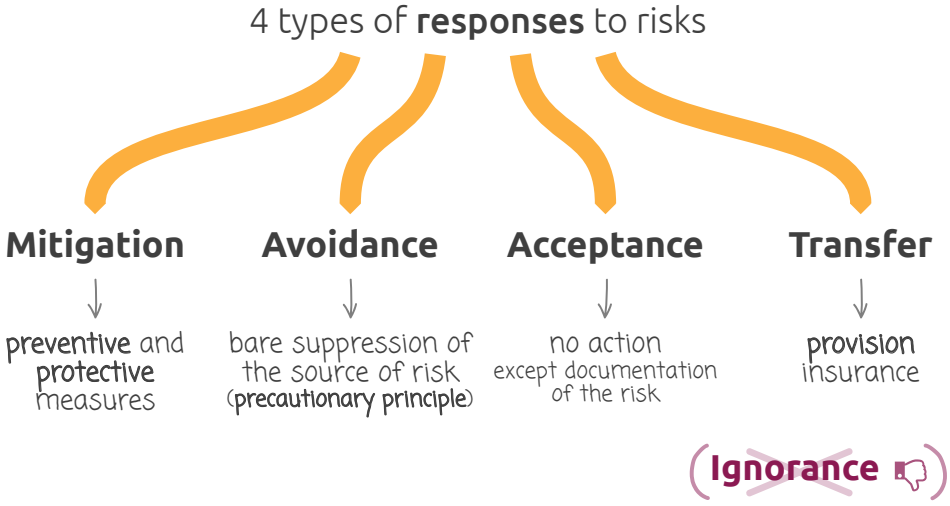
Type of response	Method of handling
Modify objectives	Reduce or raise performance targets; change tradeoffs between objectives
Avoid	Plan to avoid specified sources of risk/uncertainty
Influence probability	Change the probability of potential variations, i.e. prevent
Modify consequences	Modify the possible consequences of variations, i.e. protect
Transfer consequences	Transfer consequences to another party, e.g. contract provision, insurance
Develop continuity plans	Set aside means or make other plans to provide a reactive ability to cope
Keep options open	Delay choices and commitments, choosing versatile options
Monitor	Collect and update data about sources of uncertainty
Accept	Acknowledge and accept uncertainty
Remain unaware	Ignore uncertainty, take no action to identify, evaluate or handle it
Optimize all the above	Explicitly recognise the value of selecting an optimal combination

Stephen Ward, Chris Chapman (2011) How to Manage Project Opportunity and Risk: Why Uncertainty Management can be a Much Better Approach than Risk Management (3 ed). Wiley

Generic Response Types

In practice

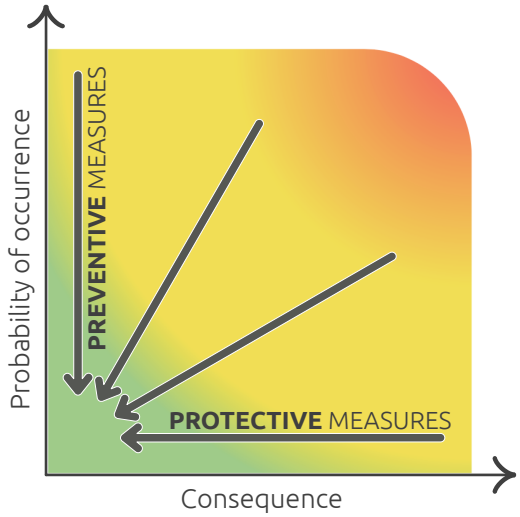
INTERMEDIATE approach



Risk

Heatmap

Prevention vs. Protection



Project Risk Management

Risk Treatment

INTERMEDIATE approach

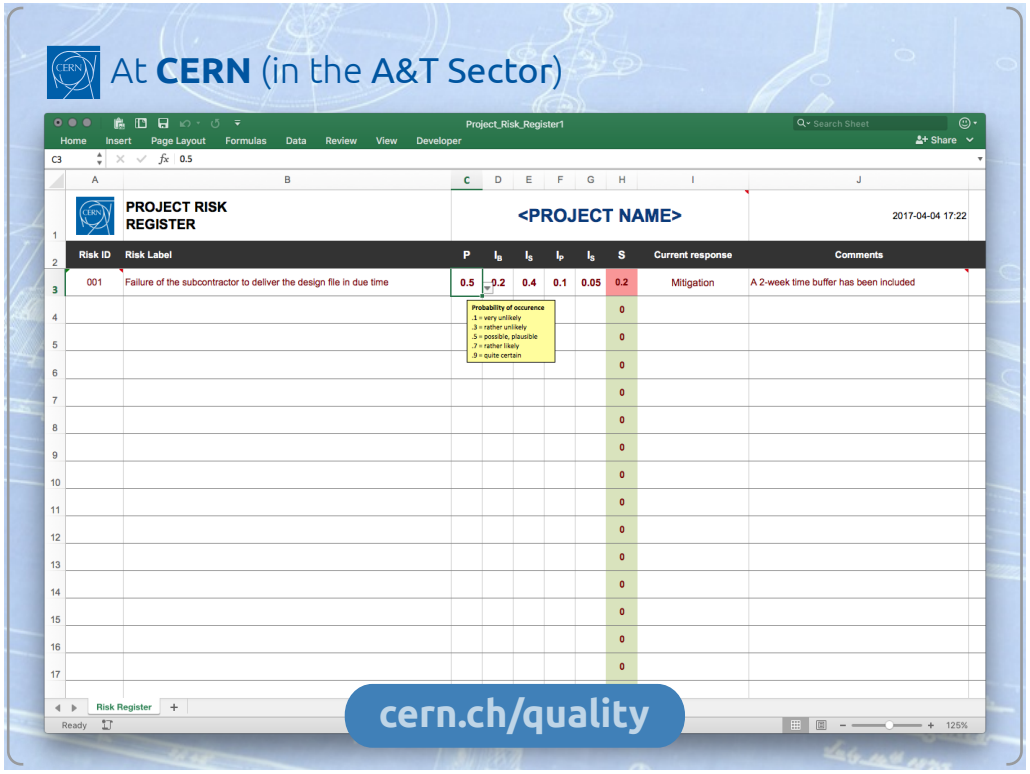
Project Roadmap | **Project Mngt. Plan** | Subject matter experts | Lessons learned | **Risk Register**

Doc. screening
Interviews

Delphi panels
Six-hats, etc.

Risk Register with response columns populated

Continuity Plan(s)



Step 5 - Risk Monitoring

Project Risk Management

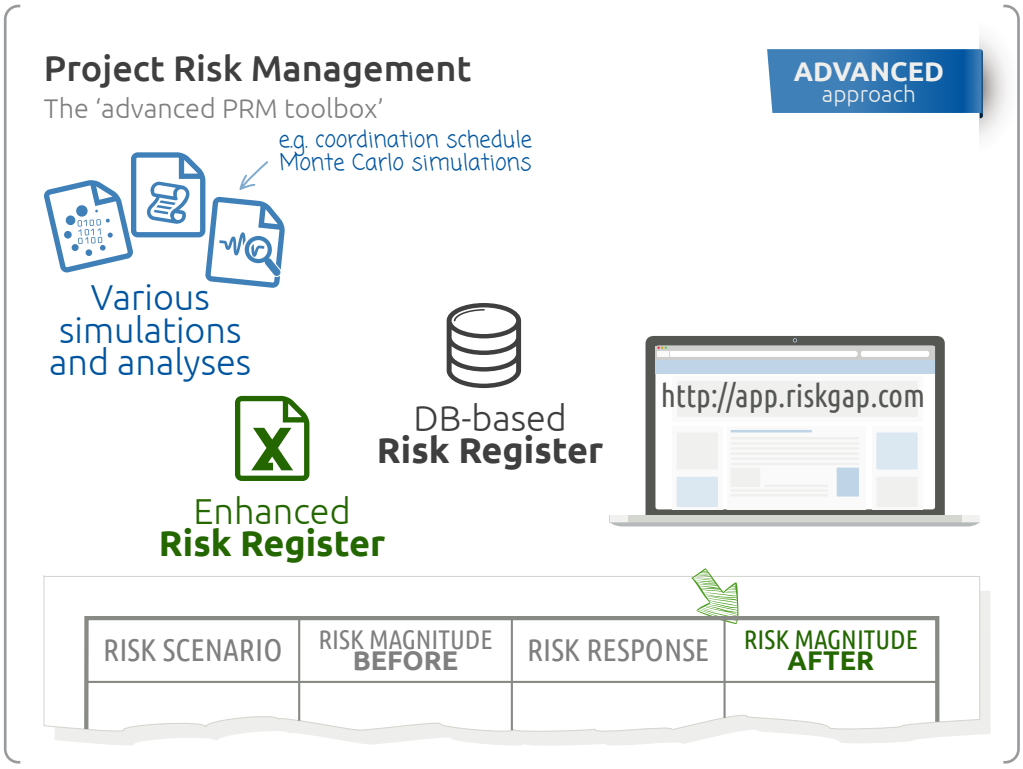
5 Risk Monitoring

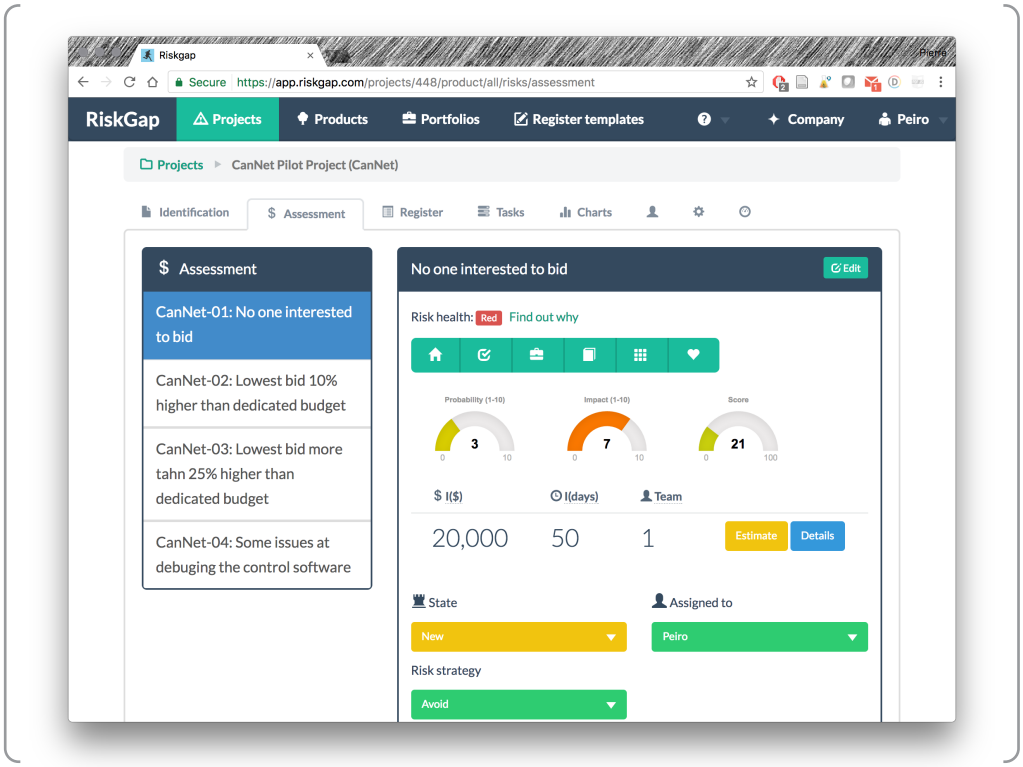
INTERMEDIATE approach

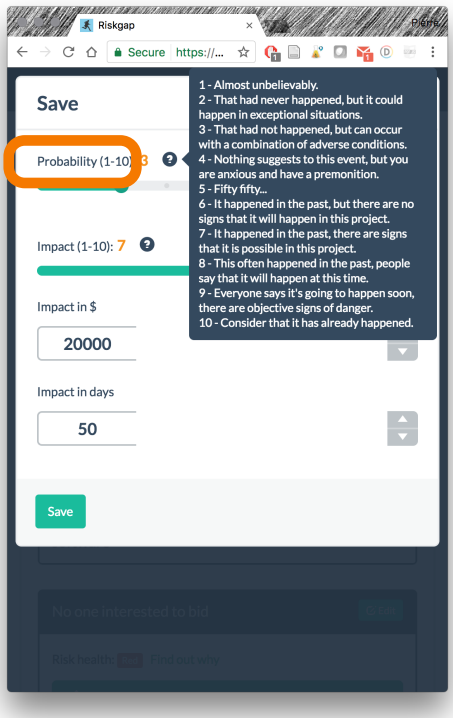
Consists of:

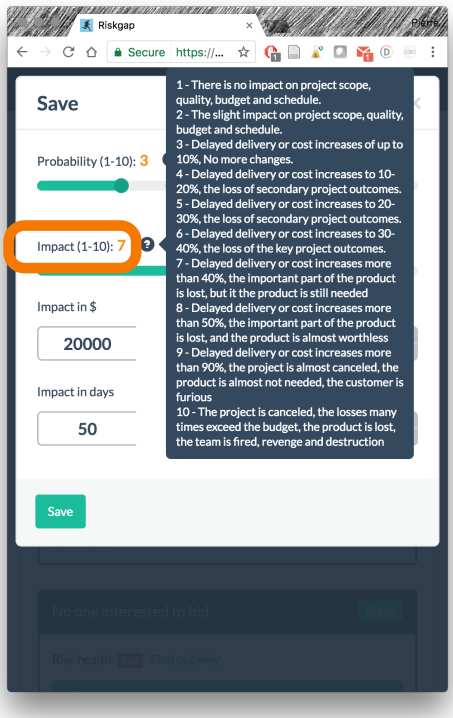
- Following up the identified risk scenarios
- Detecting the emergence of **residual risks** and engaging the appropriate actions or Continuity Plans
- Following up the implementation of Continuity Plans, appraising their efficiency
- Scrutinizing the emergence of **new risks** (i.e. these risks that were not identified during the Study Phase or the early Design Phase of the project), evaluating them, integrating them in the Risk Register, and deciding relevant responses

The 'advanced toolbox'









Project Risk Management

A 7-step process

ADVANCED approach

1. Agreeing a risk management approach for the project ✓
2. Identifying risk scenarios ✓
3. Evaluating their magnitude *(before)* ✓
4. Defining responses to these risk scenarios ✓
5. **Re-evaluating their magnitude** *(after)* ✓
6. Running relevant simulations and conducting risk analyses
   ↖ risk quantification
7. Following up the risks as the project progresses
   Running additional risk simulations
   and conducting additional risk analysis ✓

Step 6 - Risk Quantification

Risk quantification

Four approaches for dealing with probabilities:

- **Classical** approach
- **Mathematical** approach
- **Frequentist** approach
- **Bayesian** approach

Risk quantification

Four approaches for dealing with probabilities:

- **Classical** approach:

The probability P(*A*) of an event *A* is the property that determines its frequency of occurrence.

E.g.:
P(head) = P(tail) = 1/2
P(⚀) = P(⚁) = 1/6
P(⚅ and ⚅) = 1/36

Risk quantification

Four approaches for dealing with probabilities:

- **Mathematical** approach:

P(A) is a number that obeys the many axioms of the theory built up by A. Kolmogorov in the '30s:

$0 \leq P(A) \leq 1$
$P(A \text{ v } B) = P(A) + P(B)$
$\sum P(A_i) = 1$
…

Risk quantification

Four approaches for dealing with probabilities:

- **Frequentist** approach:

P(*A*) is a limit over a set, when the number of elements of this set tends to ∞

Risk quantification

Four approaches for dealing with probabilities:

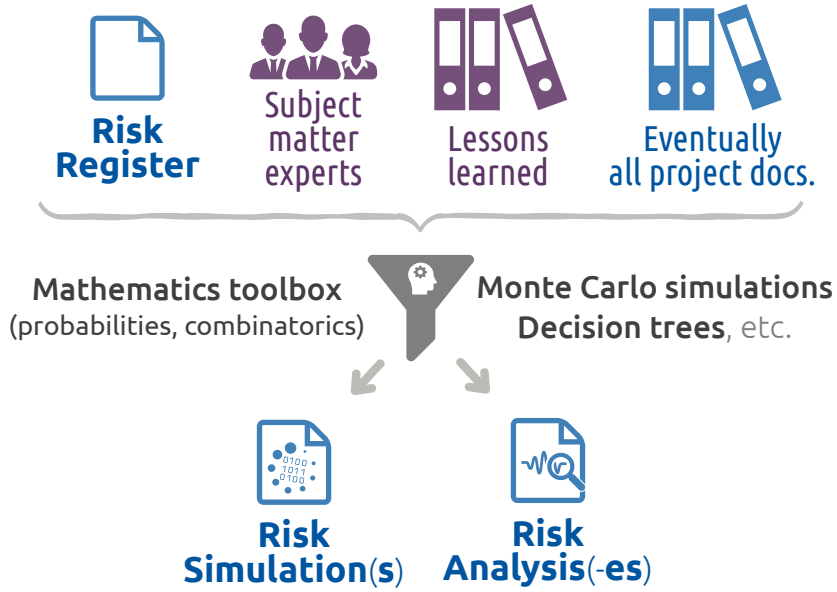
- **Bayesian** approach:

P(*A*) is the degree of belief in the occurrence of an event

Project Risk Management

6 Risk Quantification

ADVANCED approach



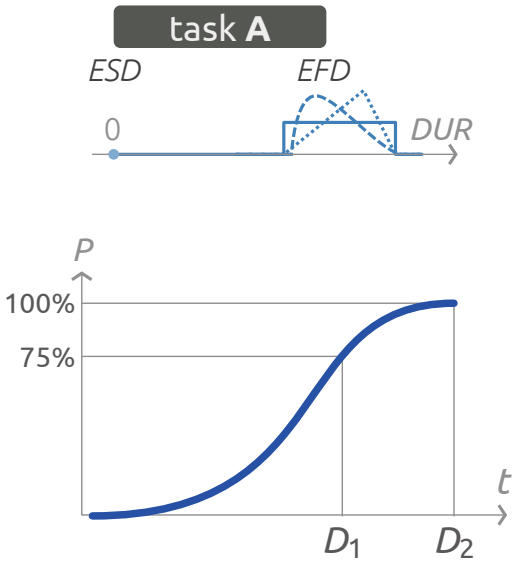
Step 6' - Risk Analyses

Probabilistic Project Scheduling

Monte Carlo-based schedule assessment

ADVANCED approach

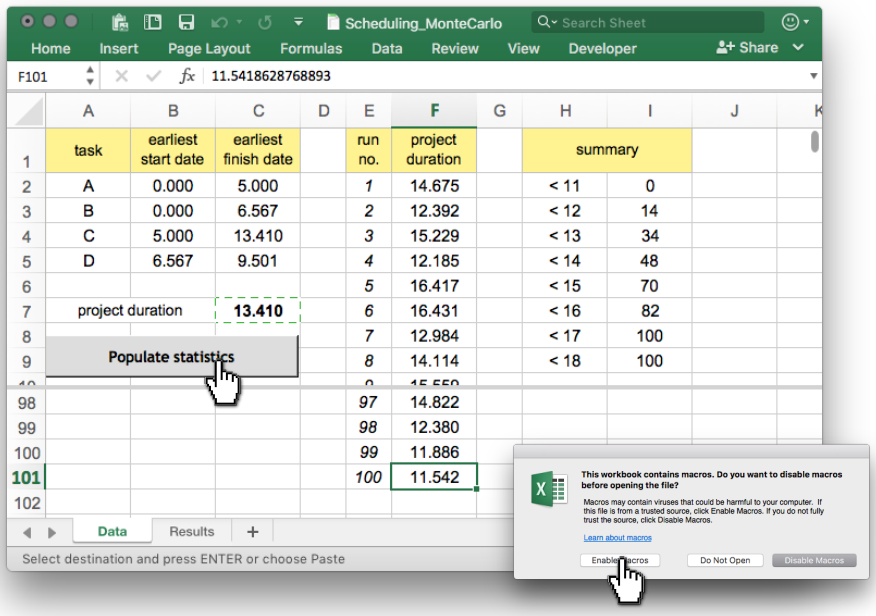
1. Identifing a **probability distribution function** for each **activity duration**
2. Using a **random number generator** for setting activity duration based on their PDF, then **computing the activity network several thousand times**
3. **S-curves** (cumulated PDFs) can be generated from the computed data for a few relevant **milestones**



Probabilistic Project Scheduling

Monte Carlo-based schedule assessment

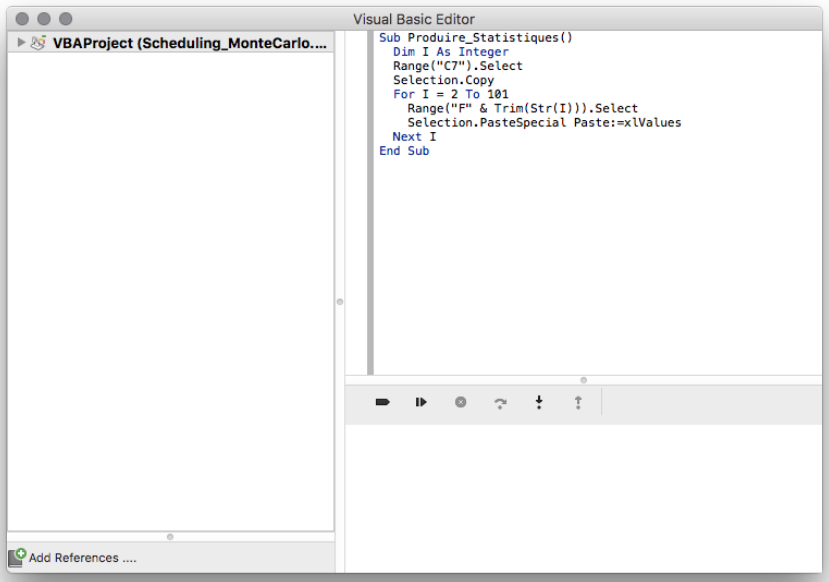
ADVANCED approach



Probabilistic Project Scheduling

Monte Carlo-based schedule assessment

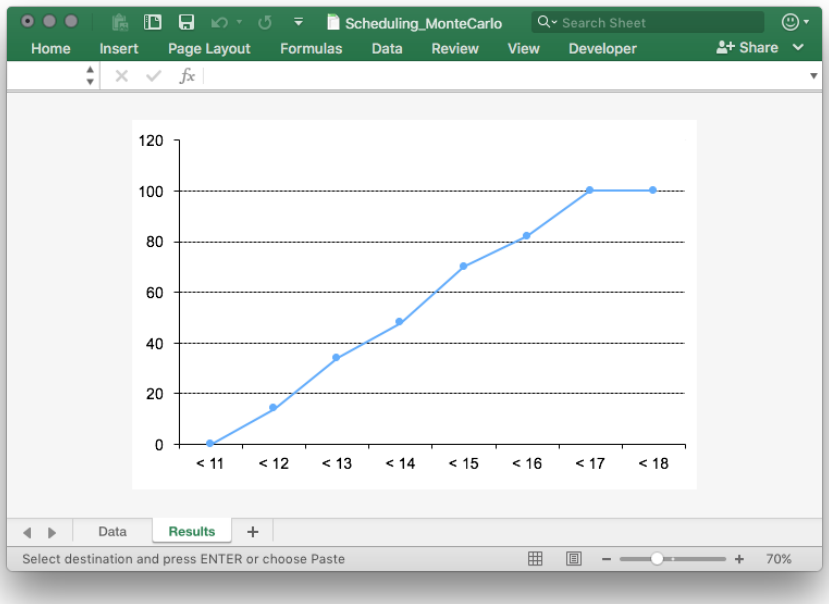
ADVANCED approach



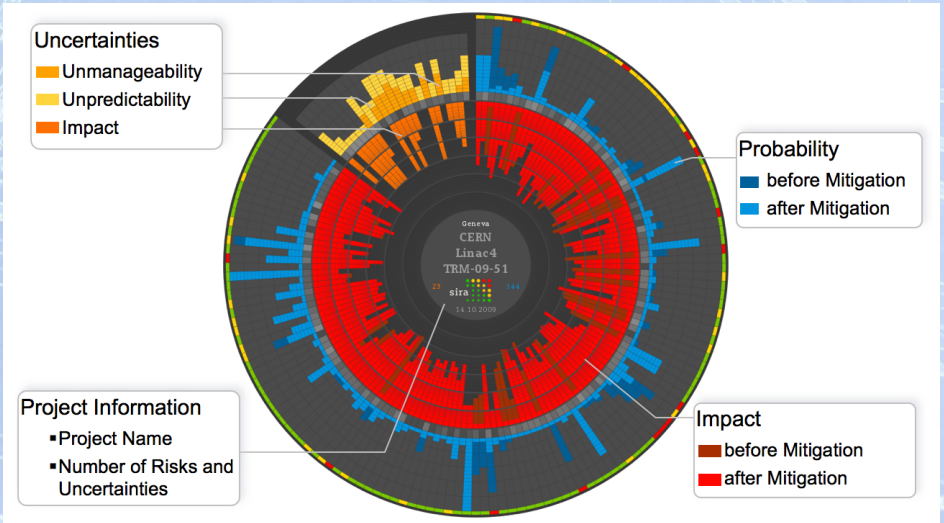
Probabilistic Project Scheduling

Monte Carlo-based schedule assessment

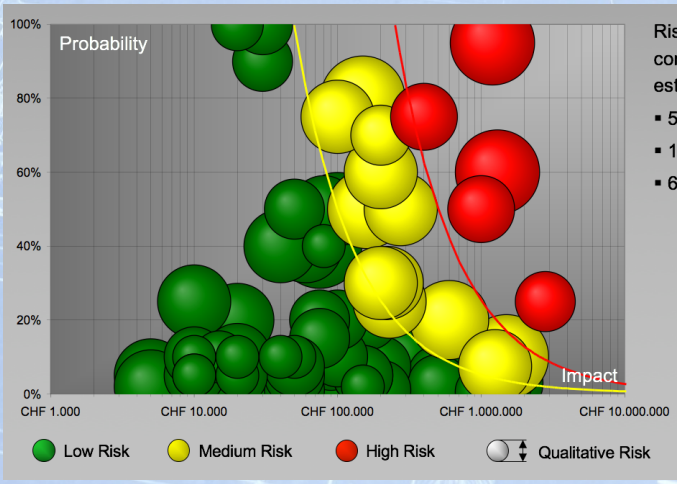
ADVANCED approach



At **CERN** (in the A&T Sector)
Linac4 Project Risk Analysis
Conducted in 2009 using the Siemens' SIRA methodology



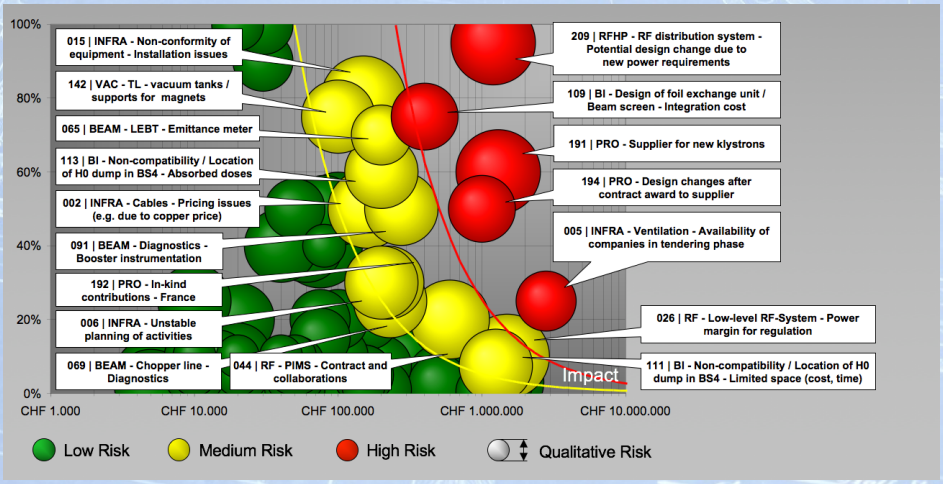
At **CERN** (in the A&T Sector)
Linac4 Project Risk Analysis
Overview of cost impact before mitigation



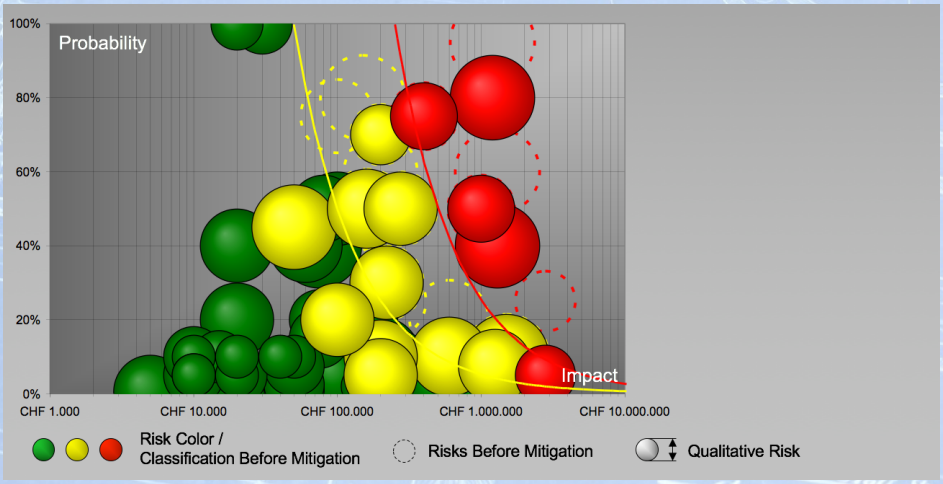
Risks of **budget overrun** compared to overall project cost estimate (baseline 2009):

- 5 high risks
- 12 medium risks
- 63 low risks

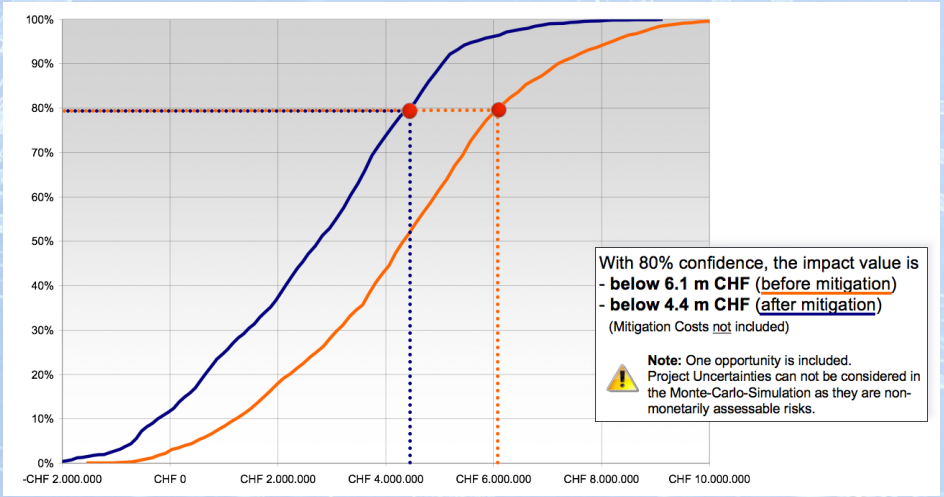
At **CERN** (in the A&T Sector)
Linac4 Project Risk Analysis
Overview of cost impact before mitigation



At **CERN** (in the A&T Sector)
Linac4 Project Risk Analysis
Overview of cost impact **after** mitigation



At **CERN** (in the A&T Sector)
Linac4 Project Risk Analysis
Monte Carlo simulation on cost impact



At **CERN** (in the A&T Sector)
Linac4 Project Risk Analysis
Uncertainties