



Risk analysis for road tunnels

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Introduction

Status Quo of Road Tunnel Safety

- dynamic development of methods and tools
- experience, research results and public opinion in many countries lead to adjustments of regulations and safety standards
- there is consensus as regards the necessity of taking an integrated approach,
- but significant differences as regards the methods and assessment concepts
- the EU Directive on Road Tunnel Safety is the first standard at international level

➔ IARC activities:
establishing of working group 2 - Management of Road Tunnel Safety at the level of the Technical Committee on Road Tunnel Operation (C3.3)

Activities of PIARC WG2

WG2 „Management of Road Tunnel Safety“

Members of Working Group 2

Rudolf Hörhan, Austria – Chairman

Alain Jeanneret, Switzerland - Secretary



29 MEMBERS from:

Austria	Belgium	Czech Republic	Denmark	France	Germany
Greece	Italy	Japan	Netherlands	Portugal	Slovenia
Swiss	Sweden	United Kingdom	USA

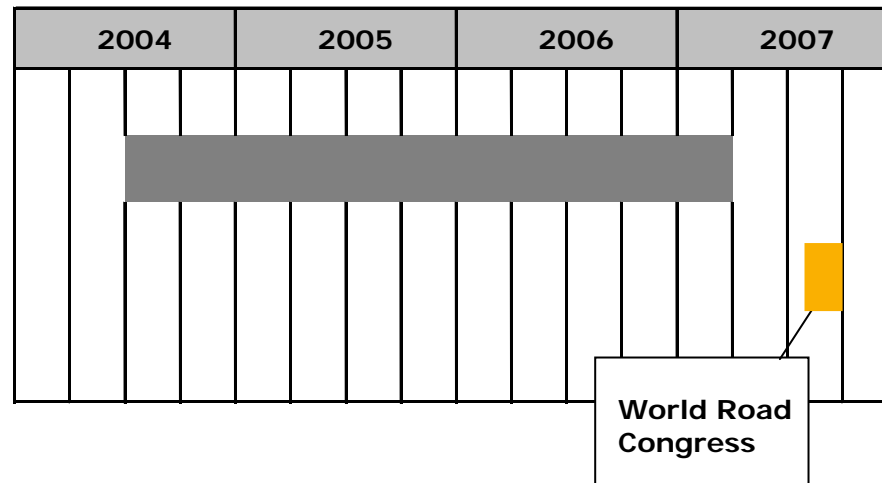
Activities of PIARC WG2

Work Plan – Schedule

general aim: to produce publications on main topics

time frame: approx. 2.5 years, 7 work sessions

Reports: results published at the World Road Congress 2007; approved reports available until end 2007



Definitions

Prescriptive based approach

... a tunnel is safe if it is designed in line with valid regulations

- ↳ Specifies particular safety features, actions etc. to be included in the design of tunnels, in processes etc. without considering the individual characteristics of the tunnel.

Risk based approach

... a tunnel is safe if it meets predefined risk criteria

- ↳ allows a structured, harmonized and transparent assessment of risks for an individual tunnel and the comparison of different safety measures coming up with the best additional measures in term of risk mitigation.

Conclusion

- ➔ Prescriptive based approach and risk based approach have to be used as complementary elements of a safety assessment process.

What is Risk Analysis?

- A big family of different approaches, methods and complex models combining various methodological components for specific tasks
- systematic analysis of sequences and interaction effects in potential accidents
- thereby identifying weak points in the system and recognising possible improvement measures
- risk analysis makes the quantification of risks feasible

Definitions

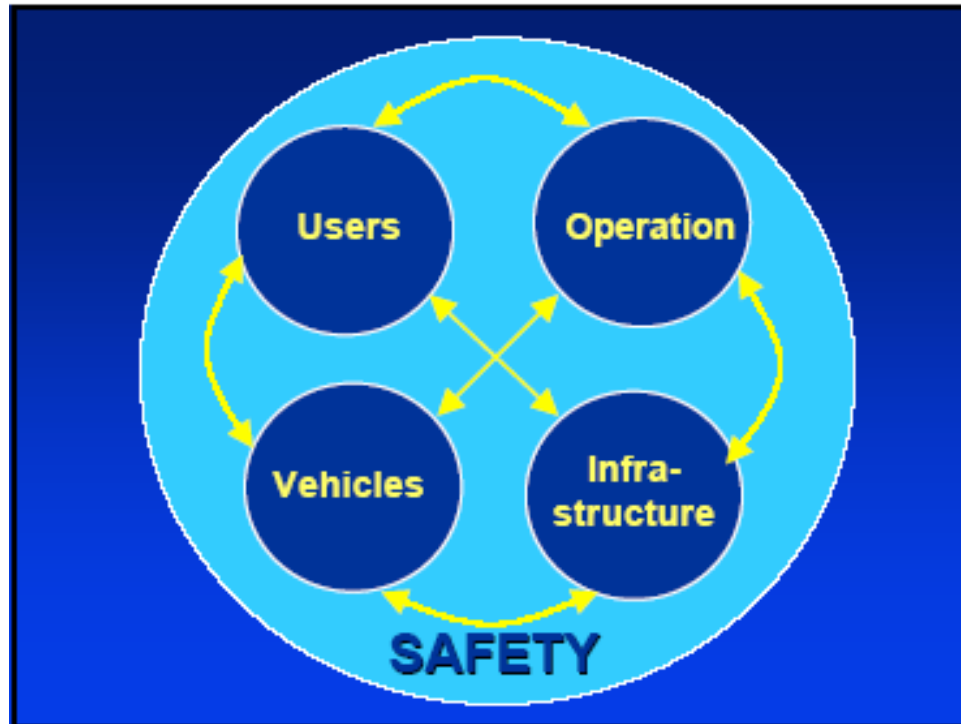
What is the Purpose of Risk Analysis?

- to check general consistency of safety planning
- to choose between alternatives
- to demonstrate safety in case of deviations from prescriptions
- to optimize safety planning in terms of cost-effectiveness
- a performance based approach for the assessment of safety standards

Risk Analysis - Methodology

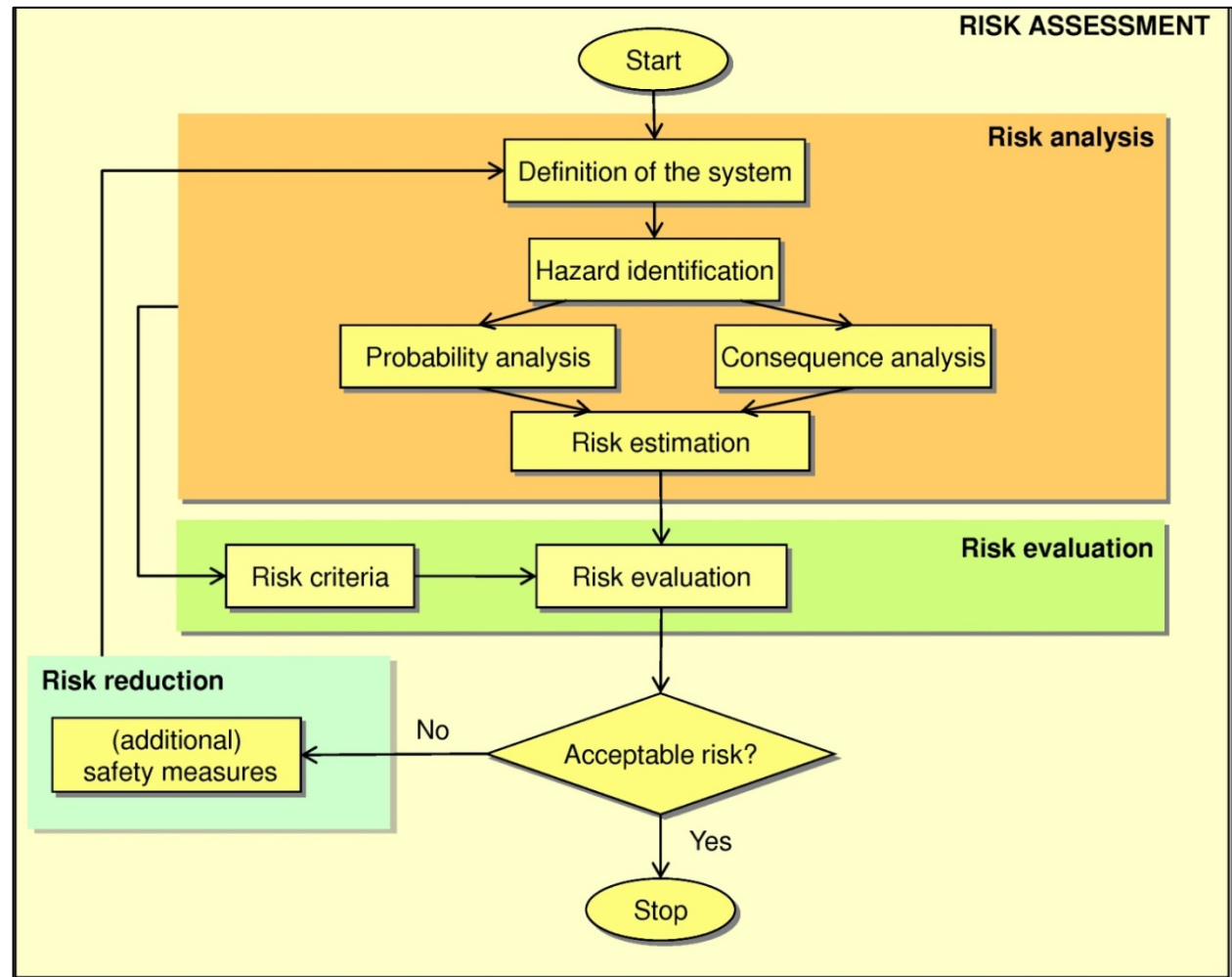
Basic Principle: Integrated Approach

take the whole system into account



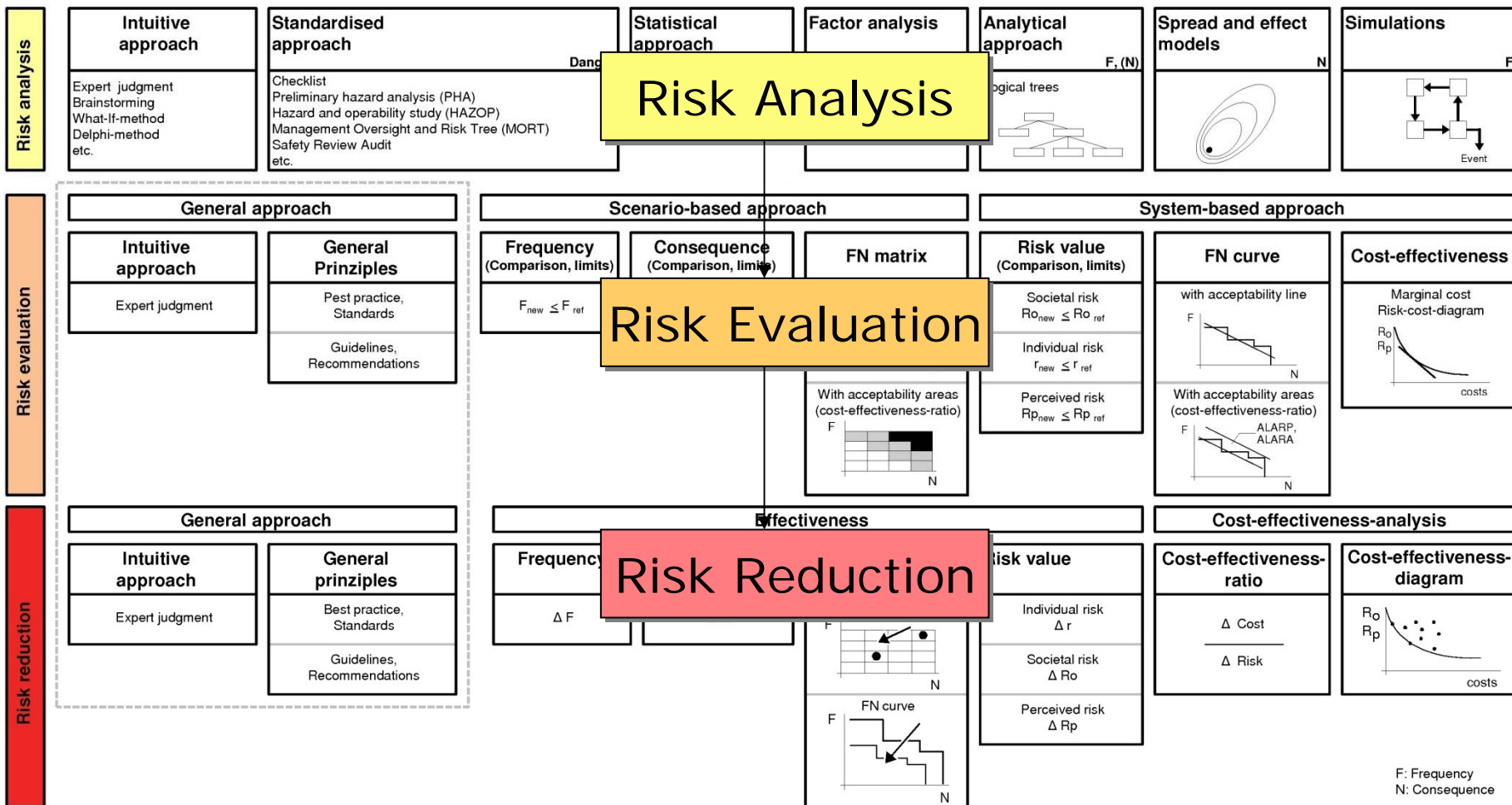
Risk Analysis – Methodology

Risk Assessment Process



Risk Analysis - Methodology

Survey of Components



Risk Analysis –Methodology

Quantitative System based Approach:

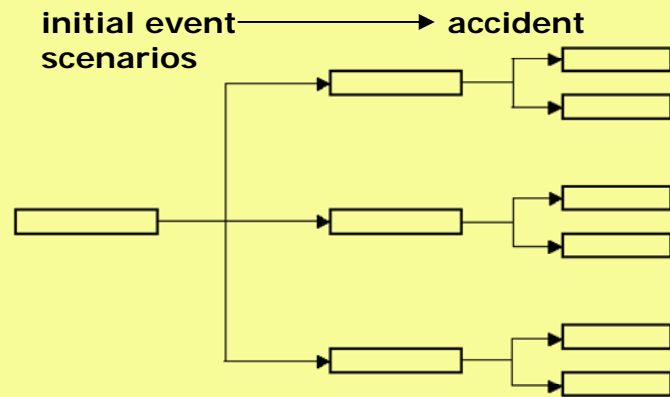
investigates an overall system in an integrated process, obtaining risk values for the whole system

Input: Influencing factors

Tunnel length Traffic volume Portion of . . .
heavy vehicles



Logical tree



X

Modelling of Consequences



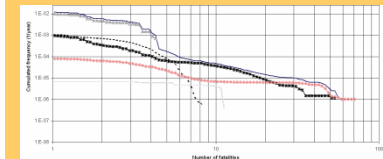
RISK

Results

Expected risk value
(fatalities/year)

R

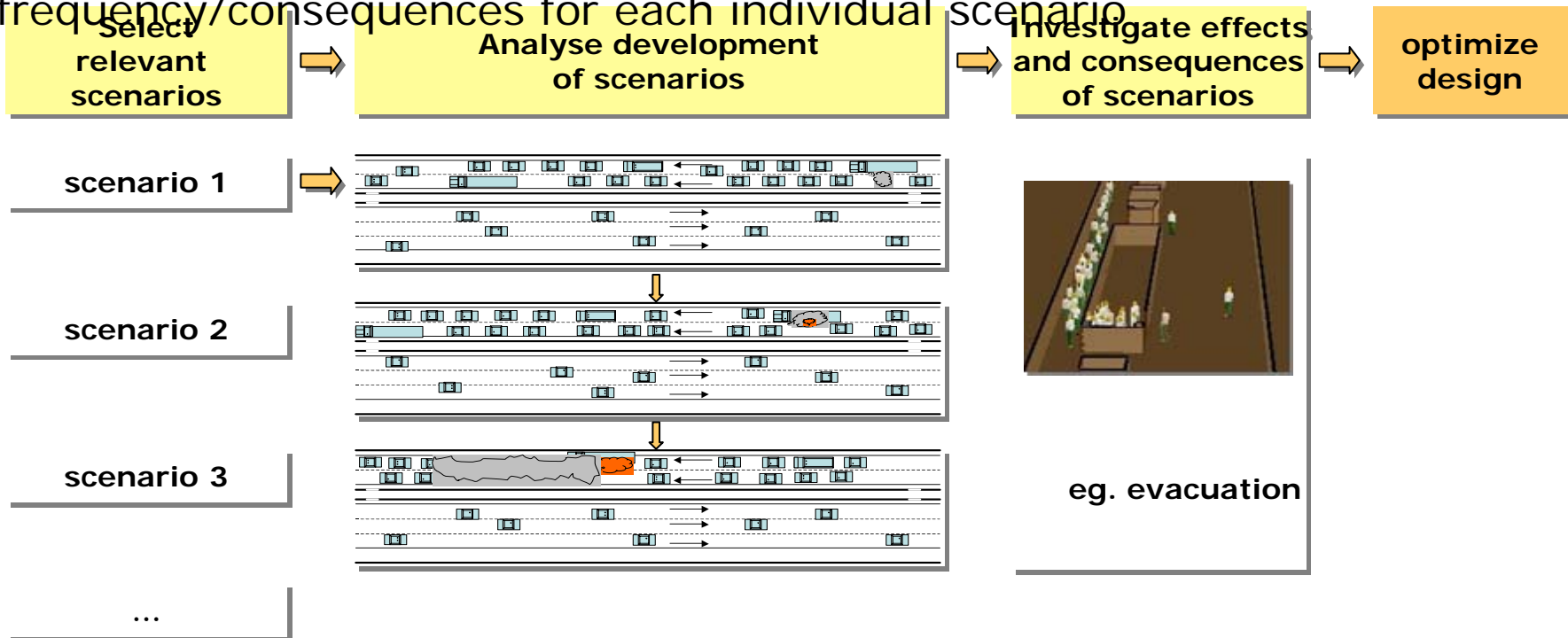
Risk distribution
(F-N-Curve)



Risk Analysis - Methodology

Qualitative or semiquantitative Scenario based Approach:

analyses a set of relevant scenarios obtaining information on frequency/consequences for each individual scenario



Results of PIARC's Work

PIARC WG2: Report "Risk Analysis for Road Tunnels"

- provides a description of basic principles and characteristic methodologies of the risk assessment process
- presents 6 practical methods and gives recommendations for the use of risk analysis

Contents of Report:

- Basic Principles and Practical Application
- Methodologies for Risk Analysis and Risk Assessment
- State of the Art of Risk Analysis in different countries
- Presentation of 6 Practical Methods
- Conclusions

Results of PIARC's Work

PIARC WG2: Report "Risk Analysis for Road Tunnels"

- demonstrates the practical application of different risk analysis methodologies by showing examples in the form of 7 case studies

PIARC Report – Appendix 3: Case Studies

- Austrian Tunnel Risk Model – TuRisMo
- France Specific Hazard Investigation
- Dutch Scenario Analysis for Road Tunnels
- Dutch TUNPRIM Model
- Italian Risk Analysis for Road Tunnels
- United Kingdom – Case Study
- OECD/PIARC DG QRA Model

Case Study - TuRisMo

TuRisMo – Risk Model for Austrian Road Tunnels

Definition of the System (example for demonstration)

- Existing single tube tunnel, length 5,5 km
- Bi-directional traffic, 9.500 vehicles per day, 25% heavy goods vehicles
- Emergency exits: every 500m
- Ventilation: transversal ventilation, extraction openings with dampers every 100m – in line with Austrian guidelines

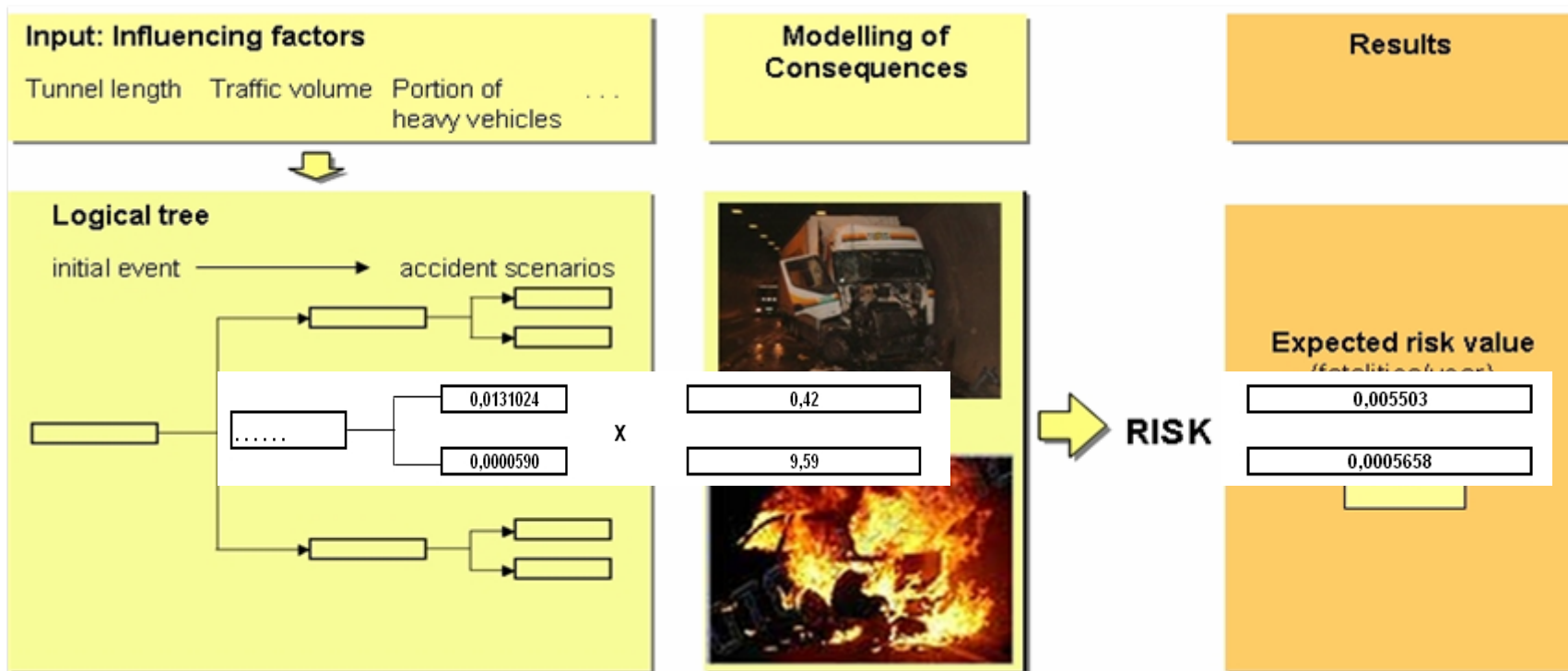
Design and equipment of the tunnel are in line with the requirements of the EC-directive, only share of heavy goods vehicles exceeds reference value of 15%

➔ risk has to be assessed

Case Study - TuRisMo

Application of TuRisMo – Risk Calculation

Quantitative System based Approach:

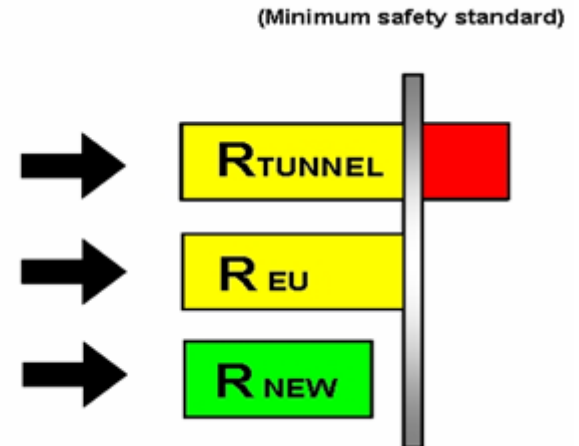


Case Study - TuRisMo

Strategy of risk evaluation

→ Risk evaluation is done by relative comparison, by comparing the tunnel as it is to a reference tunnel, designed and equipped in accordance with the requirements of the EC-directive

- Tunnel with deviating characteristics
- Minimum requirements as per EU Directive for specific tunnel
- Tunnel with alternative measures

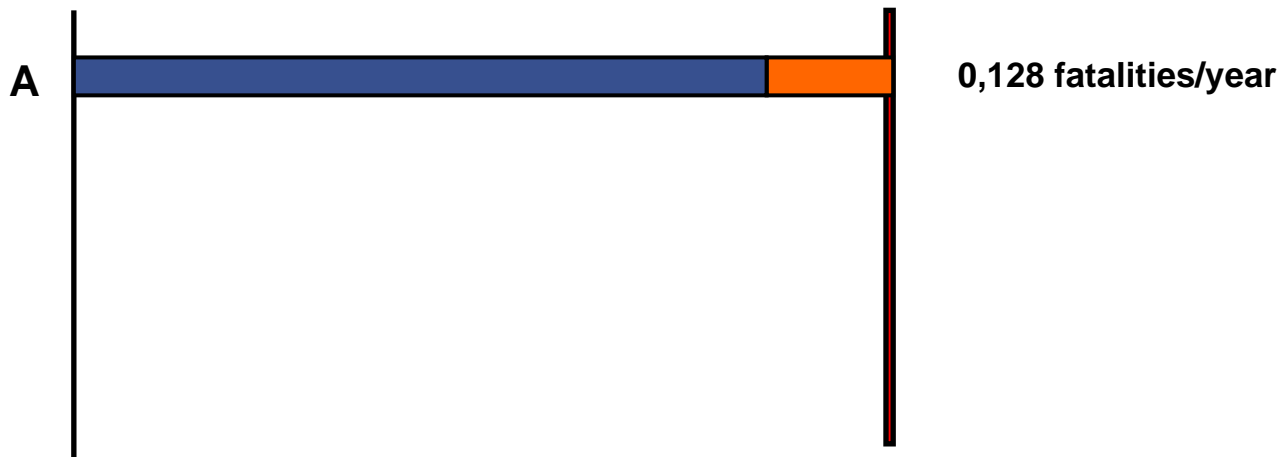


Case Study – TuRisMo

Application of TuRisMo – Results

The following cases are investigated

- A – risk of reference tunnel (definition of risk criteria)

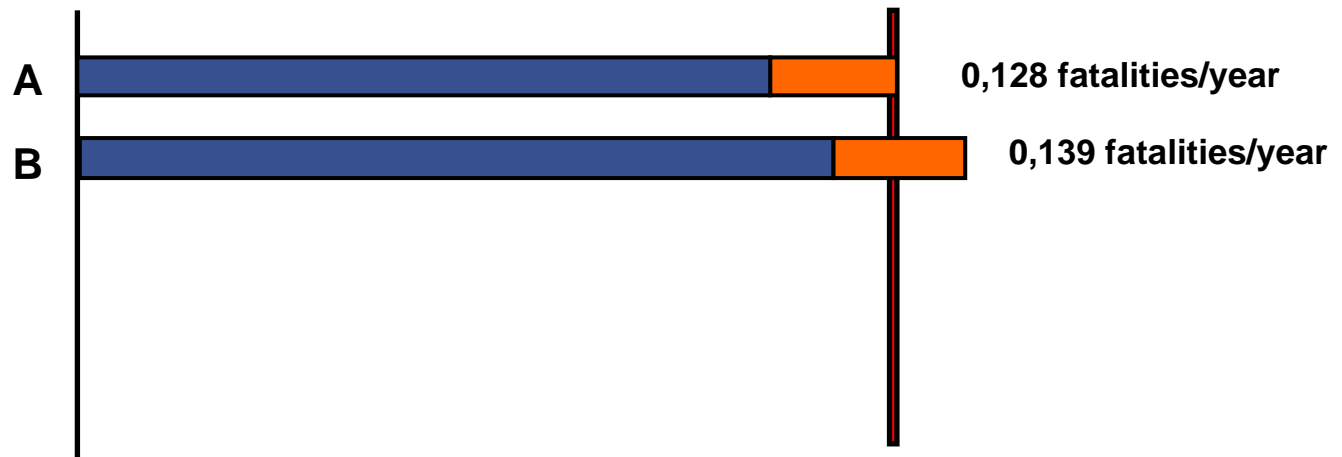


Case Study – TuRisMo

Application of TuRisMo – Results

The following cases are investigated

- A – risk of reference tunnel (definition of risk criteria)
- B – risk of existing tunnel

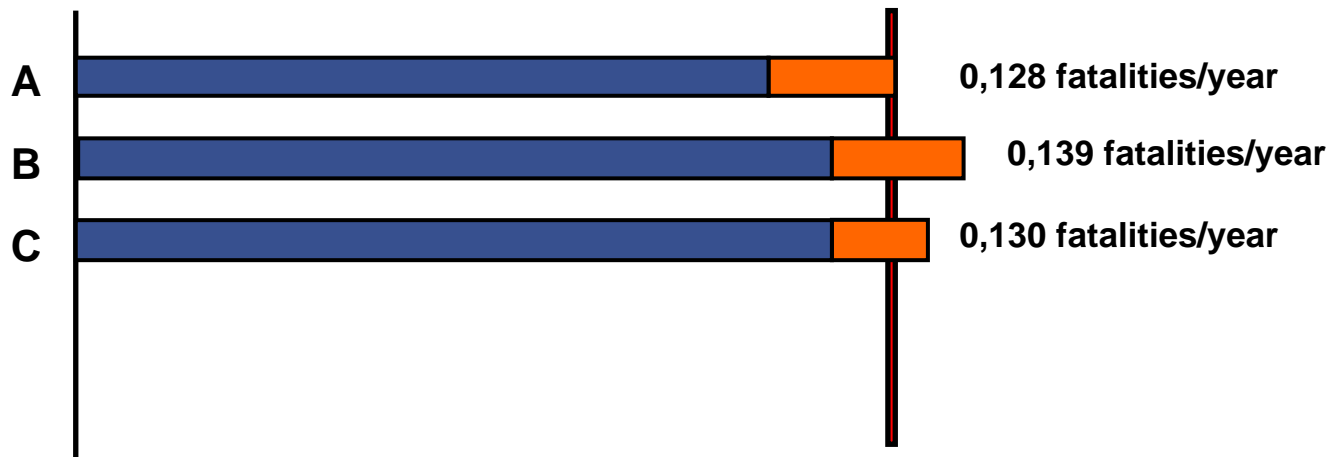


Case Study – TuRisMo

Application of TuRisMo – Results

The following cases are investigated

- A – risk of reference tunnel (definition of risk criteria)
- B – risk of existing tunnel
- C – alternative measure: reduction of cross passage distance from 500m to 250m

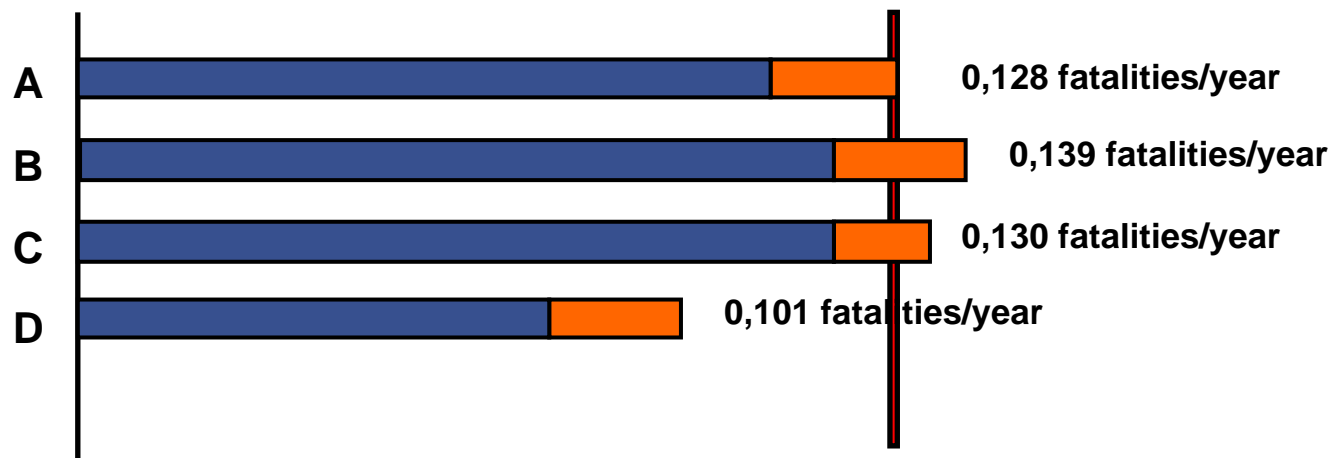


Case Study – TuRisMo

Application of TuRisMo – Results

The following cases are investigated

- A – risk of reference tunnel (definition of risk criteria)
- B – risk of existing tunnel
- C – alternative measure: reduction of cross passage distance from 500m to 250m
- D – alternative measure: speed limit 60km/h instead of 80 km/h for heavy goods vehicles



Results of PIARC's Work

Conclusions

- A risk based approach is a valuable supplement to prescriptive guidelines
- The application of risk analysis allows a structured, harmonised and transparent assessment of the risk of a specific tunnel
- It covers different fields of application such as risk-based decision making or performance-based assessment of safety standards
- All methods exhibit specific advantages and disadvantages – none can claim to be generally the most suitable
- The selection of the most suitable method depends on the specific requirements of the problem to be investigated

Results of PIARC's Work

Recommendations for the Practical Use of Risk Analysis

- Select the best method available for a specific problem
 - Be aware, that you are using a model, which is a (major) simplification of real conditions
 - Use specific data for quantitative methods
 - Risk models inevitably deliver fuzzy results
 - Relative comparison may improve the robustness of conclusions drawn
-
- ↳ Risk analysis should only be performed by experts with sufficient experience and understanding of the methods they use

Results of PIARC's Work

Outlook

- The possibilities for the harmonization of methods of risk assessment for road tunnels are limited – one unique method cannot cover all relevant issues
- However, the standardization of some specific elements of risk analysis seems to be achievable – without limiting the flexibility of the methods
- Hence, in the future it seems to be possible to develop universally applicable guidelines for risk analysis
- The methods of risk analysis and risk evaluation are strongly dependant; in the future the problems, possibilities and restrictions of different strategies of risk evaluation should be addressed in more detail

Risk analysis for road tunnels



Thank you for your attention!