



Erasmus+

RISKNET

COURSE BOOK 2

Researching and assessing risk



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Course description

This is a master's level, a 10 ECTS course which comprises three sub-courses. In this document you will find information regarding the aim of and learning outcomes for each sub-course, along with lecture descriptions, the main point for each topic, and a list of reading materials.

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2.1. Risk research methodologies and methods (5 ECTS)

Aim

The aim of this course is to develop analytical competence in risk research and also in assessment methodologies and methods.

Learning outcomes

After the successful completion of this course, the student should be able to:

- Distinguish between different risk research and assessment methodologies and methods;
- Propose the appropriate social research design when exploring risk and uncertainty;
- Choose and apply the proper methods for risk assessment.

Content

This sub-course consists of twelve lectures, each of two academic hours in length (45 mins).

2.1.1. Introduction of methods in natural risk research

Developed by Karin Reinhold

Lecture description

This topic provides an overview of risk management where it relates to natural hazards. Risk management has developed in conjunction with broader risk management theory and practice. Effective implementation of risk management strategies in terms of natural hazards requires an understanding of underlying assumptions which are inherent to specific methodologies, as well as an explanation of the process and the challenges embodied in specific approaches to risk mitigation.

Main themes

- Definitions and key terms
- Components of risks (probability and uncertainty) and risk understanding
- Concept of risk assessment and risk management
- Risk criteria and evaluation

Planned learning method

Lecture + Text material + Discussion exercise

Self-evaluation questions for students

- How do risk analysis methods differ in natural and social sciences?
- What are the effects of risk matrices on risk management decisions?
- Analyse the biases that are present in risk assessment.

Mandatory reading

Taouk, M., Lasswell, P. (2001). Workplace risk assessment: A practical approach to safety management. *Journal of Occupational Health and Safety*, 17, 477-485.

Taylor-Gooby, P., Zinn, J.O. (2006). Current directions in risk research. New developments in psychology and sociology. *Risk Analysis*, 26, 397-411.

Winder, C. & Makin, A.-M. (2006). Going beyond risk assessments using matrices. In: Guedes Soares & Zio (eds), *Safety and Reliability for Managing Risk: 787-794*. London: Taylor & Francis Group.

Optional reading

Reason, J., Hollnagel, E., Paries J. (2006) Revisiting the "Swiss Cheese". Model of accidents. *European Organization For the Safety of Air Navigation. Eurocontrol*. http://publish.eurocontrol.int/eec/gallery/content/public/document/eec/report/2006/017_Swiss_Cheese_Model.pdf.

Harms-Ringdahl, L. (2001). *Safety Analysis*. London: Taylor & Francis.

Hill, L., Sparks, R.S.J., Rougier, J. (2012). Risk assessment and uncertainty in natural hazards. In: Risk and Uncertainty for Natural hazards, *Published Cambridge University Press*.

Mamula-Seadon, L. (2016). Natural Hazards and Risk management. *Oxford Research Encyclopaedia of natural Hazards Science*. Oxford University Press USA.

Mamula-Seadon, L. (2016). Natural Hazards and Risk Management. *Oxford Research Encyclopedia of Natural Hazard Science*. Oxford University Press, USA.

Reason, J. (1990). The contribution of latent human failures to the breakdown of complex systems. *Philosophical Transactions of the Royal Society (London). Series B.327*, 475-484.

2.1.2. Introduction to risk research in social science

Developed by Evangelia Petridou

Lecture description

This lecture is designed to provide a brief introduction of the broad and multifaceted topic of methods in social sciences, especially as it pertains to risk research. Anchoring the lecture on the concepts of ontology (what is the nature of things?) and epistemology (how can we know the nature of things?) we discuss quantitative and qualitative traditions and ways to bridge the divide in the form of mixed methods.

All research is framed within certain assumptions that is, philosophical views which inform the ways knowledge is produced (Mir and Watson, 2000). Although often the researchers' philosophical viewpoints are hidden in the research, Creswell (2009) argues for the explicit articulation of philosophical worldviews in the text, as such an articulation will elucidate the researcher's choice of qualitative, quantitative or mixed methods. Worldviews are also called paradigms or "basic set[s] of beliefs that guide action" (Guba quoted in Creswell, p. 6). Creswell goes on to say that the choice of worldview depends on the discipline area of the researcher, their past experiences, the philosophical positions of their advisors, their academic interests, and the way they write. The adherence to a philosophical worldview will shape the subsequent choice of research method, as well as the structure of the text.

Students are encouraged to reflect upon the philosophical underpinnings guiding their disciplinary trajectories and research performed so far.

Main themes

- Ontology and epistemology
- Positivism
- Constructivism
- Mixed methods

Planned learning method

Lecture

Self-evaluation questions for students

- What are the main tenets of positivism?
- What are the main tenets of constructivism?
- What does "mixed methods" mean and what are some ways a researcher can conduct mixed methods research?

Mandatory reading

Morgan, D. L. (2007). Paradigms Lost and Pragmatism Regained: Methodological Implications of Combining Qualitative and Quantitative Methods. *Journal of Mixed Methods Research*, 1(1), 48-76. doi:10.1177/2345678906292462

Tashakkori, A., & Teddlie, C. (2008). Introduction to mixed method and mixed model studies in social and behavioral sciences. In V.L. Plano Clark and J.W. Creswell (Eds.,) *The mixed methods reader* (pp. 7-26). Thousand Oaks, CA: Sage.

Optional reading

Creswell, J. (2009). *Research Design*. Thousand Oaks: Sage.

Goertz, G., & Mahoney, J. (2014). *A Tale of Two Cultures: Qualitative and Quantitative Research in the Social Sciences*. Princeton: Princeton University Press.

Mir, R., & Watson, A. (2000). Strategic management and the philosophy of science: the case for a constructivist methodology. *Strategic Management Journal*, 21, 941-953

Munck, G. L. (2004). Tools for qualitative research. In H. E. Brady & D. Collier (Eds.), *Rethinking Social Inquiry: Diverse Tools, Shared Standards* (pp. 105-121). Lanham, MD: Rowman and Littlefield.

2.1.3. The psychometric paradigm of risk research: methods, results, and critique

Developed by Aistė Balžekienė

Lecture description

This lecture presents the study of risk perception using the psychometric paradigm, introduced by Fischhoff, as well as Slovic works, which have been further developed by many researchers in the field when it comes to quantitative studies on risk perception.

The main dimensions of risk perception and how they are measured in questionnaires are discussed in the lecture. Examples of visualisations are explored using the results from the psychometric paradigm; a main critique and further extensions of the paradigm are presented.

Main themes

- The concept of the risk perception psychometric paradigm.
- The dimensions of risk as defined by the psychometric paradigm and their influence on risk perception.
- The research instruments, process, and visualisation of research results in psychometric research.
- A critique on the psychometric risk research paradigm and its further development.

Planned learning method

Lecture (ppt slides)

Self-evaluation questions for students

- Please explain what is measured by psychometric research in risk studies.
- Explain how these risk characteristics influence risk perceptions: how voluntary is exposure, what is the knowledge about the risk, or the control over the risk, or the severity of the consequences?
- Provide the main arguments of a critique which covers the psychometric paradigm.

Mandatory reading

Sjöberg, L., Moen, B. E., & Rundmo, T. (2004). Explaining risk perception. An evaluation of the psychometric paradigm in risk perception research, 33.

Available from:

http://paul-hadrien.info/backup/LSE/IS%20490/utile/Sjoberg%20Psychometric_paradigm.pdf

Siegrist, M., Keller, C., & Kiers, H. A. (2005). A new look at the psychometric paradigm of perception of hazards. *Risk Analysis*, 25(1), 211-222.

2.1.4. Researching risk as a social construct. Survey research methodologies in risk perception studies

Developed by Aistė Balžekienė

Lecture description

This lecture covers risk perception and how it can be researched using surveys. The principles of scale construction are provided, along with examples of questions covering risk in survey research. The main factors which influence public risk perception are defined, the various questionnaires for risk perception research are reviewed. The lecture also provides the resources for a secondary survey analysis of risk perceptions and attitudes, while also introducing some online tools for cross-country risk perception analysis.

Main themes

- A secondary survey analysis of risk perception and attitudes.
- The construction of scales of risk perception. Sources and archives covering social survey data regarding risk perceptions and attitudes.
- An introduction to online tools for cross-country risk perception analysis.

Planned learning method

Lecture (ppt slides)

Self-evaluation questions for students

- What are the main groups of factors that shape and influence risk perceptions?
- Explain which contextual factors influence risk perceptions. Illustrate with examples.
- What is the basis for both lay and expert risk perception.

Mandatory reading

Sjöberg, L. (2000). The Methodology of Risk Perception Research. *Quality and Quantity*, 34(34), 407–418.

Micic, T. (2016). Risk reality vs risk perception. *Journal of Risk Research*, 9877(October), 1–14.

Optional reading

Sjöberg, L. (2000). Factors in risk perception. *Risk analysis*, 20(1), 1-12.

Reuben Ng & Steve Rayner (2010) Integrating psychometric and cultural theory approaches to formulate an alternative measure of risk perception, *Innovation: The European Journal of Social Science Research*, 23:2, 85

2.1.5. Imperative approaches to risk research: interviews and methods

Developed by Susanna Öhman

Lecture description

In this lecture, the qualitative research principles are defined using interviews as an example. The key philosophical and methodological issues are defined in terms of qualitative research. The lecture will then concentrate on interviewing as an important tool in qualitative research and after that it will introduce the outlines both for the theoretical and practical aspects of the interview process.

The qualitative research interview seeks to describe the meanings of central themes in the life of the respondents and to understand the meaning of what the interviewees say. It also tries to cover both a factual and a meaning level, trying to describe and interpret the meaning as well as the facts. After looking at the role of the interview in the research process, the actual stages of the interview process are examined, from designing a study to writing the report. All of the steps involved in the interview process are examined and practical examples of risk research are used to demonstrate the usability of qualitative research. The participants are supposed to conduct at least two interviews and analyse them using some form of quantitative method as an examination.

Main themes

- Qualitative research, definitions, characteristics and criticisms
- The functions of different qualitative methods
- The interview method in the research process
- The stages of the interview process
- Reliability and credibility
- Ethics
- Generalization and quality criteria

Planned learning method

Lecture (video) + Text material + A forum discussion exercise on deliberation

Self-evaluation questions for students

- What is the difference between qualitative and quantitative research in the use of interviews?
- What characterises a qualitative interview?
- What different types of interview methods are used?
- What are the stages in the interview process?
- How can an interview study of risk awareness amongst teenagers be designed and analysed? Describe the design with an example.
- How can the qualitative and quantitative research methods be combined?

Mandatory reading

Kvale, S. (1996) Interviews - An Introduction to Qualitative Research Interviewing. Thousand Oaks, CA: Sage Publications (pp. 15-36 and 113-174).

Optional reading

Kvale, S. (1996) Interviews - An Introduction to Qualitative Research Interviewing. Thousand Oaks, CA: Sage Publications (remaining pp).

2.1.6. Ethnographic methods in risk research

Developed by Anna Olofsson

Lecture description

Ethnographic research is becoming more often used in risk and security studies. This is especially true of particularly critical studies which do not take risk *per se* at face value but which seek to understand the normative underpinnings that surround risk policy as well as risk analysis and risk communication. This is because ethnographic research aims to understand the phenomenon and behaviour which is context-dependant upon a particular time and place, with such specific times and places often being described as cultures. Ethnographic research usually involves participatory observation, but such observation is often combined with interviews, group interviews, surveys, audio-visual records, etc. The participatory observations can either be open and known to the subjects who are the subject of the investigation, or a process known as complete participation can be used in which the subjects of a study are not aware of the researcher's objective in terms of their participation (or even that the researcher is actually a researcher). This can be sensitive work, and is related to severe challenges in terms of ethics. Therefore it is not used frequently. Fieldwork involving open or complete participation is carried out when the subjects are in their own environment and, usually, but not always, for long periods of time.

Main themes

- The main characteristics of ethnographic research
- Different methods used in ethnographic research
- Ethnographic study

Planned learning method

Classroom lecture with power point slides + Group discussions + Short student assignments

Self-evaluation questions for students

- What characterises ethnographic research?
- Which methods are common and how are they applied to ethnographic research?
- What epistemological assumptions are most ethnographic research based upon?
- How can an ethnographic study of children's risk-taking in everyday life be designed and analysed? Describe the design with an example.

Mandatory reading

Fetterman, D. M. (1998). *Ethnography step by step*. Sage. pp. 15-65

Optional reading

O'Reilly, K. (2012). *Ethnographic methods*. Routledge.

Douglas, M. (2002). *Risk and Blame*. Routledge.

Salter, M. and Mutlu, C. (2013) *Research methods in critical security studies*. An introduction. Routledge.

Phillips, B (2002) *Qualitative Methods and Disaster Research* In R, Stallings. (Ed). *Methods of Disaster Research*. California: Xlibris Corporation.

Van Voorst, R. (2016). Natural Hazards, Risk and Vulnerability: Floods and slum life in Indonesia. *Routledge*.

2.1.7. Risk discourse research and content analysis

Developed by Anna Olofsson

Lecture description

This topic deals with discourse analysis, and particularly with critical discourse analysis (CDA) and how it is applied in risk research as a way of uncovering underlying structures of power and how they are related to the understanding of risk in different societies. The topic draws on the work of Ruth Wodak, Teun van Dijk and, most of all, Norman Fairclough. CDA sees discourse that is language use in speech and writing as a form of 'social practice' (Fairclough and Wodak, 1997: 258). This means that there is a dialectical relationship between discursive events and the situations, institutions, and social structures which frame them. This means that discourse constitutes situations, objects of knowledge, and the social identities of and relationships between people and groups of people at the same time as it is shaped by them. Discursive practices often produce and reproduce unequal power relations between (for instance) social classes, men and women, and ethnic/cultural majorities and minorities through the ways in which they represent things and in which they position people (Fairclough and Wodak, 1997: 258). For example, by analysing risk discourses in risk communication, the mutual constitution of risk and inequality can be revealed.

Main themes

- The main characteristics of critical discourse analysis.
- Discourse analysis on a risk related problem.

Planned learning method

Classroom lecture with power point slides + Group discussions + Short student assignments

Self-evaluation questions for students

- What characterises critical discourse analysis?
- What forms of data are used and how is it analysed?
- Give an example that describes how a critical discourse analysis can be carried out.

Mandatory reading

Paltridge, B. (2006) *Discourse Analysis, An Introduction*. London: Bloomsbury Publishing, (Chapters 1 and 9).

Optional reading

Fairclough, N. (2012). Critical discourse analysis. In J. P, Gee & M, Handford (Eds.). *The Routledge Handbook of Discourse Analysis*, Routledge.

Lupton, D. (1992) Discourse analysis: A new methodology for understanding the ideologies of health and illness, *Australian journal of public health*, 16(2):145-50.

Öhman, S, Giritli Nygren, K & Olofsson, A. (2016). The (un)intended consequences of crisis communication in news media: a critical analysis, *Critical Discourse Studies*, 13(5): 515-530

Wodak, R & Meyer, M. (Eds.) (2009) *Methods of Critical Discourse Analysis*. Sage.

2.1.8. Risk, surprises, and black swans

Developed by Torbjoern Bjerga

Lecture description

In 2007 Nassim Taleb popularised the 'black swan' metaphor and associated this idea with major surprising events such as '9/11', the dissolution of the Soviet Union, and the discovery of penicillin. The metaphor has gained much attention in recent years, and not only in the world of risk research.

Main themes

- What is a surprise?
- How can knowledge be defined in risk contexts?
- Black swans, and different types of black swans in risk contexts.
- Assessments of knowledge, including assumption-deviation-risk-assessments.
- Ways of confronting black swans, including red teaming.
- The need for managerial review and judgment in risk decision-making.

Planned learning method

Lecture with power point slides + Group discussions + Short student assignments

Self-evaluation questions for students

- What is a black swan?
- What are the three types of black swan?
- How is knowledge defined in a risk context?
- What are the main steps in an assumption-deviation-risk-assessment?
- How can one confront black swans in risk contexts?

Mandatory reading

Aven, T. (2014). Risk, surprises and black swans. *Routledge*. Especially chapters: 1, 3.2, 3.4 and 5.4.

Optional reading

Society for Risk Analysis (SRA) Glossary: <http://www.sra.org/sites/default/files/pdf/SRA-glossary-approved22june2015-x.pdf>

Risk analysis foundations (SRA): <http://www.sra.org/sites/default/files/pdf/FoundationsMay7-2015-sent-x.pdf>

'What is risk?' by Professor Terje Aven:

https://www.youtube.com/watch?v=CbnllXeHw0&list=PLNFAW9iarHu_kP9n34CSPRoUM8h1hBojp&index=1

2.1.9. Risk assessment principles

Developed by Karin Reinhold

Lecture description

This topic will give you an overview of the principles of risk assessment. Risk assessment can be qualitative or quantitative or a mixture of both. Risk assessment that is carried out well has several benefits - a lower probability of accidents, environmental risks identified, improved work procedures, etc. In risk assessment, five hazard groups are processed in order to assess the risks.

Main themes

- Quantitative and qualitative assessment
- Risk assessment method
- Job safety analysis and energy analysis as examples of methods

Planned learning method

Lecture + Text material + A forum discussion exercise on deliberation

Self-evaluation questions for students

- Analyse the pros and cons of qualitative and quantitative risk assessment methods.
- What kind of risk assessment method would you use if you had a company with 45 workers and the field of work is a) administration work, b) water transportation.
- Analyse what kind of risk assessment method is best in the risk management perspective.
- Analyse the effects of assumptions in risk assessment.

Mandatory reading

Harms-Ringdahl, L. (2001). *Safety Analysis*. London: Taylor & Francis. Chapter 4.

Marhavilas, P. K., Koulouriotis, D., Germenis, V. (2011). Risk analysis and assessment methodologies in the work sites: On a review, classification and comparative study of the scientific literature of the period 2000-2009. *Journal of Loss Prevention in the Process Industries*, 24(5), 477-523.

Aven, T. (2016). Risk assessment and risk management: Review of recent advances on their foundation. *European Journal of Operational Research*, 253(1), 1-13.

Aven, T., Krohn, B.S. (2013). A new perspective on how to understand, assess and manage risk and the unforeseen. *Reliability Engineering & System Safety*, 121, 1-10.

Optional reading

Rausand, M. (2011). *Risk Assessment: Theory, Methods, and Applications*. John Wiley and sons.

Gould, J. (2000). *Review of Hazard Identification Techniques*, HSE.

Golbalaeei, F., Shahtaheri, S.J., Nasiri Parvin, A.S. (2007). Hazards identification and assessment in a production factory using job analysis (JSA). <https://www.researchgate.net/publication/232321911>

2.1.10. Standards and guidelines in risk management

Developed by Piia Tint and Ants Tammepuu

Lecture description

This topic forms an overview of the standards in the area of risk assessment (RA) and risk management (RM). Standards draw together best practice and expert knowledge in the industry, from government representatives, and from testing and certification organisations, academics, consumer groups, trade unions and, most importantly, businesses. The result is a document which shows this agreed best practice. Standards can be used by small low-risk operations equally as well as by high-risk and large, complex organisations.

Main themes

- Differences in standards
- OSH management system elements
- Risk management process
- Environmental management standard

Planned learning method

Lecture + Text material + A forum discussion exercise on deliberation

Self-evaluation questions for students

- Analyse the differences between OHSAS 18001 and 45001;
- If a company works in the field of IT, which guidelines and standards should the company follow, and why and when?
- Which companies should follow the ISO14000 standard and why?
- What are the pros and cons of ISO 31000? Could it be used for certification, and why?

Mandatory reading

Poksinska, B., Dahlgaard, J. J., Eklund, J. A. E. (2003). Implementing ISO 14000 in Sweden: motives, benefits and comparisons with ISO 9000. *International Journal of Quality & Reliability Management*, 20(5), 585-606.

Bhatia, M.S., Awasthi, A. (2017). Investigating the impact of quality management systems on business performance, *International Journal of Productivity and Quality Management*, 21(2), 143-173.

BS 8800:2010. Occupational health and safety management systems. Guide.

OHSAS 18001. Occupational health and safety systems. ISO/TC 262: Risk management. EN 62198. Managing risk in projects- Application guidelines.

Optional reading

Risk Management Standard, Institute of Risk Management, England and Wales. https://www.theirm.org/media/886059/ARMS_2002_IRM.pdf

ISO Guide 73:2009, Risk management - Vocabulary complements ISO 31000 by providing a collection of terms and definitions relating to the management of risk.

ISO/IEC 31010:2009, Risk management – Risk assessment techniques; ISO/TC 262 Risk management; SEVESO directive I, SEVESO directive II

2.1.11. The principles of risk and uncertainty management

Developed by Eivind Rake

Lecture description

How should we cope with the inherent uncertainty when coping with risk and in risk management? The lecture will discuss challenges in risk management approaches and risk management systems. It's necessary to explain and discuss types of uncertainty to be able to identify the different sources of uncertainty and strategies to handle the uncertainties, for example, Lipchitz's RAWFS strategies. During the lecture we will use practical examples, and discuss and work with practical challenges during the risk management process.

Main themes

- Methodologies of risk and uncertainty management.
- The principles of risk and uncertainty management.
- Sources of uncertainty and the methods used for coping with uncertainty during risk management.

Planned learning method

Lecture + Text material + Discussions

Self-evaluation questions for students

- What is risk management?
- Explain why risk management is essential for a sustainable company or organisation.
- Describe risk management principles.
- What is uncertainty?
- Describe different types of uncertainty and explain the RAWFS acronym.
- How can principles of uncertainty management be used in a project or when coping with a risk?
- What are the core challenges present in risk and uncertainty management?

Mandatory reading

Rasmussen, J. (1997). Risk management in a dynamic society: a modelling problem. *Safety Science*, 23(2-3), 182-197.

Lipshitz, R., & Strauss, O. (1997). Coping with uncertainty: A naturalistic decision-making analysis. *Organizational Behaviour and Human Decision Processes*, 69(2), 149-163.

Klein, G. (2011). Streetlight and shadows. *The MIT Press, Cambridge, USA*. 229 -249.

Optional reading

Lipshitz R, Omodei M, McLennan J, Wearing A. (2007). What's burning? The RAWFS heuristic on the fire ground. In: Hoffman R (ed) Expertise out of context. Lawrence Erlbaum, New Jersey

Klein, G. (1998). Source of Power. The MIT Press, Cambridge, USA. Pp 15-30

Renn, O. (2008). Coping with Uncertainty in a complex world. Earthscan. London. Chapter 6 Risk management, pp 173 – 202

Aven, T (2014). Risk, Surprises and Black Swans. Fundamental Ideas and Concepts in Risk assessment and Risk Management, chapter 5.5. (Mandatory reading in lecture 8)

2.1.12. Probabilistic risk, and uncertainty analysis and methodologies

Developed by Robertas Alzbutas

Lecture description

This lecture will provide information which covers probabilistic risk assessment, probabilistic uncertainty analysis, and probabilistic sensitivity analysis, including importance analysis which is used for probabilistic risk assessment.

Main themes

- Probabilistic risk/safety assessment
- Uncertain data and uncertainties propagation
- Sensitivity and importance analysis
- Bayesian methods application

Planned learning method

Lecture + Text material + Discussions

Self-evaluation questions for students

- How would you introduce uncertainty and classify sources of uncertainty?
- What are the differences between uncertainty analysis and sensitivity analysis?
- What are challenges and/or issues involved in uncertainty analysis in terms of probabilistic risk assessment?

Mandatory reading

Presentation material

Bedford, T., and Cooke, R. T. (2007). Probabilistic Risk Analysis: Foundations and Methods, *Cambridge University Press*, 1-38.

Optional reading

Aven, T. (2003). Foundations of Risk Analysis: A Knowledge of Decision-Oriented Perspective. *John Wiley & Sons*.

Zio, E. (2009). Computational methods for reliability and risk analysis, *World Scientific Publishing*.

Rausand, M. (2011). Risk Assessment: Theory, Methods, and Applications. *John Wiley & Sons*.

2.2. Technical risk analysis methods and techniques (2.5 ECTS)

Aim

The aim of this course is to map different risk analysis methods in accident modelling and analysis.

Learning outcomes

After the successful completion of this course, the student should be able to:

- Identify accident initiators and apply techniques for accident sequence modelling and analysis.
- Estimate and analyse the uncertainty involved in the modelling results, and local or global sensitivity measures.
- Choose proper methods for risk and accident analysis.

2.2.1. RA methods 1 (methods for reliability in design, initiating events, and hazard and failure identification, eg. HAZOP, MLD, FMECA)

Developed by Robertas Alzbutas

Lecture description

The objective of the lecture is to provide information regarding reliability for design, and hazard and operability study (HAZOP) as well as failure mode and effects analysis (FMEA). These topics will include the classification of failures, and an overview of reliability concepts and design for reliability, accelerated testing application, and engineering approaches to design verification, screening, and monitoring. The support for PSA and reliability for design will be related to the probabilistic analysis, reliability statistics, and reliability predictive modelling, as well as application of the master logic diagram (MLD) and FMEA. After the presentation of FMEA objectives and types, the general FMEA procedure will be extended with a criticality analysis (FMECA). All of the topics will be presented, describing implementation procedures and showing examples of practical analysis.

Main themes

- HAZOP analysis
- Reliability for Design
- FMEA
- Criticality analysis

Planned learning method

Lecture + Text material + Discussion exercises

Self-evaluation questions for students

- How would you introduce reliability for design?
- What are the differences between HAZOP and FMEA?
- What are the challenges and/or issues involved in initiating events and critical analysis?

Mandatory reading

Presentation material

Rausand, M. (2011). Risk Assessment: Theory, Methods, and Applications. *John Wiley & Sons*, 236-264

Optional reading

Bedford, T., and Cooke, R. T. (2007). Probabilistic Risk Analysis: Foundations and Methods, *Cambridge University Press*.

Zio, E. (2009). Computational methods for reliability and risk analysis, *World Scientific Publishing*.

2.2.2. RA methods 2 (methods for faults and events analysis, eg. PRA, ETA, FTA, the formation of MCS, etc)

Developed by Robertas Alzbutas

Lecture description

PRA begins with initiating events, and ends with the identification of worst damage states and their frequencies. The lecture will provide information regarding the PRA objectives, and the structure and its main elements. The main topics covered will be related to the identification of initial events, accident initiators, the use of event tree analysis (ETA), and fault tree analysis (FTA) techniques for accident sequence modelling and analysis. Quantification and related issues will be addressed, such as:

- A simulation of event sequences from the initiating event to worst damage states.
- The impact of qualitative results, eg. minimal cut sets (MCS), upon quantitative results.
- The formation of MCS, and the interpretation and documentation of the analysis results.

These topics will be enhanced by using practical examples.

Main themes

- PRA
- Fault Tree Analysis
- Event Tree Analysis
- Quantification

Planned learning method

Lecture + Text material + Discussion exercises

Self-evaluation questions for students

- How would you introduce PRA?
- What are the differences between ETA and FTA?
- What are the challenges and/or issues in terms of risk quantification and MCS formation?

Mandatory reading

Presentation material

Bedford, T., and Cooke, R. T. (2007). Probabilistic Risk Analysis: Foundations and Methods, *Cambridge University Press*. 99-139.

Optional reading

Zio, E. (2009). Computational methods for reliability and risk analysis, *World Scientific Publishing*.

Rausand, M. (2011). Risk Assessment: Theory, Methods, and Applications. *John Wiley & Sons*.

2.2.3. RA methods 3 (cause-consequence analysis, cause-and-effect analysis, human reliability assessment)

Developed by Piia Tint

Lecture description

The topic provides an overview and description of various risk analysis methods, such as cause-consequence analysis, cause-and-effect analysis, and human reliability assessment methods. These different methods will show how various factors may combine to cause a hazardous event and will also show the various possible outcomes.

Main themes

- Risk analysis methods
- Cause-consequence analysis
- Cause and effect analysis
- Human reliability assessment method

Planned learning method

Lecture + Text material + Discussion exercises

Self-evaluation questions for students

- Analyse the similarities and differences between cause-consequence analysis, cause-and-effect analysis, and human reliability assessment.
- What are the conditional levels of CCA?
- You should be able to draw up the fishbone analysis on a given topic.
- Which are the individual factors that are inherent in human reliability assessment?

Mandatory reading

Dale, B. G. et al. (2007). *Managing Quality*. 6th edition. *Blackwell, Chapters 2, 9 and 10*.

Optional reading

Ishikawa, K. (1990) *Introduction to Quality Control*, 448. (Translator J.H. Loftus).

Ericson, C. A. (1994). *A Guide to Practical Human Reliability Assessment*. ed. Barry Kirwan, *Taylor and Francis*.

Kirwan, B., Ainsworth, L. (1992). *A Guide to Task Analysis*, (1992), *Taylor and Francis*.

2.2.4. Uncertainty and probability in risk assessment

Developed by Torbjoern Bjerga

Lecture description

The topics of uncertainty and probability, and various types and understandings of each of them have been given much attention over several decades in risk society. This lecture intends to share some insight on probability and uncertainty in risk assessments. The presentation is largely in line with uncertainty-based risk perspectives, and views uncertainty as a concept that can be measured by various alternative tools.

Main themes

- Two interpretations of probabilities: frequentist probabilities and knowledge-based probabilities.
- The uncertainty types are: uncertainty about quantities, uncertainty about future consequences, and uncertainty about a phenomenon
- What is model uncertainty?
- Ways of measuring uncertainty, including knowledge-based probability, imprecise probability, and strength-of-knowledge judgements.
- Deep uncertainty, and adaptive risk management as an approach in terms of being able to meet deep uncertainty cases.
- Variation in a phenomenon which is relevant in a risk context.
- The need for uncertainty characterisations in risk-informed decision-making.
- Probability and uncertainty and their link to an uncertainty-based perspective on risk.

Planned learning method

Lecture + Text material + Discussion exercises

Self-evaluation questions for students

- What is a knowledge-based probability?
- What is a frequentist probability?
- How are the different types of probability linked to variation and uncertainty?
- Describe three types of uncertainty in a risk context.
- How can uncertainty be measured?
- What is deep uncertainty?
- What is model uncertainty?

Mandatory reading

Aven, T. (2014). *Risk, surprises and black swans*. Routledge. Especially chapters: 2.2, 2.3, 3.1, 3.3, and Appendices: A1, A2, and A3.1

Optional reading

Society for Risk Analysis (SRA) Glossary: <http://www.sra.org/sites/default/files/pdf/SRA-glossary-approved22june2015-x.pdf>

Risk analysis foundations (SRA): <http://www.sra.org/sites/default/files/pdf/FoundationsMay7-2015-sent-x.pdf>

2.2.5. Emergency risk assessment and management

Developed by Eivind Rake

Lecture description

The lecture starts with definitions and descriptions of elements in disasters and emergencies including decision-making, and risk and management.

The principles of risk assessment and risk management in emergencies (emergency management) will be discussed and demonstrated by practical examples. Students will analyse different types of disasters and/or emergencies to describe typical challenges, spanning from politician to incident commanders. The process to quickly identify, assess, and cope with risks in emergencies will be a core part of the lecture. An introduction to ICS, the incident commanding system, for running responses is provided, and critical leadership tasks are identified.

Discussions and work with practical examples from different emergencies.

Main themes

- Different elements and phases in emergencies.
- From decision-making to emergency management.
- Risk assessment and management during emergencies and disasters.
- Assessing practical emergency management.
- Coping with challenges during emergencies.
- An incident commanding system and critical leadership tasks.

Planned learning method

Lecture + Text material + Discussion

Self-evaluation questions for students

- What is risk assessment in emergencies? Provide examples from at least five different emergency situations.
- Explain why risk assessment during an emergency is compulsory when it comes to coping successfully at the scene.
- Describe the typical principles of risk assessment and emergency management.
- What is the relation between assessment and decision-making? Provide examples.
- Which challenges will you have to cope with during your leadership of a huge forest fire? How will you address these challenges?

Mandatory reading

Boin, A., Hart, P., Stern, E. and Sundelius, B. (2005). The Politics of Crisis Management. *Public leadership under Pressure*. Cambridge University Press, Cambridge, UK. Pp 1-15 and 137 -157

Rake, E. L. (2012). Risk assessment on-scene. In J. Emblemståg (Red.), *Risk management for the future: theory and cases*. InTech. Pp 139-144 and 149-152
Available from: www.intechopen.com.

Optional reading

Waugh, W.L. and Streib, G. (2006). Collaboration and leadership for Effective emergency management. *Public Administration Review*, 66(S1), 131 – 140.

Rake, E.L. and Njå, O. (2009) Perceptions and performances of experienced incident commanders. *Journal of Risk Research*, 12(5), 665-685.

Rosenthal, U., Boin, R. A., & Comfort, L. K. (Eds.). (2001). *Managing crises: Threats, dilemmas, opportunities*. Springfield, Ill.: Charles C. Thomas.

2.2.6. Risk assessment/analysis examples

Developed by Piia Tint and Karin Reinhold

Lecture description

This topic talks about conducting a practical risk assessment in different environments. The risk assessment begins at the planning stage where information gathering follows. The examples are related to risks to health, risks in industrial premises, and monotonous work: that which causes musculoskeletal disorders analogous to working in a static posture, plus physical overload: the work of a cleaner, an example being in a post-handling company. Examples covering hazards assessments are highlighted in terms of industrial processes.

Main themes

- Steps in risk assessment
- Selection and application of safety measures
- Examples of risk assessment

Planned learning method

Lecture + Text material + Discussion

Self-evaluation questions for students

- The main points for risk assessment in the working environment.
- An analysis of the work environment in industry and in the office: what is the difference?
- How can risk level be determined in the case of psychosocial risks?

Mandatory reading

Winder, C. & Makin, A.-M. (2006). Going beyond risk assessments using matrices. In: Guedes Soares & Zio (eds), *Safety and Reliability for Managing Risk*, London: Taylor & Francis Group, 787-794.

Covello, V.T., Merkhoher, M.W. (1993). Risk assessment methods: approaches for assessing health and environmental risks. *Springer*. 5-26.

Optional reading

Tint, P., Tuulik, V., Karai, D. Meigas, K. (2014). Health risks to computer workers in various indoor facilities. *The Scientific Journal of Riga Technical University: Safety of Technogenic Environment*, 5, 47-50.

Pille, V. (2016). Development of a model for the prevention of work-related musculoskeletal disorders in the upper extremities. PhD thesis. *Tallinn University of Technology*.

2.3. The application of tools for risk analysis (2.5 ECTS)

Aim

The aim of this course is to give students the proper risk management tools and security management principles through an assessment of different case studies.

Learning outcomes

After the successful completion of the course, the student should be able to:

- Apply qualitative and quantitative methods of risk analysis and relevant software (eg. Open FTA).
- Apply probabilistic models and software (eg. SIMLAB) for uncertainty/sensitivity analysis.
- Assess different aspects and errors of risk management on the basis of case studies.

2.3.1. The application of tools for risk management in Baltic-Nordic region

Developed by Piia Tint and Henn Tosso

Lecture description

Risk management consists of a risk assessment (RA), a risk evaluation, and risk reduction. Risk can be acceptable or unacceptable. For RA there are hundreds of analysis tools. The topic presents the application of work risk analysis methods for risk management in Finland and in Estonia, focussing primarily on industrial premises.

Main themes

- Risk management function
- Pros of risk management
- Pros and cons of flexible risk assessment method

Planned learning method

Lecture + Text material + Discussion exercise

Self-evaluation questions for students

- How do we go from risk assessment to risk management?
- Are there differences in risk assessment and management in the Baltic and Nordic countries? If yes, then why and what are they?
- How often should a risk assessment be carried out? Explain.

Mandatory reading

Pääkkönen, R., Rantanen, S., Uitti, J. (2005). Identification of health hazards. Helsinki (Finland): *Finnish Institute of Occupational Health*. 99

Anttonen, H., Pääkkönen, R. (2010). *Risk assessment in Finland: Theory and Practice. Safety Health and Work, Sep. 1(1)*, 1-10.

Reinhold, K., Tint, P., Kiivet, G. (2006). Risk assessment in textile and wood processing industry. *International Journal of Reliability, Quality and Safety Engineering*, 13(2), 115–125.

Optional reading

Anttonen, H., Ketola, L., Vorne, J. (2000). OSH management and risk control. NAM2004. In: *Abstracts of the 50. Nordiska arbetsmiljömötet; Aug 30- Sep 1; Reykjavik, Island*

Reinhold, K. (2008). Determination of Hazards Profile Using A Flexible Risk Assessment Method. PhD thesis, *Tallinn*.

Tammepuu, A., Sepp, K., (2013). Emergency risk assessment: the Estonian approach. *Journal of Risk Assessment*, 16 (2), 169-193.

2.3.2. The design and use of exercises – one way of finding and describing risks

Developed by Lena-Maria Öberg

Lecture description

This topic provides an overview of exercises and how exercises can be used to find and describe risks. The learning points will also include a critical standpoint when it comes to how exercises are performed today. During this topic examples of cross-boundary exercises will be presented.

Main themes

- Exercises
- Communication during exercises
- Exercises in blended environment
- Examples of cross-boundary exercises

Planned learning method

Lecture + Text material + Group work

Self-evaluation questions for students

- What is a crisis exercise?
- In what way could crisis exercises be used?
- List and discuss a number of weaknesses with crisis exercises.
- List and discuss a number of strengths with crisis exercises.
- What is the connection between exercises and risks?

Mandatory reading

Berlin, J.M. & Carlström, E.D. (2015). Collaboration Exercises: What Do They Contribute? – A Study of Learning and Usefulness. *Journal of Contingencies and Crisis Management* 23 (1), 11–23.

McConnell, A. & L. Drennan (2006). Mission Impossible? Planning and Preparing for Crisis. *Journal of Contingencies and Crisis Management* 14(2): 59-70.

Perry, R.W. (2004). Disaster Exercise Outcomes for Professional Emergency Personnel and Citizen Volunteers. *Journal of Contingencies and Crisis Management* 12(2):64-75.

Rankin, R., Field, J., Wong, W., Eriksson, H., Lundberg, J. & Rooney, C. (2011). Scenario Design For Training Systems In Crisis Management: Training Resilience Capabilities. I Hollnagel, E., Rigaud, E. och Besnard, D. (ed.), *Proceedings of the fourth Resilience Engineering Symposium* June 8-10, 2011 Sophia Antipolis, France

Hart, P. & Sundelius, B. (2013). Crisis management revisited: A new agenda for research, training and capacity building within Europe. *Cooperation and Conflict* 0(0):1-18

2.3.3. Qualitative and quantitative methods for risk analysis and relevant software (eg. Open FTA)

Developed by Robertas Alzbutas

Lecture description

PRA (Probabilistic Risk Assessment) practitioners will create a simplified model with one event tree and a selection of fault trees for PRA-specific issues using relevant software (eg. Open FTA). They will analyse failure rates and the reliability of components and systems. Examples for FTA (Fault Tree Analysis) models with specific software will be applied for that purpose. The group will set up the event tree and fault tree structure, quantify probabilities, and evaluate the results. With this material and thanks to this exercise, participants should become familiar with the main elements of PRA as well as being able to assess its benefits and limitations.

Main themes

- Open FTA software
- Analysis of failure rate and reliability
- Event tree
- Fault tree

Planned learning method

Lecture + Text material + Assignment

Self- evaluation questions for students

- How would you introduce the quantification of top-event probability?
- What are the differences between various approximations that are used for FTA calculations?
- What are the reasons for and issues behind the truncation or cut-off that is used for rare event risk calculations?

Mandatory reading

Presentation material and web pages from <http://www.openfta.com/>

Optional reading

Bedford, T., and Cooke, R. T. (2007). Probabilistic Risk Analysis: Foundations and Methods, Cambridge University Press. 99-139.

Zio, E. (2009). Computational methods for reliability and risk analysis, World Scientific Publishing.

Rausand, M. (2011). Risk Assessment: Theory, Methods, and Applications. John Wiley & Sons.

Saltelli, A. et. al. (2008). Global Sensitivity Analysis: The Primer, John Wiley & Sons.

2.3.4. The application of probabilistic models and software (eg. SIMLAB) for uncertainty/sensitivity analysis

Developed by Robertas Alzbutas

Lecture description

The practical course will provide information regarding models, methods, and software (eg. SimLab) for probabilistic uncertainty analysis and probabilistic sensitivity analysis.

Main themes

- Uncertainty and global sensitivity analysis
- Tolerance interval and Wilks formula
- SimLab development framework
- Monte Carlo sampling methods
- Use of various methods
- U/S analysis results

Planned learning method

Lecture + Text material + Assignment

Self- evaluation questions for students

- How would you explain the meaning of uncertainty propagation?
- What are the differences between the tolerance interval and the confidence interval?
- What are the challenges in and/or issues related to sensitivity analysis, various methods, and SimLab application?

Mandatory reading

Presentation material and web pages from <https://ec.europa.eu/jrc/en/samo/simlab>

Optional reading

Saltelli, A. et. al. (2008). Global Sensitivity Analysis: The Primer, John Wiley & Sons, 1-42.

Bedford, T., and Cooke, R. T. (2007). Probabilistic Risk Analysis: Foundations and Methods, Cambridge University Press, 17-38.

Zio, E. (2009). Computational methods for reliability and risk analysis, World Scientific Publishing.

Rausand, M. (2011). Risk Assessment: Theory, Methods, and Applications. John Wiley & Sons.

2.3.5. Case: the application of tools in everyday risk management

Developed by Henn Tosso

Lecture description

This topic provides an overview of how to implement risk analysis tools in everyday risk management. The lecture will provide various examples of how different tools can be applied in everyday risk management.

Main themes

- Case study analysis
- Tools in daily environment
- SWOT

Planned learning method

Lecture + Text material + Assignment

Self- evaluation questions for students

- What different tools could be used in an everyday situation? Analyse the pros and cons in relation to those tools.
- To whom is coal dust hazardous during loading?
- What risk level was determined in the cottage area? Why?
- How many risk levels are in the 5x5 risk matrix? Analyse whether there is any subjectivity in those risk levels?

Mandatory reading

Nedeljakova, I. (2007). Review of risk assessment methods. *Journal of Information Control and Management Systems*, 5 (2), 277-284.

Kohlbacher, F. (2006). The Use of Qualitative Content Analysis in Case Study Research. *FQS Forum. Qualitative Social Research. Sozialforschung*. 7 (1), A.21.

2.3.6. Cases: the application of tools in disaster/crisis/catastrophe management

Developed by Piia Tint and Jaana Sepp

Lecture description

This topic uses knowledge in terms of risk management which was gained in previous lectures regarding the various tools available. Students will analyse a minimum of two case studies by using different methods.

Main themes

- Case studies analysis
- Bowtie analysis

Planned learning method

Lecture + Text material + Assignment

Self- evaluation questions for students

You should be able to analyse a case study and apply the bowtie analysis.

Mandatory reading

Ostrowska, M. (2014). Risk management in crisis situations. *Forum Scientiae Oeconomia*, 2(2), 1-10.

Peterson, M.J. (2009). Bhopal Plant Disaster – Situation Summary. *International Dimensions of Ethics Education in Science and Engineering*, 1-8

Minamata case study in Moodle, 1-9