SPECIAL MOBILITY STRAND

RISK MANAGEMENT OF INVESTMENT PROJECTS

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Concepts of Project and Risk management

- **Project Management** is the science which applies skills, tools and techniques to complete project activities in a way that the expectations and requirements of stakeholders are fulfilled or exceeded.
- **Risk Management** is an integral part of the process which aims at identifying the potential risks associated with a project and responding to those risks.
    - It includes activities which aim to maximize the consequences associated with positive events and to minimize the impact of negative events.

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Concepts of Risk management

- Risk can occur during all project activities; it is only the amount which varies from one activity to another
- The riskier the activity is, the costlier will be the consequences in case a wrong decision is made
- Proper evaluation and analysis of risks will help decide about implementing a costly measures to reduce the level of risk. It can also help to decide if sharing the risk with an insurance company is justified.
- Risks cannot be totally avoided, but with proper risk management they can be minimized!

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Uncertainty and risk

- Uncertainty is not the same as risk. These two terms are distinct and have different meanings.
- '**Risk**' describes a situation, in which there is a chance of loss or danger.
- '**Uncertainty**' refers to a condition where we are not sure about the future outcomes.

- 'Uncertainty' refers to the **occurrence of an event** about which little is known, while a 'risk' is the **outcome of an event** which is predicted on the basis of statistical probability.

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Difference between Uncertainty and Risk

- **Risk can be measured** and quantified, through theoretical models. On the other hand, it is not possible to measure uncertainty in quantitative terms, as the future events are unpredictable.
- The **potential outcomes are known** in risk, whereas in the case of uncertainty, the outcomes are unknown.
- **Risk can be controlled** if proper measures are taken to control it. On the other hand, uncertainty is beyond the control of the person or enterprise, as the future is uncertain.
- **Minimization of risk** can be done, by taking necessary precautions. As opposed to the uncertainty that cannot be minimized.

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Uncertainty and risk

- Managing risk is easier because you can identify risks and develop a response plan in advance based on your past experience.

- Managing uncertainty is very difficult as previous information is not available, too many parameters are involved, and you cannot predict the outcome.

However, to complete the project successfully you must be very cautious, proactive, and open minded to manage risk and uncertainty.

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Risk definitions

- The word '**risk**' is used with many different meanings.
- The European Commission suggests that a risk is any factor, event or influence that threatens the successful completion of a project in terms of time, cost or quality.
- A situation where there is no knowledge of its outcome.
- The variation in possible outcomes that exist in nature in a given situation.
- A high probability of failure.
- The chance of something happening that will have an impact on project objectives.

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Risk definitions

- Risk represents an uncertain condition and, if it occurs, it may have one or more impacts which in turn may have positive and negative effects on the project objectives (PMI, 2013)
- Risk is the effect of uncertainty on the achievement of objectives (ISO /FDIS 31000:2009):
  - An effect is a deviation from the expected, and can be positive and / or negative.
  - Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process).
  - Uncertainty is the state, even partial, of a lack of information related to knowledge of an event, its consequences or likelihood.

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Risk definitions

- The classic definition of risk is the probability of occurrence of an unwanted event multiplied by the consequence (loss) of the event (impact of this risk):

$$R = P * I$$

R – grade (rang) of the risk
P – probability of occurrence of a defined event
I – quantified level of the consequences caused by that event

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What is project risk?

- **Project risk** is an uncertain event or condition that, if it occurs, has an effect on at least one project objective: cost, time, scope or quality.

- Risk has a cause (source) and a consequence (one or more)

- Risks can occur during every project or process!

- Any project uncertainties can be considered a project risk

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What is project risk?

- Project risks include events or conditions that could be positive or negative in nature
  - Positive risks are also known as opportunities
  - Negative risks are also known as threats

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Project risks

- The most common project risks are:
  - **Cost risk**, typically escalation of project costs due to poor cost estimating accuracy and scope creep.
  - **Schedule risk**, is the risk that the project takes longer than scheduled. It can lead to cost risks, as longer projects always cost more, and to performance risk, if the project is completed too late to perform its intended tasks fully.
  - **Performance risk**, the risk that the project will fail to produce results consistent with project specifications.

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Examples of Project risks

- Governance risk relates to board and management performance with regard to ethics, community stewardship, and company reputation.
- Strategic risks result from errors in strategy, such as choosing a technology that can't be made to work.
- Operational risk includes risks from poor implementation and process problems such as procurement, production, and distribution.

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Examples of Project risks

- Market risks include competition, foreign exchange, commodity markets, and interest rate risk, as well as liquidity and credit risks.
- Legal risks arise from legal and regulatory obligations, including contract risks and litigation brought against the organization.
- Risks associated with external hazards, including storms, floods, and earthquakes; vandalism, sabotage, and terrorism; labor strikes; and civil unrest.

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Risks in Construction projects

- The construction industry is characterized with the **largest exposure to risks and uncertainties** from the whole industry sectors!
- Records obtained from the statistical analyses of risks – for the last decades – show that the construction process is extremely sensitive to risks!
- The construction industry demonstrates major number of accidents with critical consequences

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Risks in Construction projects

- Compared to many other industries, construction industry is subjected to more risks due to its unique features, such as long duration, complicated processes, unpredictable environment, financial intensity and dynamic organizational structures.
- The process of planning, executing and maintaining all project activities is complex and time-consuming.
- The whole process require many people with diverse skill sets and coordination of a vast amount of complex and interrelated activities.
- The situation is made complex by many external factors.

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Risks in Construction projects

- The track record of construction industry is very poor in terms of coping with risks, resulting in failure of many projects to meet time schedules, targeted budget and sometimes even the scope of work.
    - High rate of accidents and a poor reputation for coping with problems!

- Risk in the construction industry is perceived to be a combination of activities, which adversely affect the project objectives of time, cost, scope and quality.

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Risks in Construction projects

- Some risks in construction processes can be easily predicted or identified; still some can be totally unforeseen.
- Construction risks can be related to technical, management, logistical, or socio-political aspects or can be related to natural disasters.
- Some of the critical effects of risks are:
  - failure to achieve operational requirements and the required quality,
  - non completion of the project within stipulated time and estimated cost.

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Risks in Construction projects

- Construction projects are very complex and can face various internal and external risks!

- Specific characteristics of construction projects as possible risk sources:
  - Uniqueness, complexity
  - Long project life-cycle
  - Large number and variety of project participants
  - Specific construction conditions
  - Human factors that influence the decision-making

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Risks in Construction projects

- Unfortunately, there is **no way to completely avoid risks** as they are bound to be unknown factors that arise over the project lifecycle.

- A strict set of codes, laws and regulations must be followed during the construction process to best avoid these risks.
- One of the best ways to manage risks is to know the various types and to learn how to manage them.
- If we can **identify and categorize risks** before we start a project, we can optimize our risk management activities and avoid possible losses.

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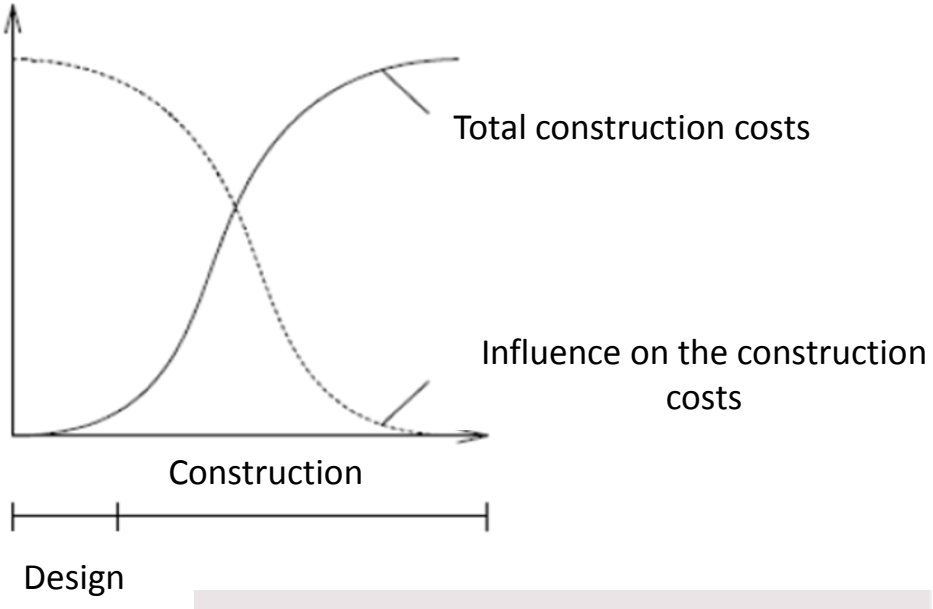
Risks in Construction projects

- The influence on the project cost and time is more efficient at the beginning phases of the project life-cycle
- The influence is decreasing as we reach the final project realization



- Identification and analysis of the potential risks, as well as Risk Management, should be performed at the beginning of the project
- Risk management should be in accordance with the strategic project management

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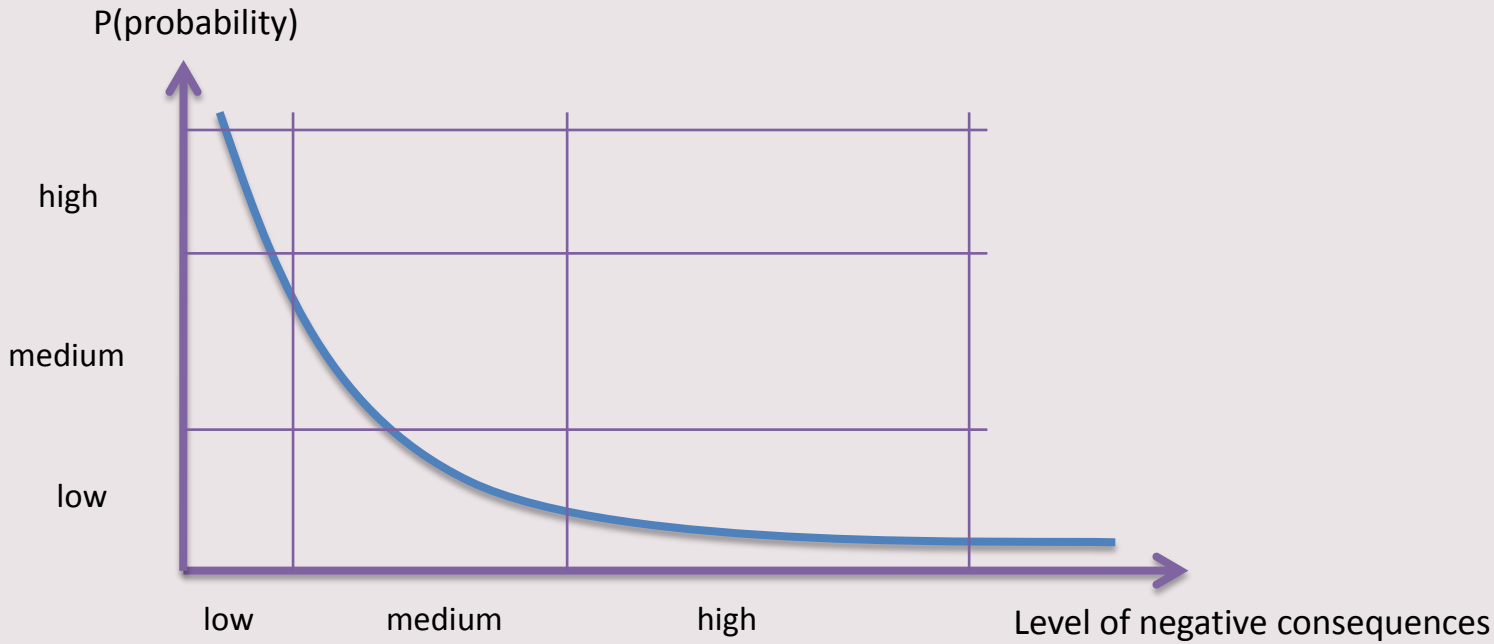
Risks in Construction projects

- Dependence between the probability of risks occurrence and the level of negative consequences



- Longer planning and designing phase = shorter construction time!!
- Almost none of the projects in Macedonia are being finished inside the planned schedule and planned budget

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Risks in Construction projects

- The main sources of risks are:
  - Complexity of the project
  - Location of the construction
  - Number of project participants
  - Number of project activities
  - The construction time
  - Investment of huge financial resources
  - Complex scope of work

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Risks in Construction projects

- Consequences from risks:
  - Human resources losses (accidents, death)
  - Structural damages, damages of the construction materials, equipment
  - Financial losses
  - Legal losses

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Risks in Construction projects

- Risks can be **Known** or **Unknown**:
  - Known Risks are handled with contingency reserves
  - Unknown risks are handled with management resource
- The risks can be characterized as **internal** or **external**.
  - An internal risk is unique to a project and is caused by sources inherent in the project; example can be the inability of a product to function properly.
  - An external risk has origin in sources external to the project scope, such as cost cuts by senior management.

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Risks in Construction projects

- Risks can be either **acceptable** or **unacceptable**.
  - An unacceptable risk is one which has a negative impact on the critical path of a project.

- Risk Acceptance Factors:
  - **Risk Appetite**: How valuable is the reward compared to the risk?
  - **Risk Tolerance**: What is the amount or degree of risk that can be withstood?
  - **Risk Threshold**: What level of impact or uncertainty is considered intolerable?

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Risks in Construction projects

- Risks can be viewed as **manageable** and **unmanageable**.
  - A manageable risk can be accommodated, example being a small change in project requirements.
  - An unmanageable risk, on the other hand, cannot be accommodated, such as turnover of critical team members.

- Risks can either have **short term** or **long term duration**.
  - In case of a short term risk, the impact is visible immediately, such as a requirement change in a deliverable. The impact of a long term risk is visible in the distant future, such as a product released without adequate testing.

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Risks in Construction projects

- Construction project risks are interrelated and interdependent.
- Risk will be peculiar to each particular project and each project participant, however, it is recognized that all construction projects share **common risks** that can be classified as follows:
  - Technical risks
  - Logistical risks
  - Environmental (external) risks
  - Management related risks
  - Financial risks
  - Socio-political risks

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Risks in Construction projects

- Technical risks

  - Include anything that restricts us from creating the project that our investor wants.
  - They include uncertainty of resources and availability of materials, inadequate site investigations, or incomplete design...
  - These risks can commonly occur when there are changes in project scope and requirements, and if there are design errors or omissions.

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Risks in Construction projects

- Technical risks – examples
  - Owner involvement in design
  - Inadequate and incomplete desi
  - Late drawings and instructions
  - Late surveys, incomplete or wrong
  - Errors in structural / geotechnical / geological / foundation conditions
  - Wrong selection of materials
  - Uncertainty over the source and availability of materials and resources
  - Site access

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Risks in Construction projects

- **Technical risks – examples**
  - Changes in the project requirements
  - Cost of tests and samples
  - Inaccurate contract time estimates, Inaccurate quantities of work
  - Work permissions
  - Unsuitable equipment and materials
  - Equipment commissioning
  - Construction occupational safety, Worker and site safety
  - Accidents (such as collision, fire and so on)

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Risks in Construction projects

- **Logistical risks**
  - There are various logistical risks that need to be addressed before beginning a project. Without addressing these logistical issues, you risk huge project delays and losses.
    - Procurement planning and execution (ordering, reception, transport and storage)
    - Availability of transportation facilities and availability of resources (equipment such as spare parts, fuel and labor).
    - Supply chains delivering products from external sources to the building site (supply logistics)
    - Coordination of material flows on the building site (on-site logistics), x participants of the construction project as separate entities participating in other projects at the same time.

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Risks in Construction projects

- Management related risks

  - The most common is uncertain productivity of resources.
  - Before we begin a project we need to be sure that we have sufficiently skilled staff and that we have adequately defined their roles and responsibilities.
  - Failing to do this can lead to disastrous losses.

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Risks in Construction projects

- **Management related risks – examples**
  - Project purpose definition, needs, objectives, costs, deliverables are poorly defined or understood
  - Uncertain productivity of resources
  - No control over staff priorities
  - Too many projects
  - Consultant or contractor delays
  - Estimating and/or scheduling errors
  - Lack of coordination / communication
  - Inexperienced workforce / inadequate staff / resource availability

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Risks in Construction proje

- Environmental risks

  - They include natural disasters, weather and seasonal implications.
  - These risks are commonly overlooked when people are unfamiliar with local conditions.
  - If we are going to be working on a project in a new city, we need to become familiar with that region's weather patterns. If we prepare for possible weather risks, we are much more likely to avoid potential delays and losses.

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Risks in Construction projects

- **Environmental risks – examples**
  - Environmental regulations change
  - Water quality issues
  - Environmental analysis incomplete or wrong
  - Hazardous waste, preliminary site investigation wrong
  - Historic site, endangered species, or wetlands present
  - Subsurface geology and geotechnical conditions, ground water
  - Weather and seasonal implications
  - Natural disasters

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Risks in Construction projects

- Financial risks

  - Inflation, local taxes and availability and fluctuation of foreign exchange are few of the possible financial risks during a construction project.
  - For international projects – it is very important to understand how the foreign currency will be exchanged.
  - Different countries have drastically different taxes that need to be taken into account before starting a project. The project finances look very different when working in a tax-free city versus a high-tax city.

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Risks in Construction projects

- Financial risks – examples
  - Funding
  - Inflation
  - Delays in payment
  - Availability and fluctuation in foreign exchange
  - Local taxes
  - Repatriation of funds

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Risks in Construction projects

- Socio – political risks – examples
  - Customs and import restrictions and difficulties disposing of equipment are a few of the socio-political risks that might occur during a construction
  - Different regulations and codes depending on where our project is.
    - Constraints on the availability and employment of expatriate staff
    - Customs and import restrictions and procedures
    - Difficulties in disposing of plant and equipment
    - Insistence on use of local firms and agents
    - Local communities pose objections

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Risks in Construction projects

- **Force majeure risks**
  - The term ‘force majeure’ comes from French law, where it translates as 'superior force'
  - Very broadly, it relates to exceptional, unforeseen events or circumstances that are beyond the reasonable control of a party to a contract and which prevent or impede performance of their obligations under the contract.
  - Generally it cannot be an event that the party could reasonably have avoided or overcome, or an event attributable to the other party.

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Risks in Construction projects

- Force majeure risks – examples
  - Political factors change (political interference)
  - Political climate
  - Economic instability
  - Market conditions
  - Exchange rate fluctuation
  - Public safety regulation
  - Unforeseen changes to legislation

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Risks in Construction projects

- **Force majeure risks – examples**
  - Wars and other hostilities (such as terrorism)
  - Fires
  - Exceptionally adverse weather
  - Civil unrest, such as riots or revolution.
  - Strikes (other than by the contractor or subcontractors).
  - Natural catastrophes such as earthquakes, floods and volcanoes.
  - Epidemics or pandemics.

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Examples of important risk classifications

- Classification according to the level of occurrence
- Geographical classification
- Classification according to the scope of work and project complexity
- Classification according to the type and intensity of the possible consequences
- Chronological classification
- Classification according to the type of the Contract
- Classification according to risk responsibility

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Risk classification for Investment projects – according to the level of occurrence

To better understand risks, it is essential that we understand that risks fall into categories!

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Risk classification for Investment projects – according to the level of occurrence

- Strategic risks represent systematic threats that significantly influence on the Company as a whole
- Operational risks occur during the project realization and are mostly caused by the ongoing work activities
- Project risks are all risks that can occur during the project realization

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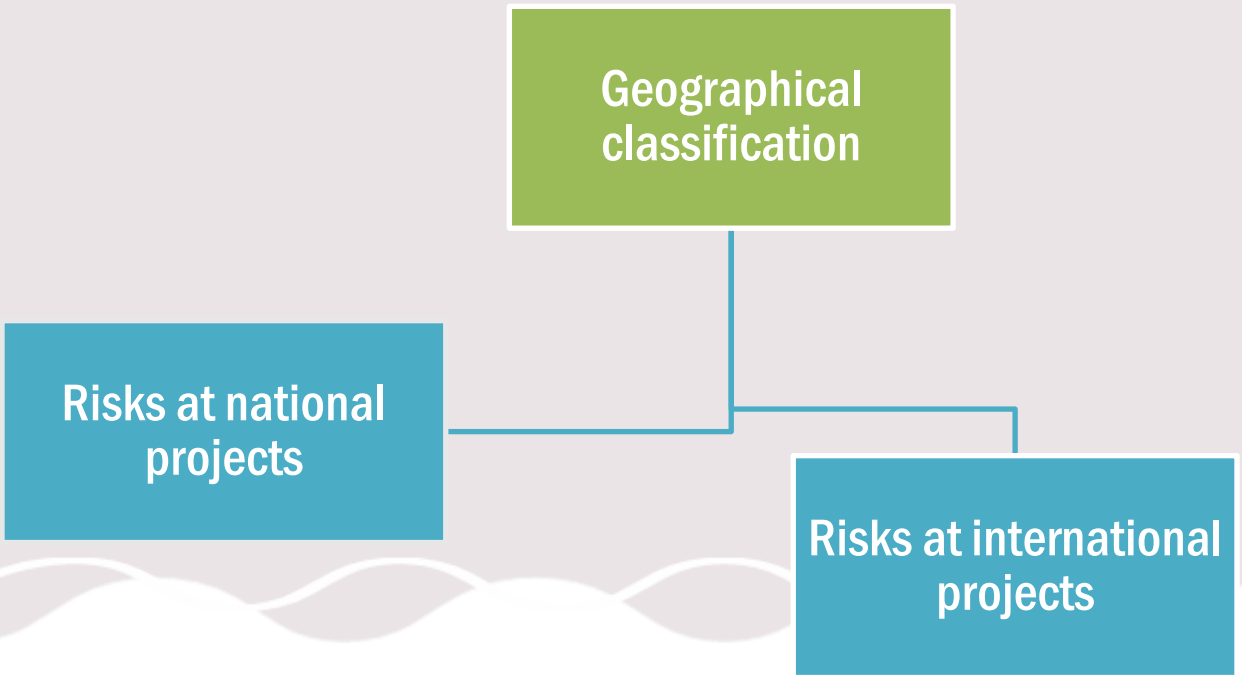
Geographical classification of risks

- Risks are divided according to the market, culture, tradition, habits, applied materials, methods of work in the country, region or location of project realization



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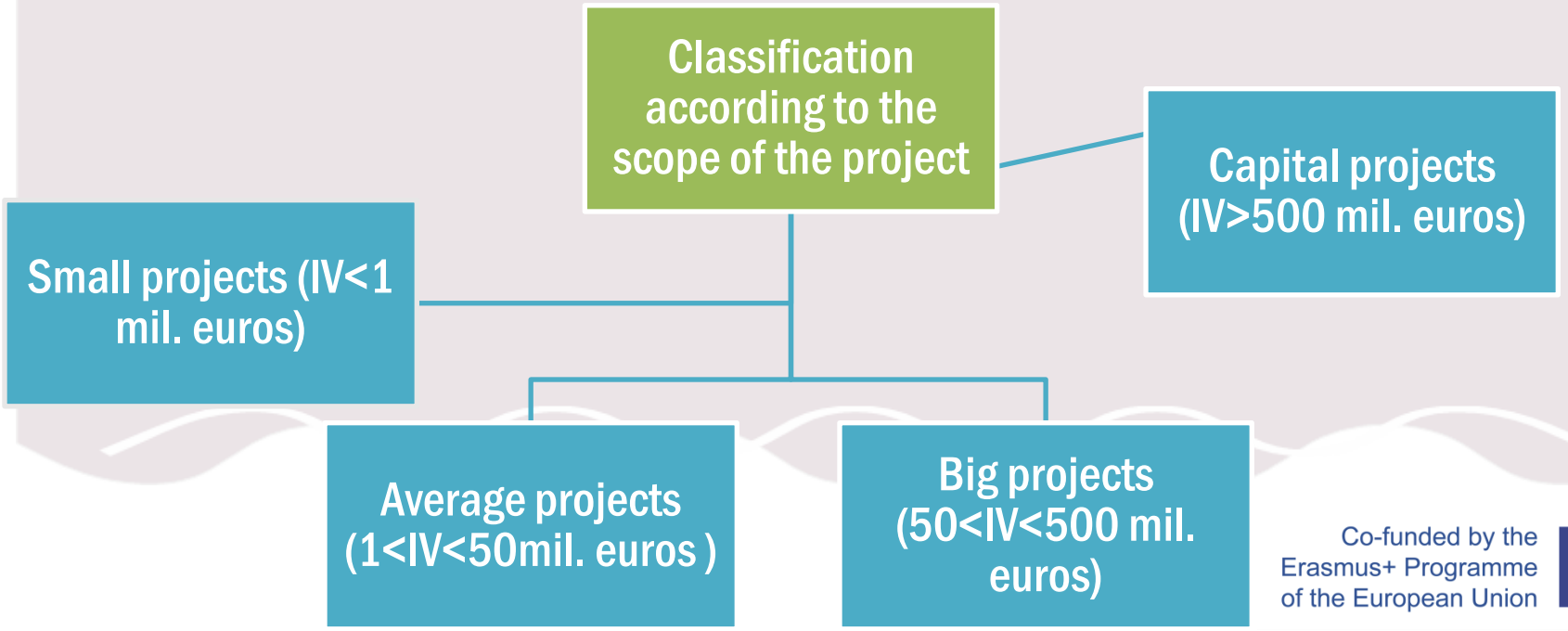
Classification according to the size and project complexity

- Number of risks that might occur is not proportional to the size, scope of work and financial value of the project
- All risks should be identified on time, before the beginning of the design phase, regardless of the complexity of the project



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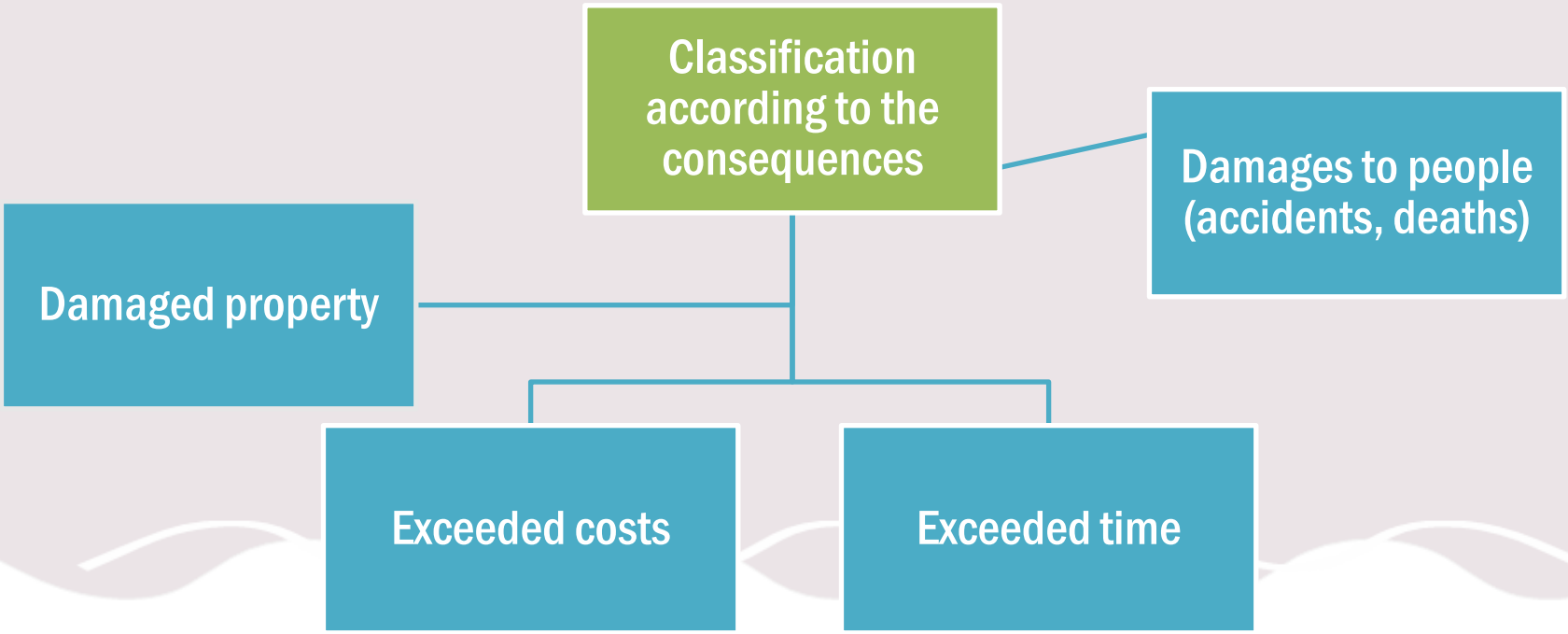
Classification according to the type and intensity of the possible consequences

- It includes the possibility of the occurred events and the type and intensity of the uncertain events



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Chronological classification of project risks

- Risks before construction
  - Risks during the initial phase of the project
  - Risks during the design phase
- Risks in the construction phase
  - Risks of location
  - Technical risks
  - Risks cause by the people actions
- Risks after construction phase

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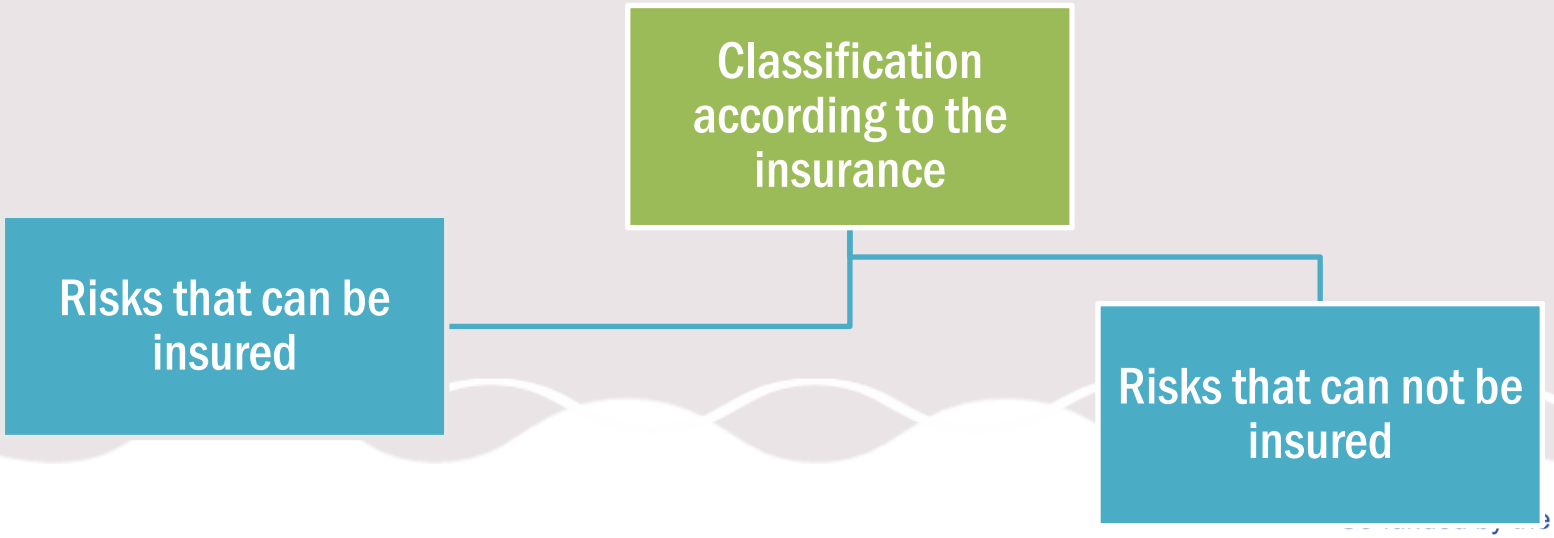
Classification of risks according to the standard types of Contracts

- The responsibilities for risk actions are allocated through different project participants therefore risks can be classified according to the responsible person (Contractor, Investor, Designer ..)
- Risks can be classified according to the possibility for insurance



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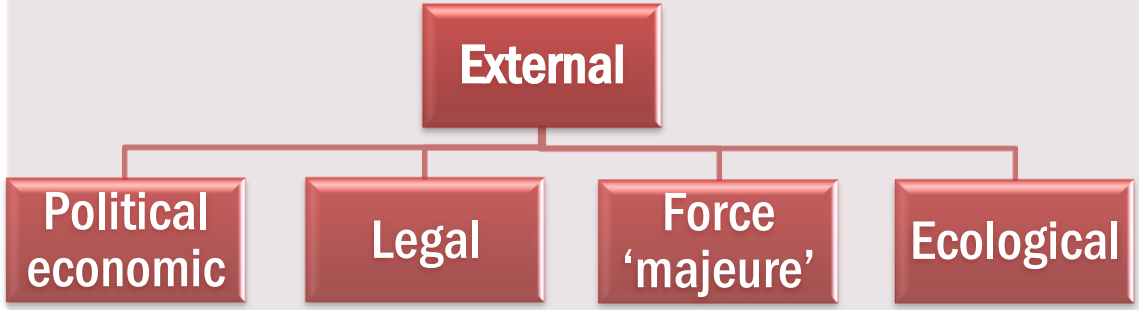
Classification of risks according to the location of the risk source

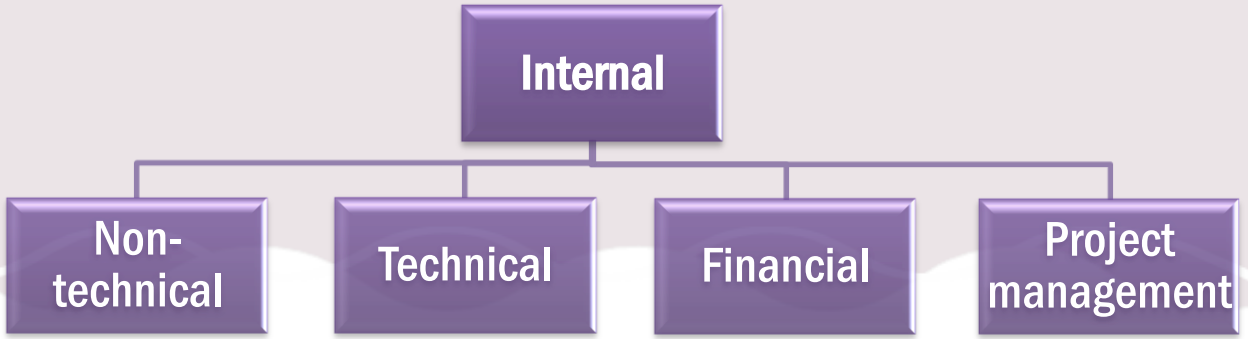


Risks from the surrounding area – it is hard to mitigate, avoid or lower their effects

They have to be identified and taken into account before signing of the Contract

Risks that are directly connected to the project realization

They can be effectively managed



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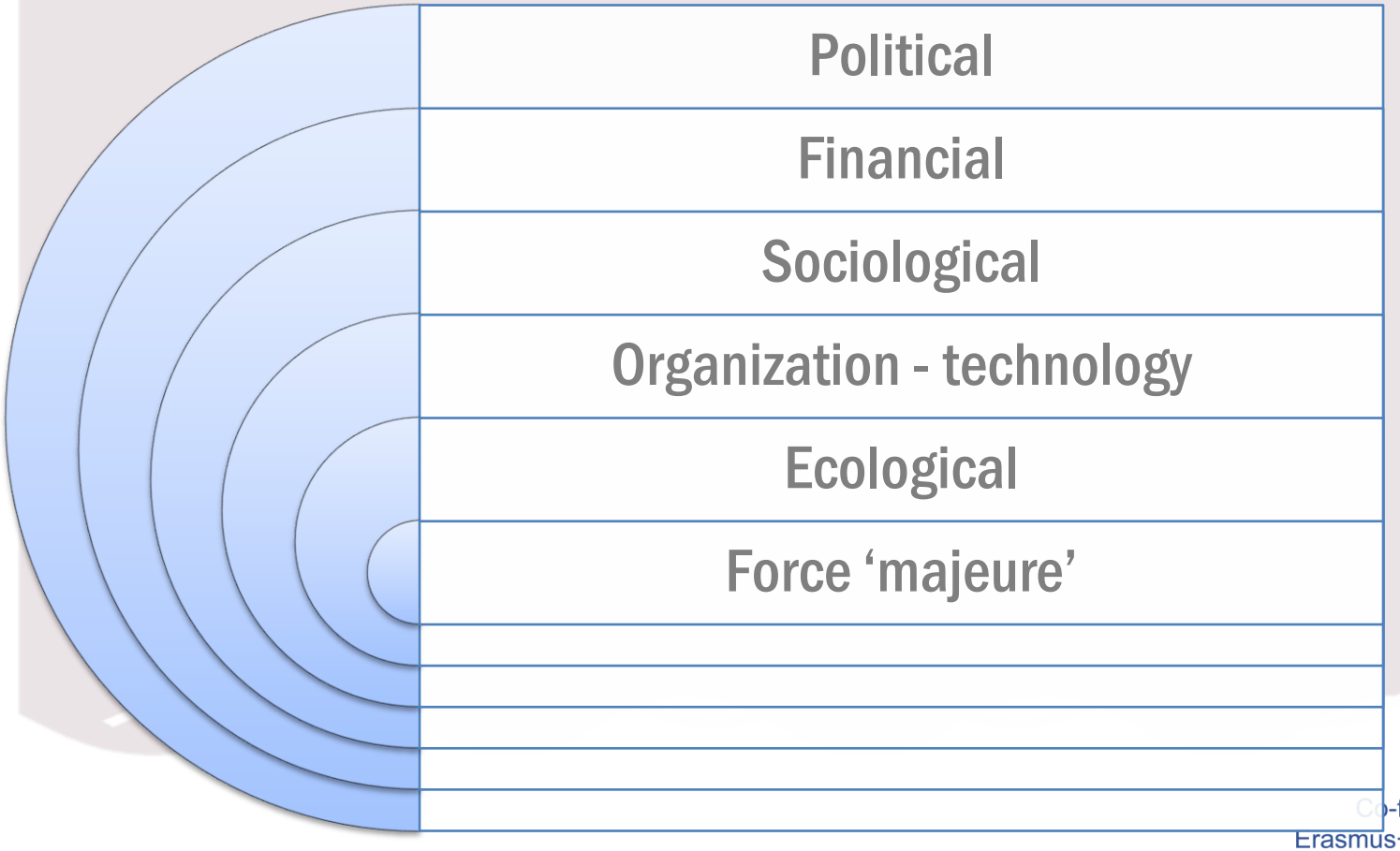
Risks classification according to the cause



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Risk management

- How to manage these risks?
  - Identification
    - Determine what risks are most likely to affect the project and which risks are the most important
  - Quantification and planning
    - Careful assessment of the risks, identification of the implications that risks might have on the project
  - Response monitoring and control
    - Monitor the risk responses that have been implemented as planned and determine if the risk exposure has changed. Monitor the risk metrics and milestones and the effectiveness of the risk management actions

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Risk management

- **Risk management** – formal and regular process of systematic risk identification, analyses and responses, towards elimination, mitigation and/or control of the risks
- The decision making process in the risk environment has to be **iterative, adaptive and open**!
- Special attention has to be paid at the beginning project phases, because they are the most risky ones and can cause major consequences on the project goals

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Risk management

- To maximize the chances and the impact of positive events and to minimize the probability and the impact of negative events, in order to meet the project objectives
- It is a decision-making process, and it involves having a full understanding of a known risk and/or necessary actions to reduce the effect and chances of the event of such risks, in other to reduce its complications and increase the chances of success
- To achieve a major improvement in the performance of the construction project management
- **The goal of risk management process is not to completely remove all project risks. Its aim is to produce an organized framework for managing project risks, especially the crucial ones, in a more efficient and effective way**

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Risk management

- Risk management, as a part of the total project management, improves the other management processes, especially the cost, time and quality management
- The financial implications of risks (for risk mitigation, transfer or neutralization) has to be included in the planning phase of the project, because sometimes risks can significantly change the total value of the investment
- **It may seem that the price for risk management is high, but it is clear that the price for no-management of the risks is even higher!**

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Risk management

- STANDARDS
  - British standard **BS 6709**
  - **ISO 3100**
  - American standard **ANSI/PMI 99-001-2004**

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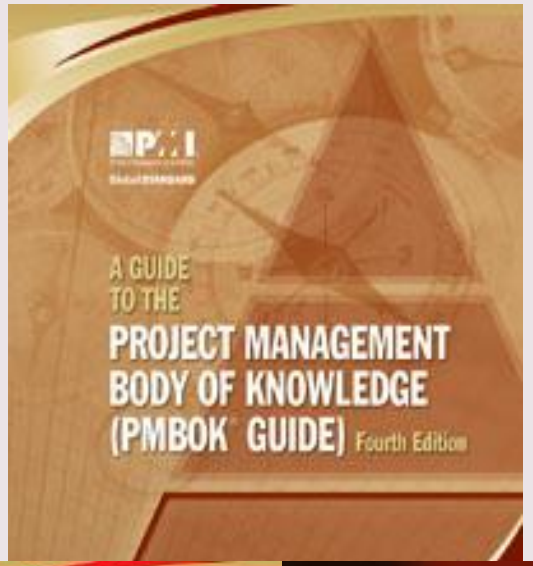
PMI approach

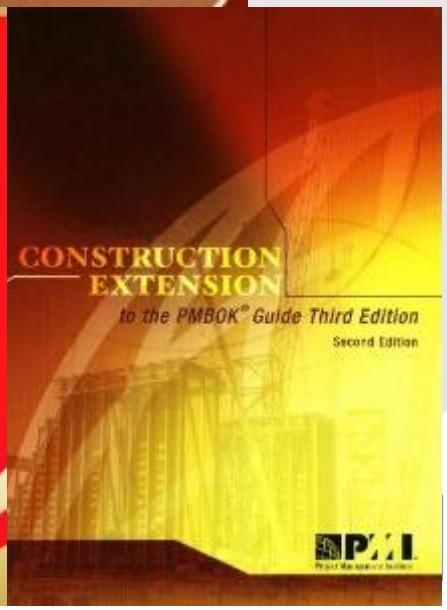
The American standard **ANSI/PMI 99-001-2004** is recommended for professional project management in the field of civil engineering

Has well established position on the investment market and it has been accepted in the international engineering practice:

Practical and concrete approach

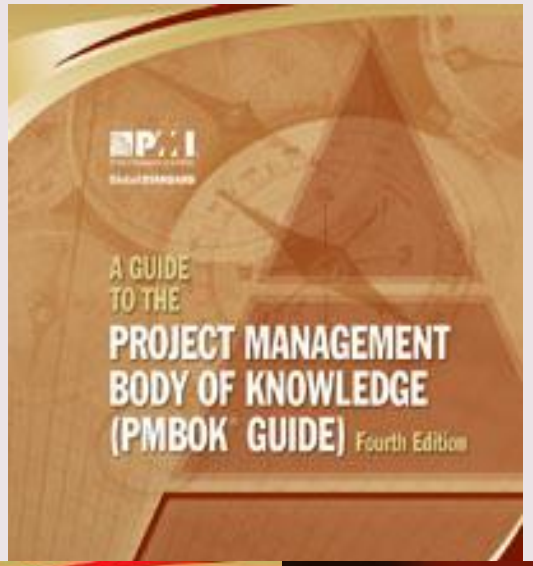
Continuous work of PMI, has data base of all members and supports the education and certification of professional project managers

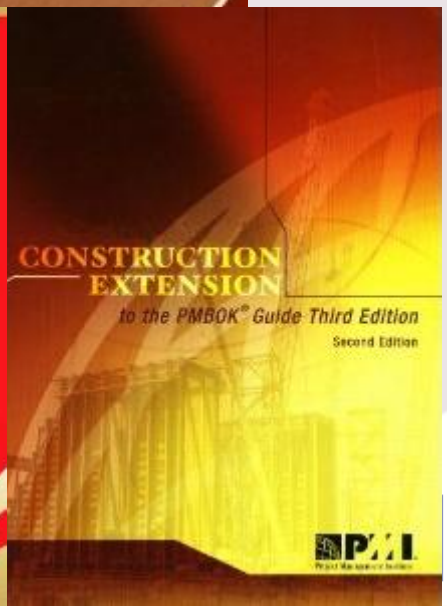




PMI approach

- PMI - Risk management is one of 10 fields of project management process
- The appendix of PMBOK for construction defines 4 additional areas: management of project safety, management of environmental safety, management of project financing, claims management





PMI approach

- **Project Risk Management** includes the processes of **conducting risk management planning, identification, analysis, response planning and controlling risk** on a project!

- The **objectives of PRM** are to increase the probability and impact of positive events and decrease the probability and impact of negative events in a project.

PMI approach
Risk management phases

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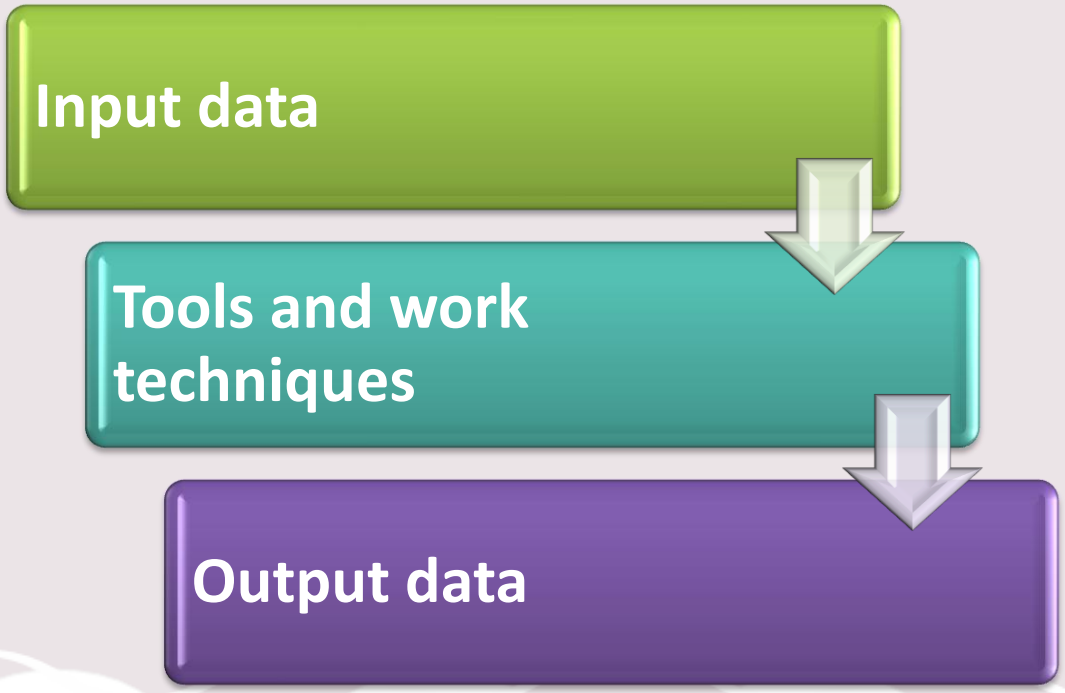
PMI approach – Risk management phases

- For each phase:



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Risk Management Planning

The process of defining how to

conduct risk management activities for a project

- Risks can arise from the very beginning of a project
- Risk Management should begin right away, and continue throughout project
- Early planning allows sufficient resources and time to be allocated to risk management

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Plan Risk Management

- Outline how Risk Management will be conducted on the project
- Identify techniques to be used in risk discovery, analysis and management
- Discover and document potential project risks
- Catalog risk characteristics and attributes
- Sort and prioritize project risks
- Determine probability or risk transpiring

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Plan Risk Management

- Determine impact of risk on project should it occur
- Quantitatively analyze the impact risks can have on the project
- Derive specific projections of cost and schedule implications
- Determine which risks require a response, then draft responses accordingly
- Generate plans to reduce or mitigate threats and enhance opportunities
- Implement risk response plans
- Track and monitor risks / Identify new risks that arise
- Gauge effectiveness of risk management

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Plan Risk Management

Risk Management Methodology

What approach, and what tools, will we use to manage project risks?

What data sources can be useful in identifying, managing and controlling project risks?

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Plan Risk Management

Roles & Responsibilities

Who holds responsibility for – and who conducts work on – project activities?

Who from the risk management team hold purview over which activities?

What responsibilities are held by each party for risk planning and response?

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Plan Risk Management

Budgeting

- Assists in estimating funds and resources needed for risk responses
- Outlines how and when contingency and management reserves can be used

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Plan Risk Management

Timing

- Risk management activities outlined for inclusion in project schedule
- Determine how and when schedule contingency reserves can be applied

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PHASE 1 – Risk management planning

PHASE 1: (Risk Management Planning)		
Inputs	**Tools & techniques**	**Outputs**
✓ Project Management Plan ✓Project charter ✓ Stakeholder Register ✓Enterprise Environmental Factors ✓Organizational Process Assets	✓ Analytical Techniques ✓Meetings ✓ Expert judgment All inputs are analyzed during the meetings lead by project manager	✓ **Risk management plan**

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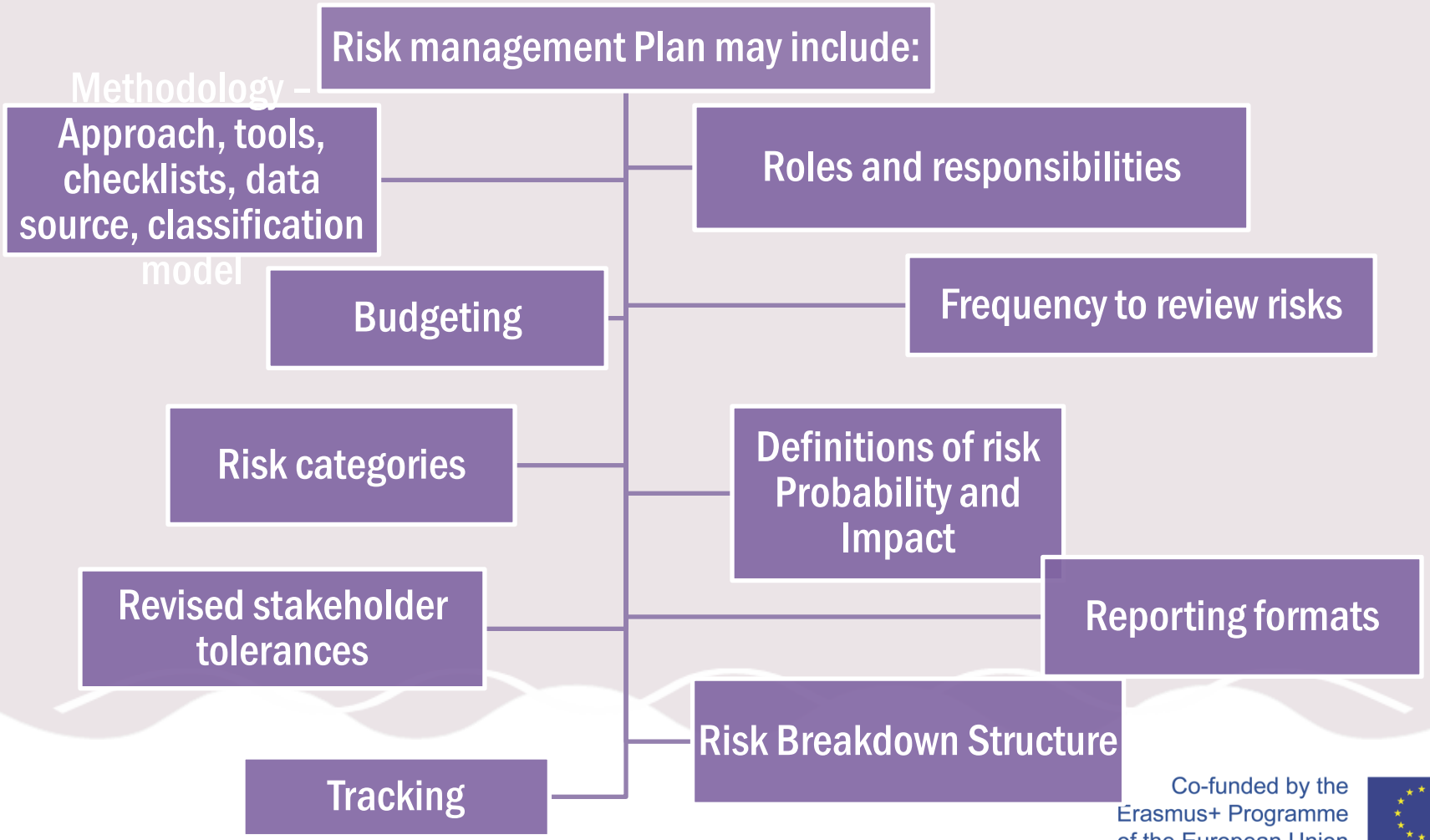
PHASE 1 – Risk management planning – Output



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Example of Risk Management Planning

Content	What is included?	Example
Methodology	How to identify and rang risks?	Meetings, expert judgment, engagement of the management team participants
	Which tools and techniques will be used?	MS Excel
	Simplification of the risk management process	The quantitative analysis will be conducted only for the 20 most important risks
	Types of communication	E-mails
Input data	List of project input data	Historical project data, company's forms and policies, official approval of the project, description of the scope of work, WBS, plan for the project realization, cost and time estimations, management plans, list of project limitations and assumptions

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Example of Risk Management Planning

Content	What is included?	Example
Responsibility	Who initiates meetings and make conclusions?	Project manager
	Who organizes meetings and who is responsible for their content?	Design manager (for the design phase) Construction manager (for the construction phase)
	Who participates?	In the pre-design phase: project manager, financial consultants, legal experts During the project course: project manager, members of the construction team, main designer and contractor representatives
	What is the role of the company leadership?	To study the main 10 risks and to make crucial decisions (for an example: to approve the main design criteria before the design phase begins)

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Example of Risk Management Planning

Content	What is included?	Example
Budget and time schedule	Time and money planned for the risk management processes	Money for organization of meetings and for engaging experts Planning of the working hours required for risk management processes The procedure is applied in each project phase at least once
Grading system and interpretation	Scales for quantitative and qualitative risk analysis	Scales from 1 to 10 will be used for assessment of the risk probability and risk impacts The consequences are divided on: cost, time, quality, scope of work, safety and influence on the project environment

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PHASE 2 – Risk Identification

It is a process of determining which risks may affect the project and documenting their characteristics

- Makes team aware of potential risks and allows a suitable preparation
- Documents and characterizes risks, allowing a better understanding and planning

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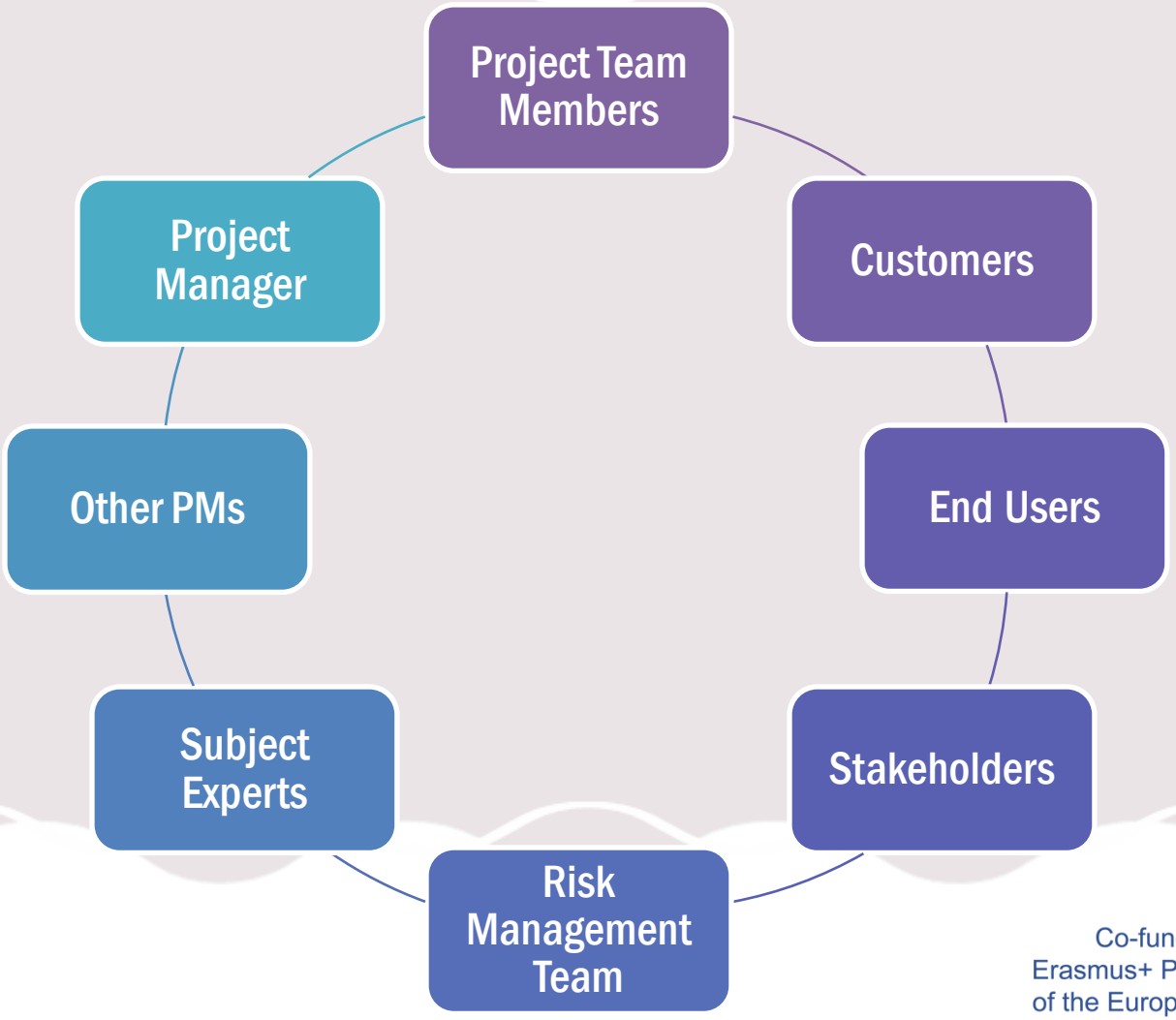
PHASE 2 – Risk Identification



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PHASE 2 – Risk Identification

PHASE 2: Risk Identification		
Inputs	**Tools & Techniques**	**Outputs**
✓ Risk management plan ✓ Cost management plan ✓ Schedule management plan ✓ Quality management plan ✓ Human Resource management plan ✓ Scope baseline ✓ Activity cost estimates ✓ Activity duration estimates ✓ Stakeholder register ✓ Project documents ✓ Enterprise environmental factors ✓ Organizational process assets	✓ Documentation reviews ✓ Brainstorming ✓Delphi method ✓ Interviewing ✓ Root Cause Analysis ✓ Checklists analysis ✓ Assumptions analysis ✓ Diagramming techniques (cause-and-effect diagrams) ✓System or Process Flow Charts ✓Influence Diagrams ✓ SWOT analysis ✓ Expert judgment	✓ **Risk register**

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PHASE 2 – Risk Identification – Tools and Techniques

Brainstorming

- Intuitive expert method - used to generate and collect ideas in a collaborative environment
- Expert meetings - Various ideas are brought up for solving certain problem
- Doesn't include voting or prioritizing
- The prediction for future uncertain events is based on:
  - Numerous ideas
  - All ideas are analyzed, they are not “a priory” rejected
  - Ideas are not underestimated, they are discussed and analyzed
- List of adopted ideas

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PHASE 2 – Risk Identification – Tools and Techniques

Delphi Technique

- Its based on collecting, analysis and adjustment of **experts judgments** and answers to different questions for project risks
- Experts are answering **questionnaires** (anonymously) composed of more than 10 precise questions
- 2 or 3 rounds of questionnaires
  - In the first round experts give answers for all questions
  - Obtained answers are analyzed and systematized
  - New questionnaire is made and experts answer the new questions
- The risk probability is obtained at the end of rounds, for each risk separately

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PHASE 2 – Risk Identification – Tools and Techniques

Interviews

- May be formal or informal, one-on-one or involving several parties
- Mixture or prepared and spontaneous questions
- Helpful in leveraging subject matter expertise to identify project risks

Root Cause Analysis

- Discovers underlying causes of problems and challenges
- Useful in determining the true sources of risk and in prioritizing risk management activities

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PHASE 2 – Risk Identification – Tools and Techniques

Checklist Analysis

- Checklists built using
  - Historical information
  - Organizational and team knowledge
  - Risk breakdown structure
- Useful in monitoring most common or well-known risk areas
- Not a substitute for comprehensive risk management
- They should be revised regularly

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PHASE 2 – Risk Identification – Tools and Techniques

SWOT Analysis

- Analyzes strengths and weaknesses of organization or project team
- Highlights where strengths lead to opportunities and weaknesses to threats
- Shows how strengths can overcome threats and opportunities can combat weaknesses

Expert Judgment

- Those with experience in relevant areas can often identify risks based on their prior work
- PM should identify useful experts and also their areas of bias

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PHASE 2 – Risk Identification Output

Risk Register

- Risk analysis and response results are documented in the risk register
- Risks are added to the risk register as they are identified
- Updated with additional information as risk management progresses
- Should include as much information as could for each risk
- Equal explanation or risk, triggers, probabilities and impacts is recommended when possible
- Root causes for risks should be highlighted by the register when evident

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PHASE 2 – Risk Identification

Example

Risk	WBS 1	WBS 2	Cause	Risk	Consequence	Risk owner
R-005	Preparatory works	Access to the construction site	Temporary access road is passing through an existing parking area	The owner of the parking may forbid the passing through, to avoid any potential disturbance	This veto can cause a delays of the preparatory works and delays of the construction itself	Executive construction manager

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PHASE 3 –
Qualitative Risk Analysis

It is a process of prioritizing risks for further analysis or action

by assessing and combining their probability of occurrence and impact

- It puts risks in perspective by comparing them with each other and predicting their effects on the project
- Allows risks to be rated based on type of impact:
  - Cost
    - Schedule
      - Scope and quality

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PHASE 3 – Qualitative Risk Analysis

PHASE 3: Qualitative Risk Analysis		
Inputs	**Tools & Techniques**	**Outputs**
✓ Risk management plan ✓ Scope baseline ✓ Risk register ✓Enterprise environment factors ✓ Organizational process assets ✓ List of probability and impact of risks	✓Risk probability and impact assessment ✓**Probability and impact risk rating matrix** ✓Risk data quality assessment ✓Risk categorization ✓Risk urgency assessment ✓Expert judgment	✓ **Risk score list**

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PHASE 3 – Qualitative Risk Analysis – Tools and techniques

Probability and impact matrix

- It is one of the mostly used tools for qualitative risk analysis
- Team technique for all engaged project stakeholders who can analyze the risk probability of all identified project risks and their effect on the project goals
- Can be completed quickly and at low cost
- It consists of assessment of two risk factors: **probability** and **impact** of risks in order to obtain the risk **priority**

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PHASE 3 – Qualitative Risk Analysis – Tools and techniques

Probability and impact matrix

The three components of risk: R = P * I

R- Risk score

I – Impact of Risk Event (Risk Event Value)

P – Probability of Risk Event

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PHASE 3 – Qualitative Risk Analysis – Tools and techniques

- **Probability** measures the likelihood an event will occur
- **Impact** measures the effect a risk may have on a project

- **Risk ratings** are created by multiplying probabilities and impacts!
  - They indicate how important a priority each risk should be in risk management

- According to the obtained risk ratings a **risk priority** is gained, as a input for preparation of risk strategies and risk responses that are required for other project management phases as well

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PHASE 3 – Qualitative Risk Analysis – Tools and techniques

Probability and impact matrix

- Teams and organizations may weight different risk types differently
- The scale is defined by the Company
- Scales for risk factors can be different:
  - High, moderate, low risk
  - Catastrophic, high, moderate, minimal, insignificant risk
  - Almost certain, probable, possible, less possible and rare influence
  - 1, 3, 5
  - 1, 2, 3....9, 10

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PHASE 3 –
Qualitative Risk Analysis – Tools and techniques

Matrix and its color coding is used to make prioritizing easier

		Probability				
		1 - Low	2- Low/Medium	3-Medium	4-Medium/High	5-High
Impact	5 – High	Low (5)	Medium (10)	High (15)	High (20)	High (25)
	4- Medium/High	Low (4)	Medium (8)	Medium (12)	High (16)	High (20)
	3 - Medium	Low (3)	Medium (6)	Medium (9)	Medium (12)	High (15)
	2 – Low/Medium	Low (2)	Low (4)	Medium (6)	Medium (8)	Medium (10)
	1 - Low	Low (1)	Low (2)	Low (3)	Low (4)	Low (5)

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PHASE 3 – Qualitative Risk Analysis – Tools and techniques

Probability and impact matrix

Risk thresholds and number of thresholds may vary, and are set by the project team

Score	Severity
1-5	Low
6-12	Medium
13-25	High

Organization determines which combinations are “Low”, “Moderate” and “high”, defining them in the Risk Management Plan

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Example of Qualitative risk analysis – Probability and impact matrix

		Impact			
		Minimal	Moderate	High	Catastrophic
Probability	Probable	moderate	moderate	high	high
	Possible	low	moderate	moderate	high
	Less probable	low	low	moderate	High

Risk	Probability	Impact	Priority
Elementary trouble	Less probable	Catastrophic	High
Delays in completion of works from the Contractor	Possible	High	Moderate
Unscheduled materials cost increase	Less probable	Moderate	Low
Changes of low regulative	Probable	High	High

Example of Qualitative risk analysis – Probability and impact matrix

			Risk probability				
			Insignificant	Not probable	Probable	Very probable	Almost certain
			1	*2*	*3*	*4*	*5*
Impact	*1*	insignificant	1	2	3	4	5
	2	low	2	4	6	8	10
	3	moderate	3	6	9	12	15
	4	high	4	8	12	16	20
	5	critical	5	10	15	20	25

Risk	R = Vj x Ut	Priority
Acceptable to unacceptable	15-25	Very high
Significant	9-12	Attention is needed
Critical	5-8	Normal attention
Insignificant	1-4	Under control

PHASE 3 – Qualitative Risk Analysis - Outputs

Risk score list (Project Documents Updates)

- Risk register Updates (assessment results, risk categories and rankings)
- Assumptions Log Updates (assumptions may be revised, removed or added)

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PHASE 4 – Quantitative Risk Analysis

- The Quantitative Risk Analysis follows the qualitative analysis, it is more costly and time - consuming
- It provides firmer numbers to indicate the risk impact on the:
  - Project costs
  - Project schedule
- It may **not** be **always possible** to perform this analysis, it depends on the amount of available information
- It is **not always necessary**, depending on probability and potential impact

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PHASE 4 – Quantitative Risk Analysis

PHASE 4: Quantitative Risk Analysis		
Inputs	**Tools & Techniques**	**Outputs**
✓ Risk management plan ✓ Cost management plan ✓ Schedule management plan ✓ Risk register ✓ Enterprise environment factors ✓ Organizational process assets	✓Data gathering and representation techniques **✓Quantitative risk analysis and modeling techniques** ✓Expert judgment	**✓ List of priority quantified risks** Risk list should consists of risk description and the measures for its control. ✓ Project Documents Updates

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Perform Quantitative Risk Analysis – Inputs

- **Risk Management Plan**
  - How should risk be analyzed?
  - What methods and tools may be used?
  - What level of depth should the analysis cover, and in regards to which risks?

- **Cost Management Plan**
  - Contingency and management reserves are key to the risk management (reserves are one of our key tools for dealing with risks once they arise)
  - Outlines how reserves should be established, maintained and controlled

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Perform Quantitative Risk Analysis – Inputs

- **Schedule Management Plan**
  - As with cost, contingency and management reserves are important tools in managing risk
  - Outlines how reserves are developed, managed and controlled
- **Risk register**
  - Includes information on risks, including qualitative analysis
  - It helps to understand where quantitative analysis may be useful or necessary
  - Gives information about how quantitative analysis should be conducted in order to be most effective

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Perform Quantitative Risk Analysis – Inputs

- **Enterprise Environmental Factors**
  - They impact the quality of the risk management process
  - Industry studies of similar projects
  - Industry or proprietary risk databases
- **Organizational Process Assets**
  - Information from similar past projects
  - Information from earlier project phases

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Perform Quantitative Risk Analysis – Tools and Techniques

- Data gathering and representation techniques:
  - Interviewing
    - Interviews with stakeholders & subject-matter experts
    - These interviews can focus on worst-case, best-case and most-likely scenarios
    - Expert judgment is critical in pairing risks with numbers
      - It is required to discover and evaluate potential impacts and probabilities

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PHASE 4 –
Quantitative Risk Analysis

- Risk experts estimate the probability and impact of risks
- They can rely on past experience to guide estimates and choose methods of analysis
- Typically Risk analysis might result in a **Three-point estimates**
  - optimistic, pessimistic and most likely figures for each potential risk
  - Closely tied to the: Estimate Activity Durations and Estimate Activity Costs (there we also use 3-point analysis in order to help estimate how long activity takes to complete or how much it will cost)

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PHASE 4 – Quantitative Risk Analysis

- Often times the Quantitative analysis alone doesn't provide enough information about what risks should have the highest priority!
- Sensitivity analysis:
  - Modeling technique that determines which risks have the most impact on the project
  - Prioritizes risks by potential outcome variance
- One way of conducting sensitivity analysis is by using Tornado diagrams

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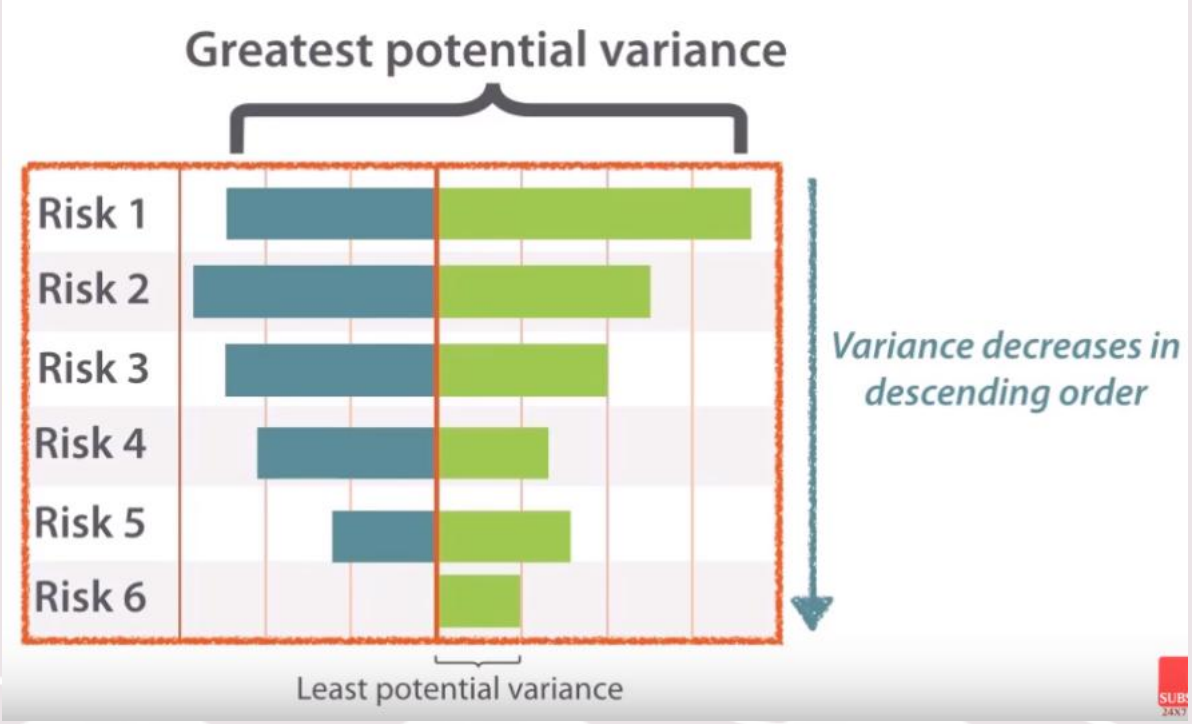
PHASE 4 – Quantitative Risk Analysis

- Special bar chart that is used to compare the importance (relative) of different variables.
- Y-axis names risks
- X-axis shows impact in standardized units
- Zero point on X-axis is typically located near the center of the chart



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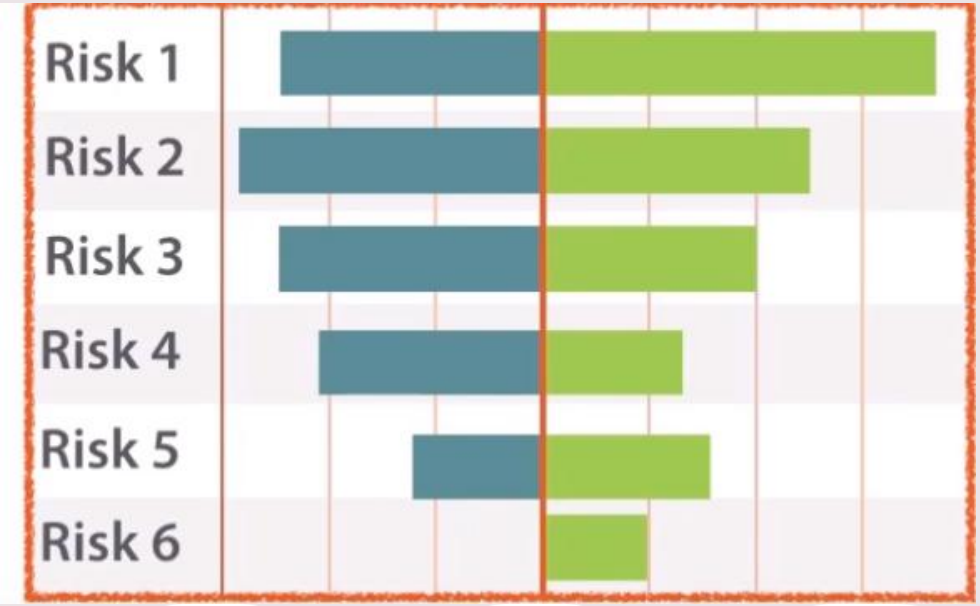
PHASE 4 – Quantitative Risk Analysis

- Visualizes both positive and negative risk outcomes
- Not all risks must have both positive and negative potential outcomes to be included
- One of the most useful ways of comparing potential risk outcomes



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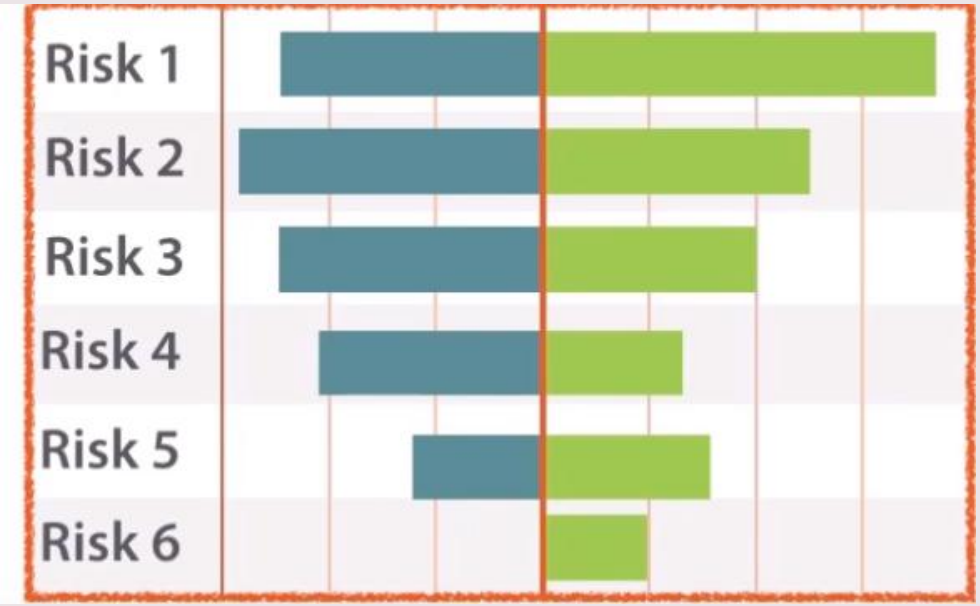
PHASE 4 – Quantitative Risk Analysis

- It is simple to see how wide the potential variance for each different risk factor might be, and how much the risk stays in one direction or another
- Risk 3: larger potential variance
- Risk 4: has more potential for a negative outcome than a positive one →more likely to cause trouble!



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Perform Quantitative Risk Analysis – Tools and Techniques

- Expected Monetary Value (EMV) Analysis
  - One of most valuable quantitative risk analysis
  - Often times there a several different pathways that a project can be completed
  - However, each of these pathways might have a different risks
  - All potential impacts of various decision and risks can be difficult to grasp
  - EMV analysis help us in discovery of **optimal decisions** to make in our project, given the different risks, probabilities and benefits we might see depending on the path we choose

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Perform Quantitative Risk Analysis – Tools and Techniques

- Expected Monetary Value (EMV) Analysis
  - EMV analysis calculates the average outcomes of future scenarios
  - Very good at comparing effects of various decisions and scenarios
  - Positive values represent **opportunities**
  - Negative values represent **threats**
    - Example – one risk may cost the project an additional 20 000 Euros if it occurs, but there is only a 20% probability of the event happening
    - So EMV for above example would be 4000 Euros

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Perform Quantitative Risk Analysis – Tools and Techniques

- **Decision Tree Analysis**
  - EMV often powers Decision Tree Analysis
  - Possibilities are sketched out based on different decisions and potential outcomes
  - Each decision (path/branch) is evaluated for Risk and Impact i.e. EMV
  - The resulting net value are calculated for each set of decisions and possibilities
  - The **option** offering the **highest EMV** should be **selected**

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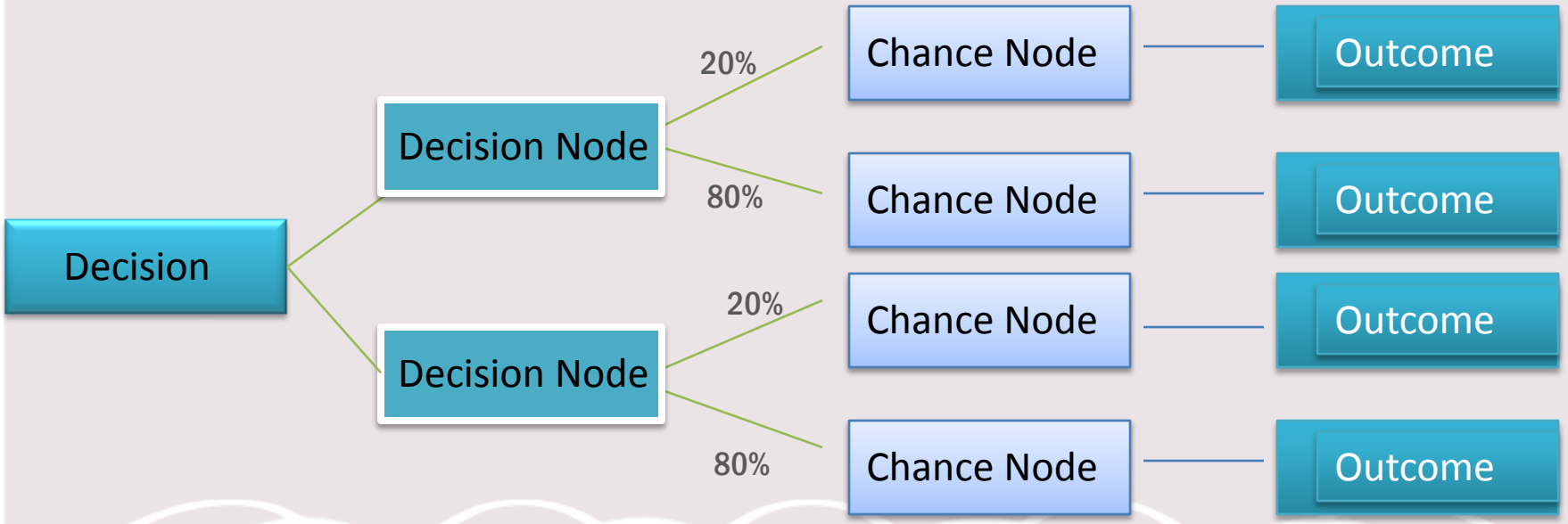
Perform Quantitative Risk Analysis – Tools and Techniques

- **Decision Tree Analysis**



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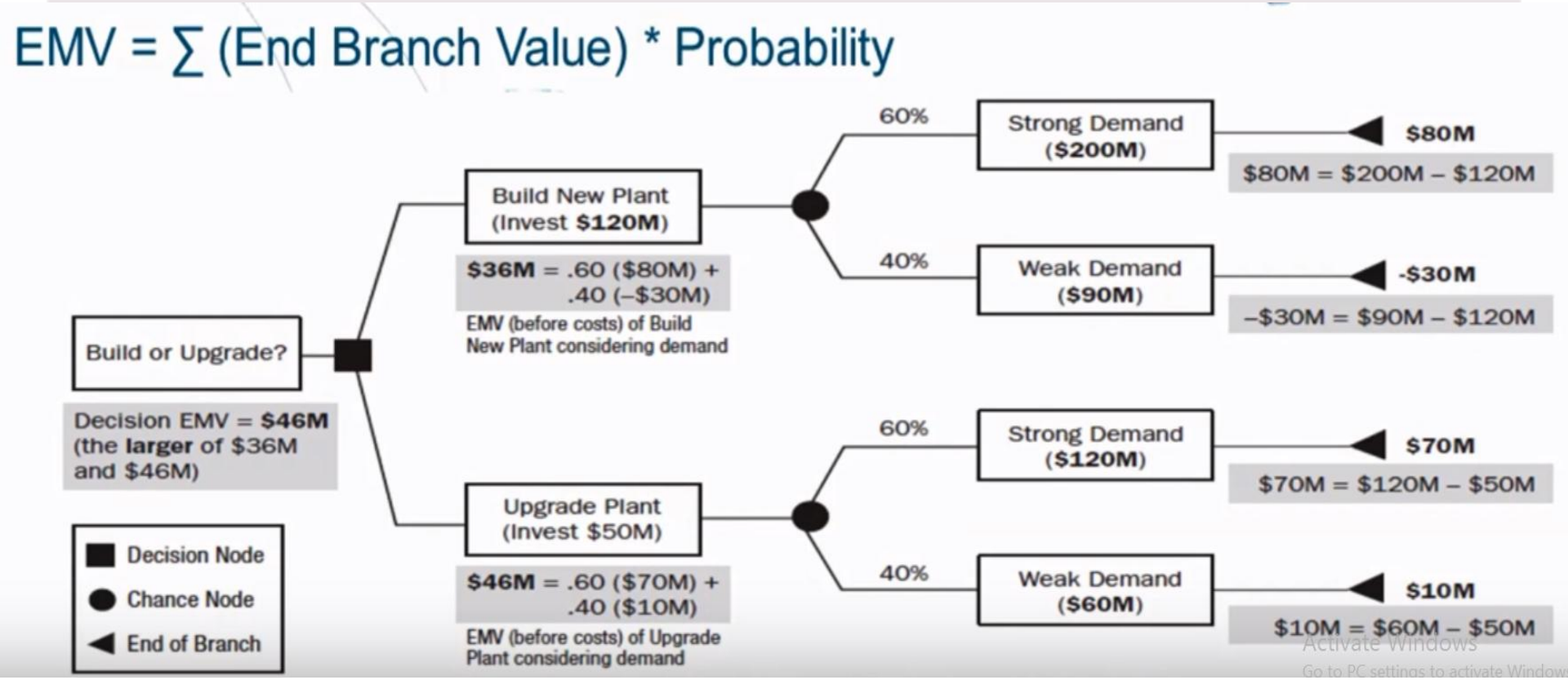
Perform Quantitative Risk Analysis – Tools and Techniques

- Decision Tree Analysis



Perform
Quantitative Risk Analysis – Tools and Techniques

- **Modeling and simulation**
  - Models calculate outcomes using variables
  - Simulations use models in order to predict and visualize a range of outcomes given certain variables
  - Simulations are computed over and over again using many possible input variables
  - Results are presented in graphical form, showing odds of various results
  - Simulations are useful when there are number of project variables to be considered

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Perform
Quantitative Risk Analysis – Tools and Techniques

- Modeling and simulation
  - Simulations are typically performed using the Monte Carlo technique
  - We can use models and simulations for cost and schedule estimates!
    - Cost Risk Analysis use cost estimate data
    - Schedule Risk Analysis use schedule network diagrams and activity duration estimates

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Perform Quantitative Risk Analysis – Process Outputs

- **Project Documents Updates**
  - **Probabilistic Project Analysis**: estimates of budget and schedule requirements for activities
    - Used in conjunction with risk tolerances to create appropriate contingency reserves
  - **Probability of achieving cost and time objectives**: Likelihood of meeting goals shifts over time, useful in shaping project and risk management activities
  - **Prioritized list of quantified risks**: Makes clear which risks pose the greatest threats, or present the greatest opportunities
  - **Trends in quantitative risk analysis results**: patterns and trends may emerge as work progresses and additional analysis is conducted

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Difference between qualitative and quantitative risk analysis

- The qualitative analysis is required for project planning, while the quantitative analysis is not
- The qualitative analysis represents a subjective assessment of the risk factor and its influence
- The quantitative analysis represents an exact (objective) calculation of the risk effect and risk factor

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Example of qualitative analysis of project risks

Risk number	WBS 1	WBS 2	Risk	Probability	Mark of consequences	Rang (probability x consequence)	Risk priority
R-005	Preparatory works	Access to the construction site	Not getting approval for the access road	3	4	12	2

Example of quantitative analysis of project risks

Risk number	Risk	Probability	Estimated time delay (days)		Estimated cost overrun (Euros)		Expected monetary value– in Euros (probability x costs)	
			Min	Max	Min	Max	Min	Max
R-005	Not getting approval for the access road	30%	5	7	100 000	180 000	30 000	54 000

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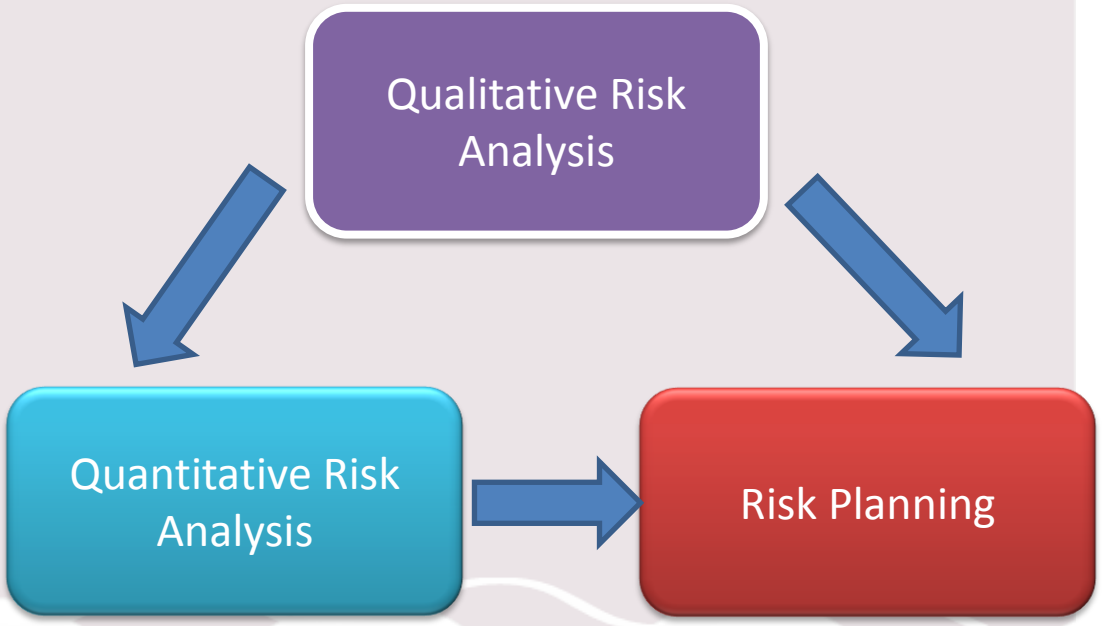
PHASE 5 – Plan Risk Responses

The process of developing options and actions to enhance opportunities and to reduce threats to project objectives.

- For risks prioritized by qualitative and quantitative analysis
- Responses planned in an order based on this prioritization
- Planned responses add resources and activities to project plan, budget and schedule



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PHASE 5 – Plan Risk Responses

- Process assigns an individual **owner** to each risk response
- Owner is responsible for ensuring risk responses are effective and have the intended effect
  - Project manager
  - Member of the risk management team
  - Front line worker

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PMI approach – Plan Risk Responses

PHASE 5: Plan Risk Responses		
Inputs	**Tools & Techniques**	**Outputs**
✓ Risk management plan ✓Risk register	✓Strategies for negative risks or threats ✓Strategies for positive risks or opportunities ✓Contingent response strategies ✓Expert judgment	✓ **Plan for Risk Responses** ✓Project management plan updates ✓Project documents updates

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4 basic ways to handle a risk:

Negative risks may impact the project cost, schedule, quality, performance or ability to complete objectives

Strategies for Threats

- Avoid
- Transfer
- Mitigate
- Accept

Positive risks may allow project work to be completed: more quickly, at lower cost, with better quality and with secondary objectives being achieved

Strategies for Opportunities

- Exploit
- Share
- Enhance
- Accept

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PHASE 5 – Plan Risk Responses

- Responses must be appropriate for the risk they address
- They have to fulfill the 4 criteria:
  - Cost – effective
  - Time – effective
  - Realistic
  - Supported by the key stakeholders

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PHASE 5 – Plan Risk Responses – Tools & Techniques

- Strategies for Negative Risks or Threats
  - **Avoidance**: Revise plans to steer clear of the potential risk, when possible
  - **Transference**: Shift ownership and responsibilities to a third party, often in the form of insurance or special structured contracts
  - **Mitigation**: Develop a strategies to reduce the likelihood or impact of threats to the project
  - **Acceptance**: Team defers any action until a risk comes to pass; often dealt with using a contingency reserves at that point

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PHASE 5 – Plan Risk Responses – Tools & Techniques

- Strategies for Positive Risks or Opportunities
  - **Exploitation**: Revise plans to guarantee opportunity can be leveraged, often by applying its best resources or technology
  - **Enhancement**: Develop strategies to increase the likelihood or impact of opportunities to the project
  - **Sharing**: developing a joint venture or partnership that allows a third party to exploit an opportunity to the benefit of both parties
  - **Acceptance**: Team defers any action until and opportunity comes to pass; may apply contingency reserves at that time

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PHASE 5 – Plan Risk Responses – Outputs

- **Project Management Plan Updates:**
  - Schedule Management Plan: to update the strategy in order to reduce risks and take advantages of opportunities
  - Cost Management Plan: update the budget strategy and contingency reserve policies based on the risk response strategies
  - Quality Management Plan: update the quality assurance and control policies and quality tolerance levels to better align with risks
  - Procurement Management Plan: update the contracting decision processes based on the risk analysis and response strategies
  - Human Resources Management Plan: update the project organizational structure and resource allocation to better fit the risk response needs

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PHASE 5 – Plan Risk Responses – Tools & Techniques

- **Contingency Response Strategies**
  - Plans developed for use only if specific events first occur
  - Specific events often activate contingency plans
  - Includes fallback plans should project targets be missed

- **Expert Judgment**
  - Critical in developing the risk responses
  - Helps ensure risk responses are appropriate and adequate

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PHASE 5 – Plan Risk Responses – Outputs

- **Project Documents Updates:**
  - Assumptions log updates
  - Technical documentation updates
  - Change requests

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PHASE 5 – Plan Risk Responses – Outputs

- **Risk register Updates:**
  - Risk owners and responsibilities
  - Response implementation strategy
  - Risk symptoms, triggers and warnings
  - Contingency and fallback plans
  - Residual risks following the response planning
  - List of accepted risk factors
  - Secondary risks of risk response

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Example of Risk Responses Plan

Strategy for risk response	Description	Example (unfavorable foundation conditions)
Avoid	To eliminate the threat by eliminating the cause	Change of the construction location
Transfer	To transfer the risk to some other engaged sub-contractor or to buy an insurance	Increase of the contractor's contracted responsibilities
Mitigate (control)	To reduce the expected influence by reducing the probability and/or risk consequences	Better ground investigations and engaging of experienced designer ad contractor
Accept	To accept the risk with all its consequences	Preparation of alternative solutions for the foundation and adding the worst possible scenario in the project budget
Combined response	To combine two or more strategies	Combination of above mentioned actions

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Example of Plan Risk Responses Plan

Risk number	WBS 1	WBS 2	Risk	Response strategy	Description of the recommended risk response
R-0005	Preparatory works	Access to the construction site	Access road is not approved	Mitigate / control	Location surveying, preparation of drawings for the access road and requesting an approval from the owner of the parking area To propose measures for noise and dust control and noise and dust reduction (protection fence 3 m height, access road asphalting)

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PHASE 6 - Control and Monitor Risks

The process of implementing risk response plans, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating risk process effectiveness throughout the project

- Risks and risk responses must be controlled throughout the project lifecycle
- New risks emerge, known risks change, some risks become outdated
- Constantly review all of the project data:
  - to be able to react quickly if a new risk is uncovered or
  - to implement one of the proposed response strategy
- Without careful monitoring even the best plans and strategies will not get implemented in time to save the project if a risk happens!

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PHASE 6 - Control and Monitor Risks

To implement risk response plans, track identified risks, monitor residual risks, identify new risks, and evaluate risk process effectiveness!

PHASE 6: Control and Monitor Risks		
Inputs	**Tools & Techniques**	**Outputs**
✓ Project management plan ✓Risk register ✓Work Performance Data ✓Work Performance reports	✓Risk reassessment ✓Risk audits ✓Variance and trend analysis ✓Technical performance measurement ✓Reserve analysis ✓Meetings	✓ **Plan for Unpredicted Risk Responses *(workaround plans)*** ✓Work Performance Information ✓Changes requests ✓Project management plan updates ✓ Project Documents Updates ✓Organizational process assets updates

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PHASE 6 - Control and Monitor Risks

Monitoring Risks:

- It is recommended to mark the risk activities into the dynamic plans of project realization and to control and monitor them on the same way as for the critical activities
- An additional column for risks should be added into the project **Gantt charts** for easier and efficient risk control and monitoring
- The priority risks, the responsible for risk response and the risk status should be subject of discussion of every monthly meeting and should be included into the official Reports for project work progress

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PHASE 6 - Control and Monitor Risks

Monitoring Risks:

- If previous phases of PRM are not properly conducted:
  - They will make unplanned decisions as risk responses that are not systematically identified and analyzed
  - The project managers will spend lots of time to solve problems for risk scenarios that could have been avoided

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Conclusions

Important notice:

Risk management processes have to be iterative!

Each project change requires immediate identification of new possible risks, risk analysis and preparation of new risk response strategies and tactics!

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Conclusions

- Risk management has to be:

Thorough	Systematical	Continuous
• it has to include all project activities and components (human resources, processes and technological elements)	• it has to include the iterative management processes through precisely defined phases and activities	• implemented throughout the project life-cycle

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Conclusions

- Risk management has to be:

Proactive	Adjustable	Oriented towards the future
• to aim towards prevention or mitigation of risk impact and consequences	• to include a wide spectrum of quantitative and qualitative methods for risk analysis	• dedicated to continuous individual learning and improvement of the company's knowledge

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Conclusions

- The main imperative is to :
  - Recognize the importance of Risk Management
  - Organize a quality implementation of risk management processes throughout each phase of the project life-cycle
- Proper Risk Management leads to:

More successful projects

More successful companies

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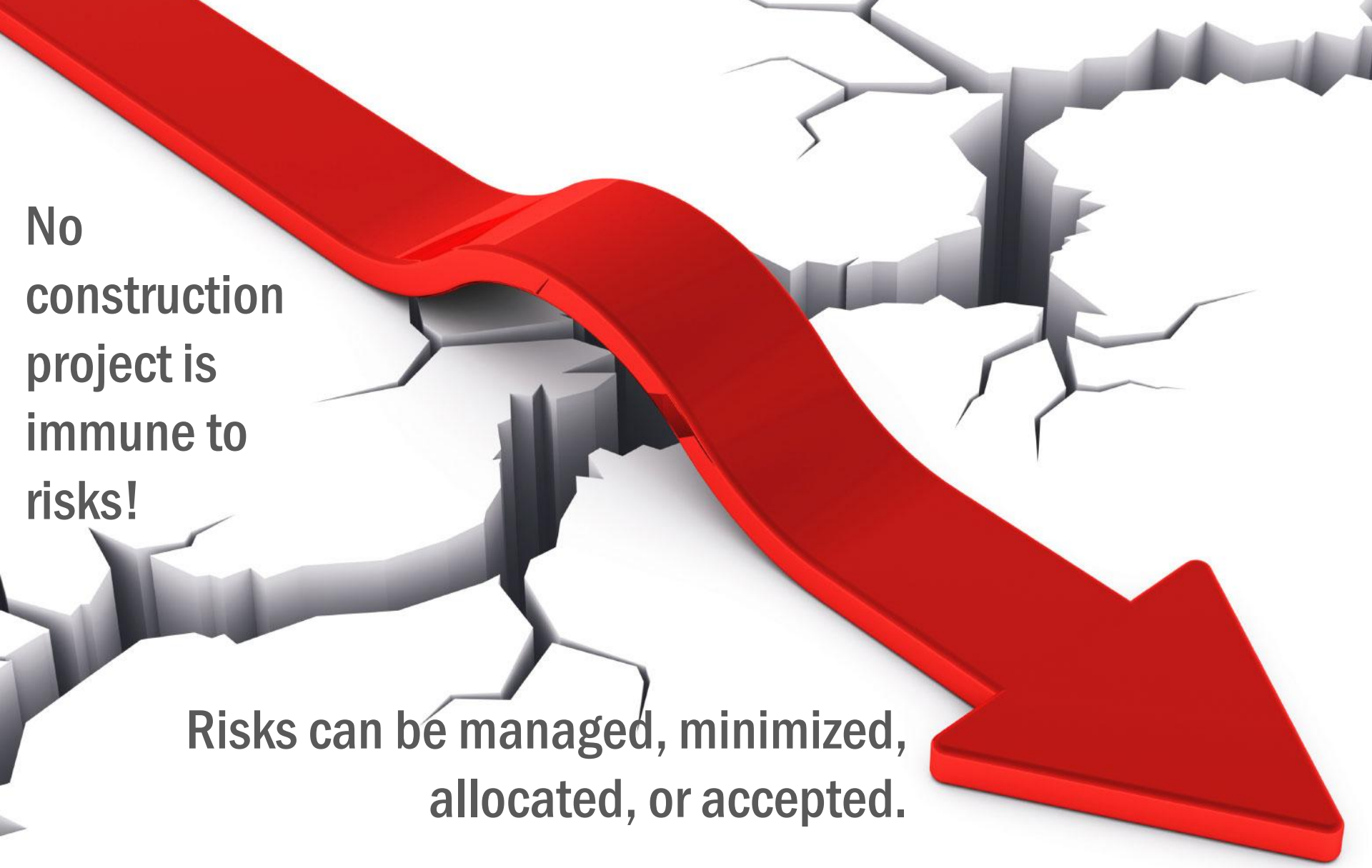
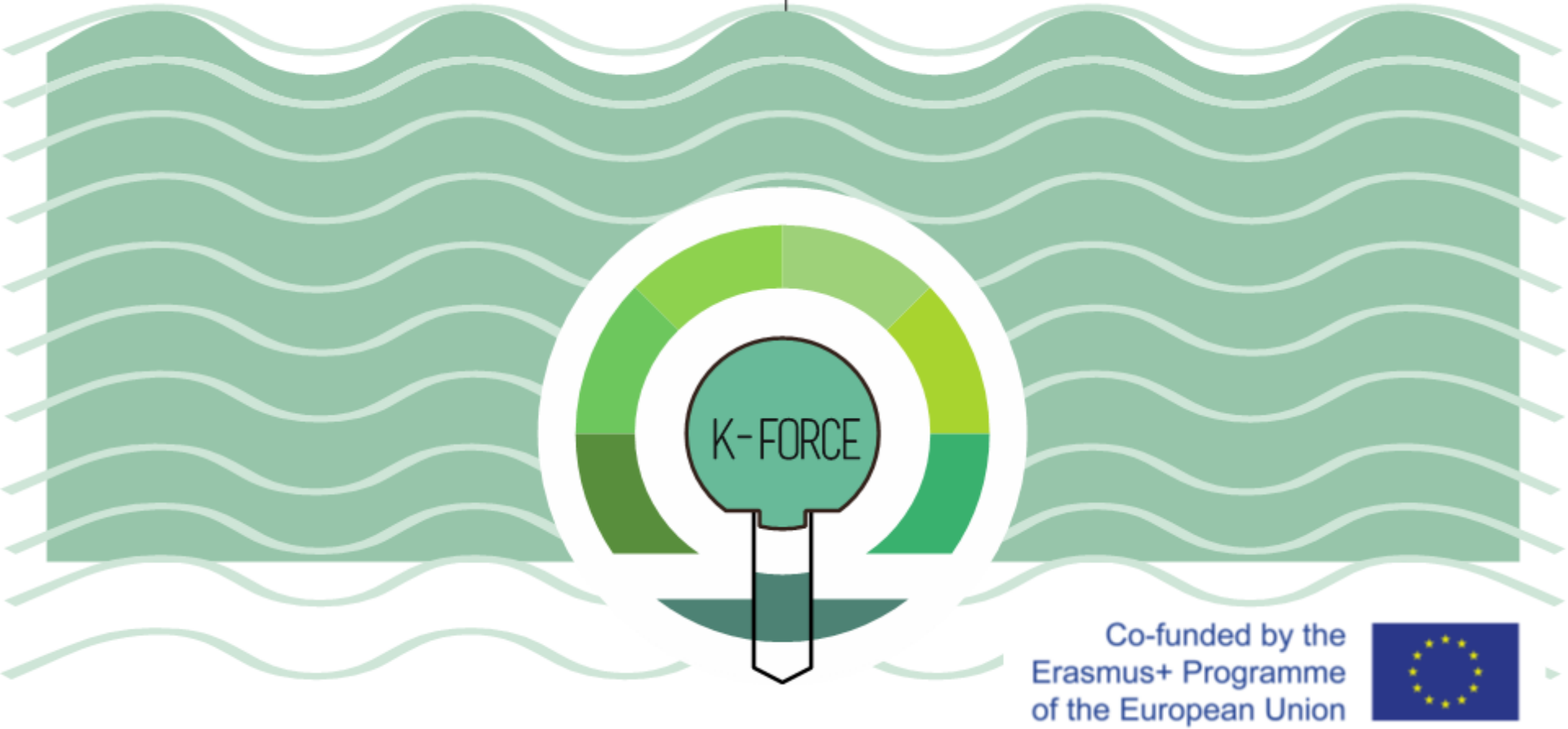


No construction project is immune to risks!

Risks can be managed, minimized, allocated, or accepted.

Risks can not be ignored!



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Thank you
for your attention

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Knowledge **FO**r **R**esilient so**C**i**E**ty