Risk Assessment
1. Introduction

Stein Haugen
stein.haugen@ntnu.no

Marvin Rausand
marvin.rausand@ntnu.no

RAMS Group
Department of Production and Quality Engineering
NTNU

(Version 0.1)

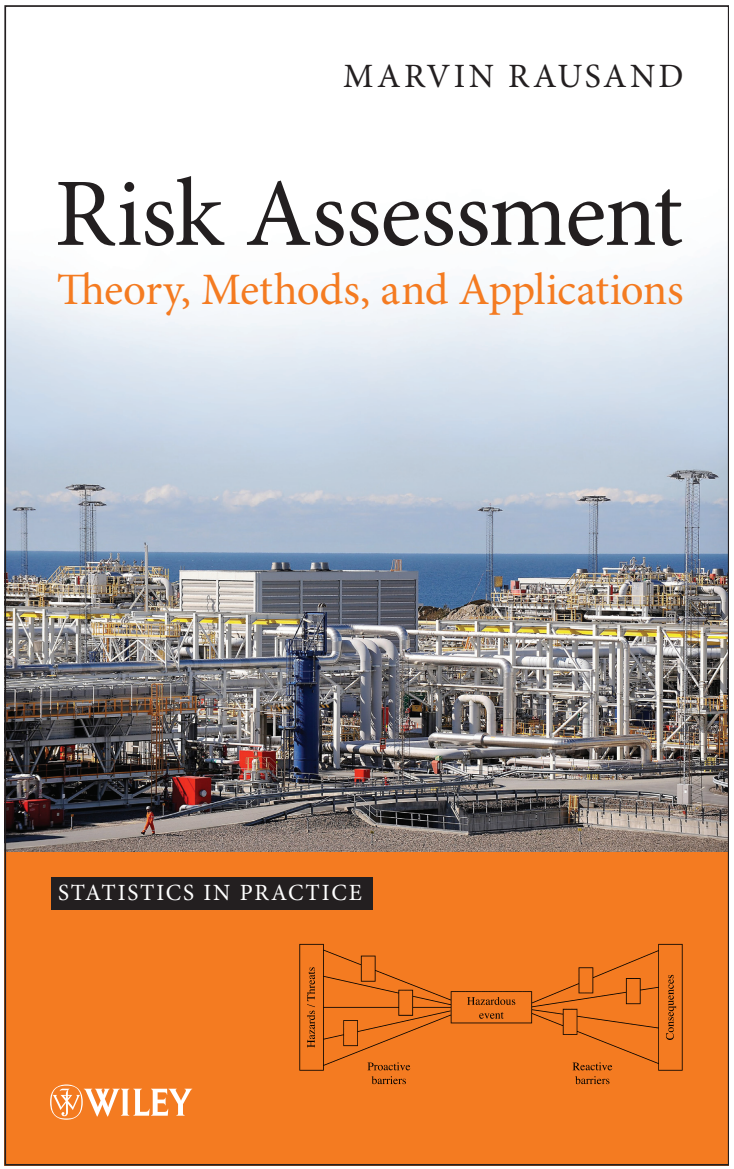
NTNU – Trondheim
Norwegian University of
Science and Technology

Slides related to the book

Risk Assessment
Theory, Methods, and Applications

Wiley, 2011

Homepage of the book:
http://www.ntnu.edu/ross/books/risk



What is risk?

To define risk is not an easy task

"The words of risk analysis have been and continue to be a problem .... When our Society for Risk Analysis was brand new, one of the first things it did was to establish a committee to define the word 'risk.' This committee labored for 4 years and then gave up, saying in it's final report that maybe it's better not to define risk"

Stan Kaplan: The words of risk analysis. *Risk Analysis*, 17(4):407-417

What is risk in this context?

- Risk is related to what can happen in the future.
- At present, let us define risk as the answer to these three questions:

  1. What can go wrong?
  2. What is the likelihood of that happening?
  3. What are the consequences (if it goes wrong)?

- Risk analysis is our tool to answer these questions.
- In our context, risk is associated with accidents—and mainly accidents that have severe consequences and happen not very often (often called "major accidents").

Risk analysis

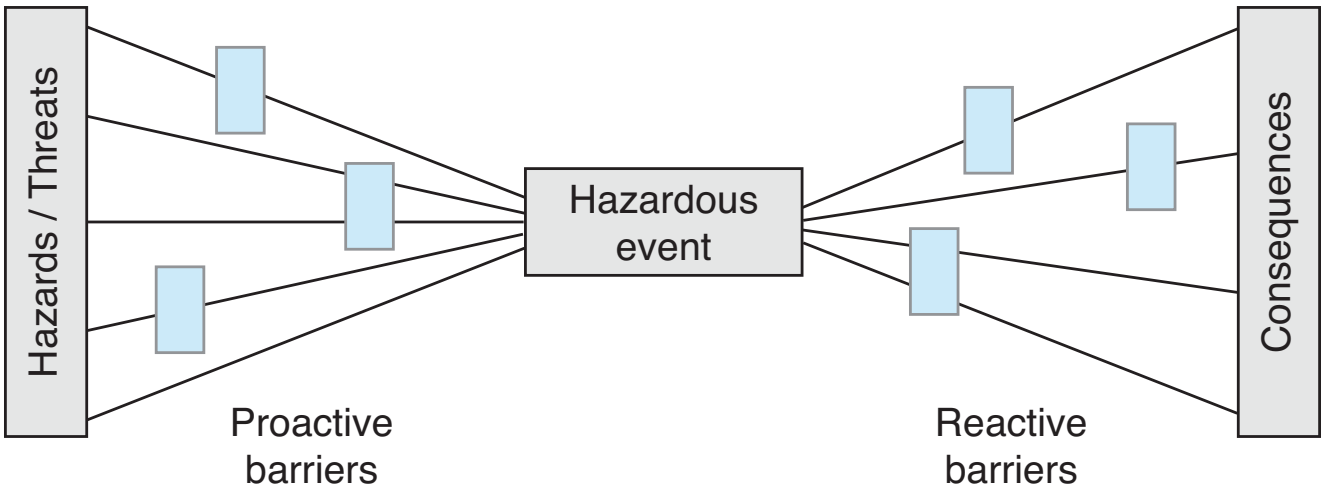
- Risk analysis involves understanding how accidents can happen and what the consequences might be.
- Risk analysis was “born” within military and space applications.
- Risk analysis can be used within almost all types of business, and especially where the consequences of accidents can be large, such as nuclear power plants, chemical and process industry, oil and gas industry, transport industry, and so on.
- There is a rapidly growing need for risk analysis (new applications, new requirements)

San Juan, Puerto Rico accident, 2009

Deepwater Horizon accident, 2010

Conceptual model

The bow-tie model



Objectives
– of this course

1. Present and discuss terminology
2. Define how risk can be quantified and how these metrics may be used to evaluate tolerability of risk
3. Present methods for risk assessment and discuss applicability, pros and cons for each method.
4. Present and discuss some problem areas related to risk assessment (e.g., human errors, dependent failures).
5. Describe how risk assessment may be carried out in practice and illustrate some application areas.

Focus

- Technical and/or sociotechnical systems
- Future events
- Unwanted (negative) consequences
- Assets or values that we want to protect
- Accidents (sudden and unexpected negative consequences)
- Mostly on severe accidents (but not limited to this)
- Providing information for decision-making, not decision-making in itself

Risk analysis

☞ Risk analysis: Systematic use of available information to identify hazards and to estimate the risk to individuals, property, and the environment.

Three main steps:

1. Hazard identification
2. Frequency analysis
3. Consequence analysis

The risk analysis may be qualitative, quantitative, or semi-quantitative.

Types of risk analysis

Assets	Hazard source		
	Humans	The environment	Technology / materials
Humans	1	2	3
The environment	4	5	6
Material / financial	7	8	9

Focus in this course

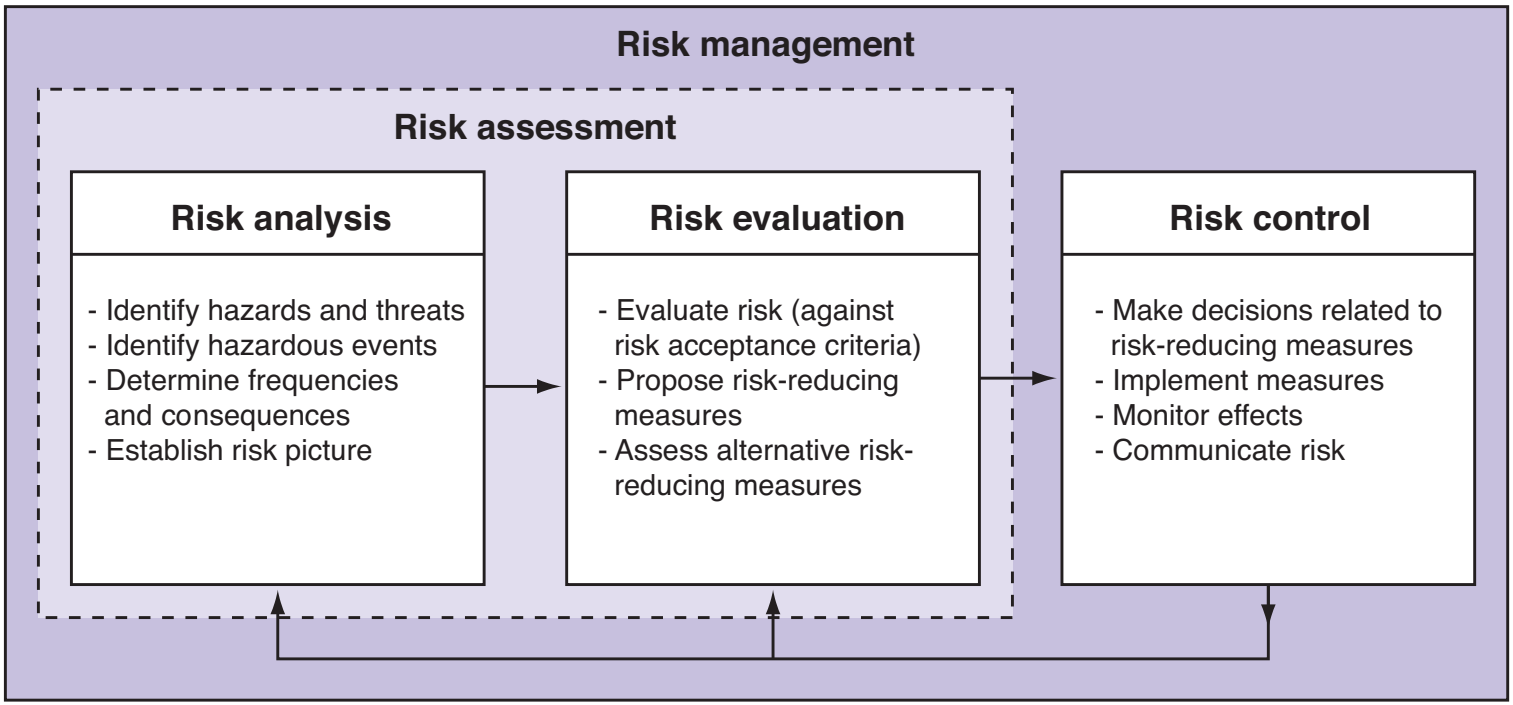
Risk evaluation

☞ Risk evaluation: Process in which judgments are made on the tolerability of the risk on the basis of a risk analysis and taking into account factors such as socioeconomic and environmental aspects.

- Sometimes: Comparing results from risk analysis with *risk acceptance criteria*.

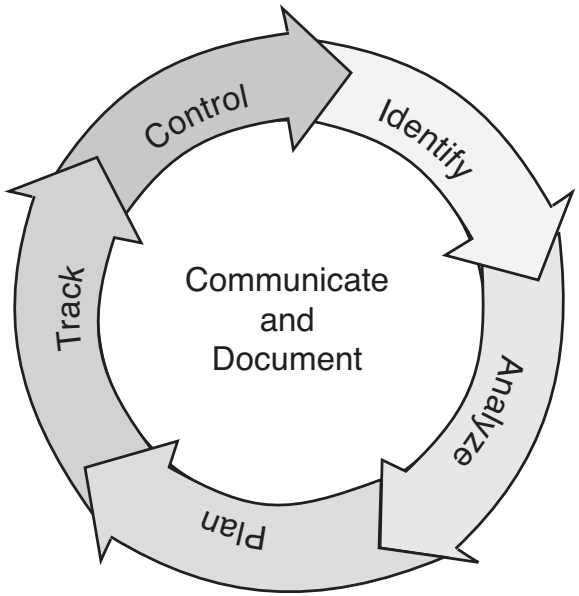
Risk assessment

☞ Risk assessment: Overall process of risk analysis and risk evaluation.

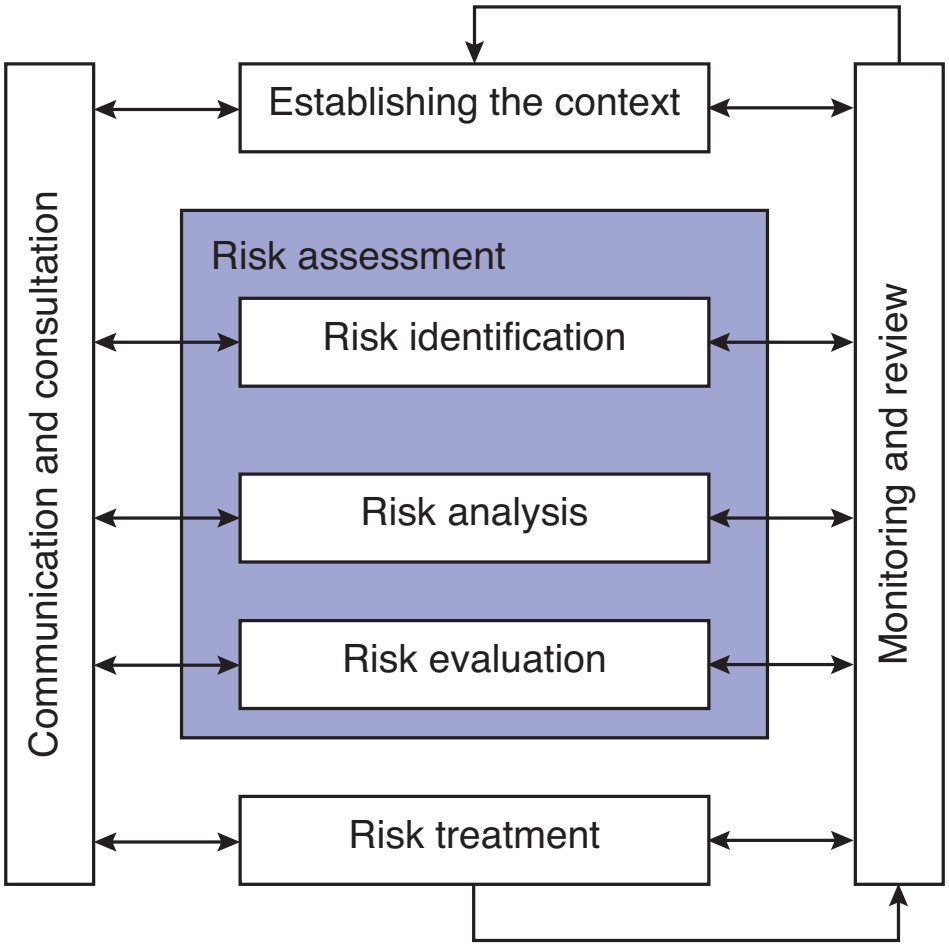


Risk management

☞ Risk management: A continuous management process with the objective to identify, analyze, and assess potential hazards in a system or related to an activity, and to identify and introduce risk control measures to eliminate or reduce potential harms to people, the environment, or other assets.



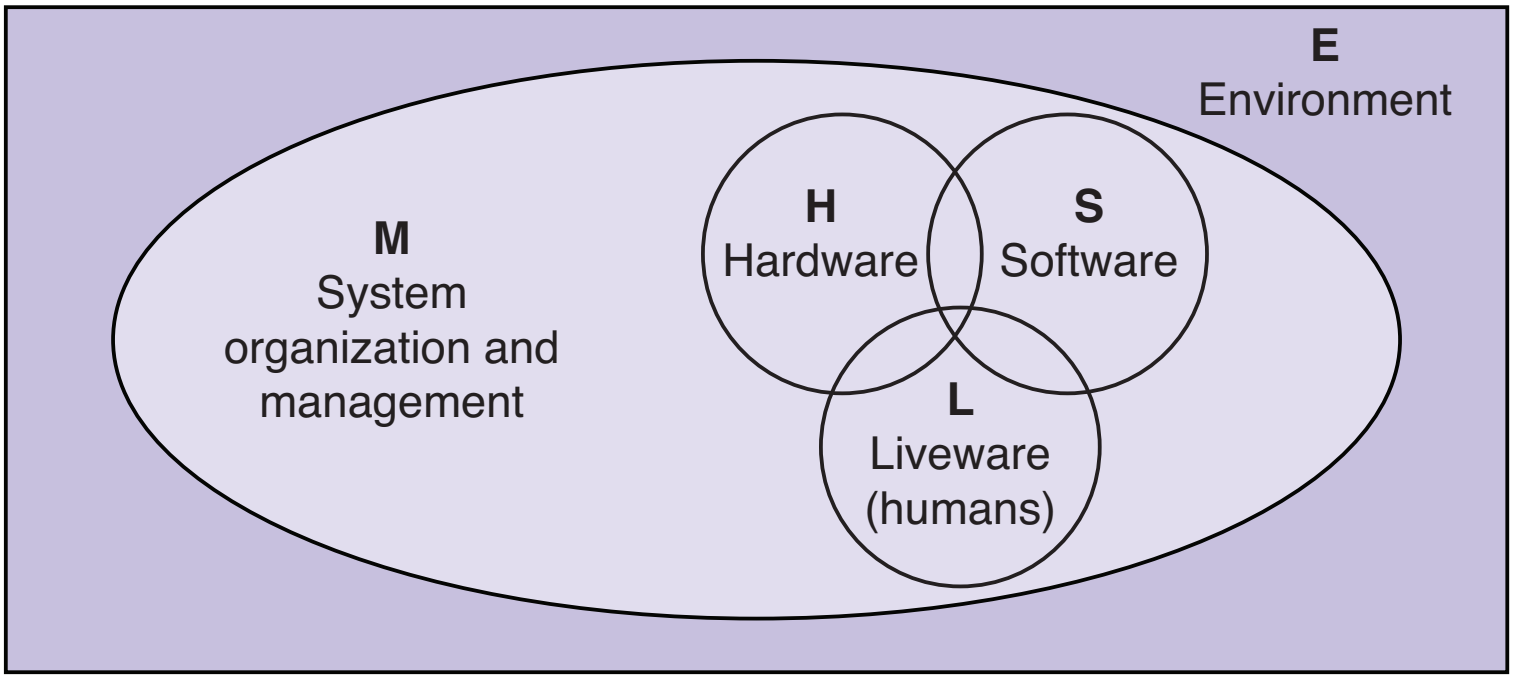
Risk management in ISO 31000



Study object

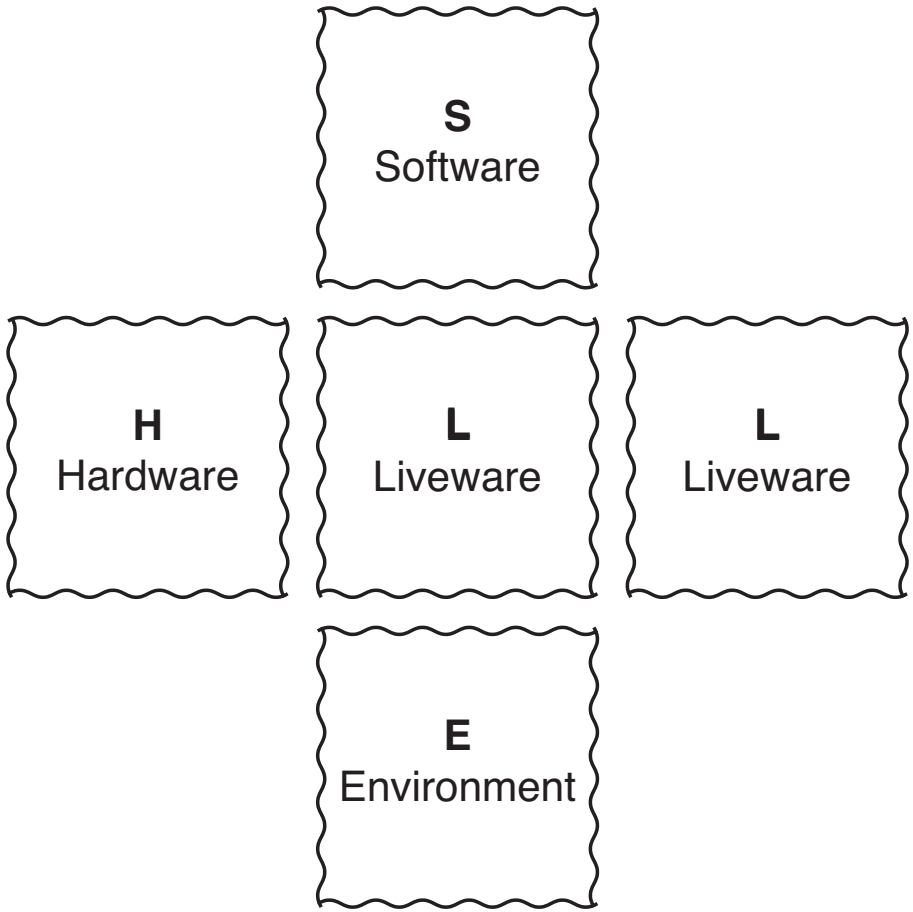
☞ Study object: Composite entity, at any level of complexity, of personnel, procedures, materials, tools, equipment, facilities, and software. The elements of this composite entity are used together in the intended operational or support environment to perform a given task to achieve a specific objective.

Sociotechnical system



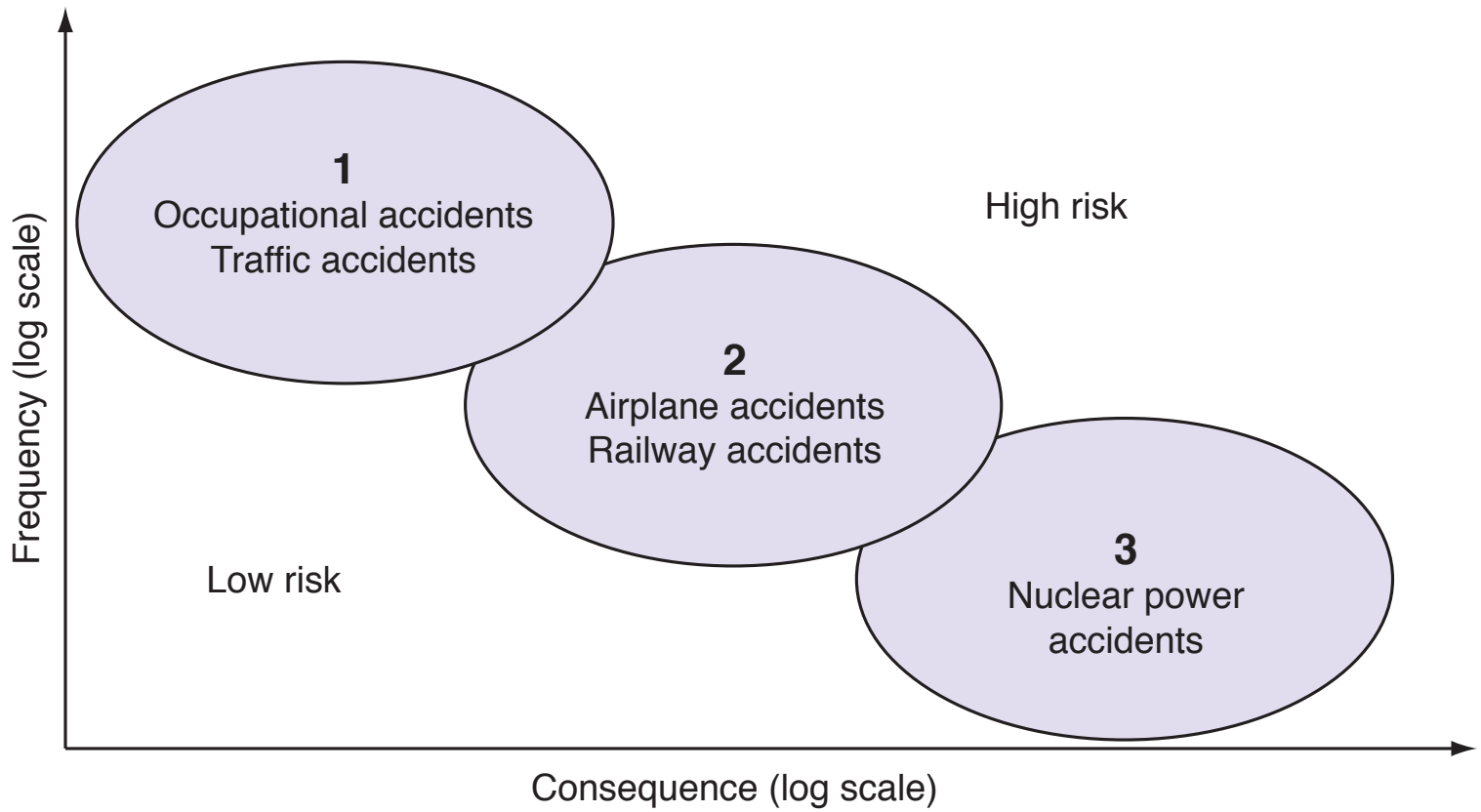
MTO = man, technology, and organization

SHEL model



Accident categories

Adapted from Rasmussen (1997)



Accident categories

- James Reason:
  - Organizational accidents vs. individual accidents
- Process industry:
  - Process safety accidents vs. individual accidents
- Offshore industry in Norway:
  - Major accidents vs. occupational accidents

Increasing risk

- Technological change, complex relationships between humans and automation
- Increasing scale of industrial installations
- Rapid development of ICT
- Aggressive and competitive marketplace
- Demand for speed (faster cars, trains, ships, ...)
- The increased likelihood of sabotage and terrorism
- The increasing use of multicultural workforces
- The emerging climate changes

Legislation

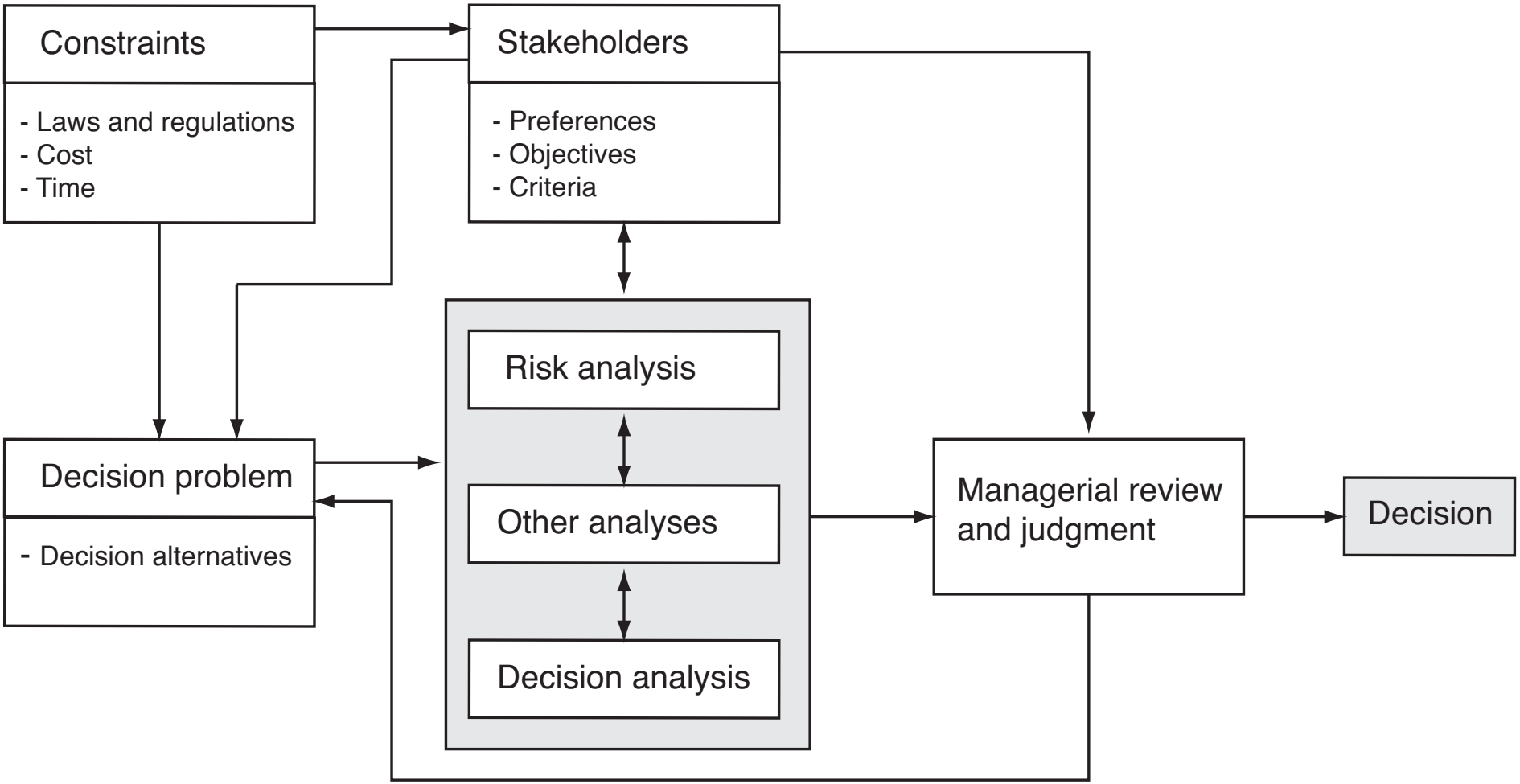
- EU Seveso II directive
  - Control of major accident hazards
- EU Machinery directive
  - Safety aspects of a wide range of machinery
- Health and safety at work act, UK
- Offshore installations (safety case) regulations, UK
- US Maritime transportation security act
- Offshore safety regulations, Noeway

Risk and decision-making

- Decisions may related to:
  - Should the activity be permitted?
  - Are additional safety barriers or improvements necessary?
  - Which options should be preferred?
  - How much should be invested to reduce risk?
- Requires an answer to the question “what is safe enough?”

Model for decision-making

Adapted from Aven (2003)



Decision-making

- Deterministic: Decisions without consideration of the likelihood of possible outcome.
- Risk-based decision-making (RBDM): A process that uses quantification of risks, costs, and benefits to evaluate and compare decision options competing for limited resources.
- Risk-informed decision-making (RIDM): An approach to decision-making representing a philosophy whereby risk insights are considered together with other factors to establish requirements that better focus the attention on design and operational issues commensurate with their importance to health and safety.

Stakeholders

☞ Stakeholder: Person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity.

- Stakeholders may be classified in different ways:
  - People who are affected directly.
  - People who are interested, want to become involved in the process, and seek an opportunity to provide input.
  - People who are generally interested and seek information.
  - People who are affected but are unaware of it or do not participate in the stakeholder process.