



## Special Issue: Risk Analysis Validation and Trust in Risk management



### 1. Introduction

Many risk analysis techniques, models, approaches and applications have been proposed and presented in very diverse application areas. Policy instruments and standards are in place in many industries that require risk analyses and risk management activities to be performed as part of design or operational processes. Nevertheless, there is much less academic research or policy guidance on the validation of risk analyses. Compared to more established scientific disciplines, quality control mechanisms for assessing the credibility of risk analyses and the validity of their results are not equally well developed. Conclusive criteria are yet to be established for assessing the scientific validity of claims about risk, and there is a lack of strong empirical evidence about the practical cost-effective usefulness of risk analysis. Closely linked to the validation and credibility of risk analyses per se, is the trust in ensuing decision-making and risk management. There is little academic research about how risk analyses are actually used in decision-making, or about which features of risk analyses or their context of execution and application are important for different stakeholder groups to ensure trust in the decisions made.

Criticisms against especially quantitative risk analysis are relatively well known and have been voiced repeatedly during the relatively short lifespan of risk as a field of research, see e.g. [Cumming \(1981\)](#) and [Apostolakis \(2004\)](#). Even recently, strong arguments have been made that there is little evidence that executing risk analyses enhances system safety in a cost-effective manner ([Rae et al. 2014](#)). [LeCoze et al. \(2014\)](#) point to the lack of established normative criteria for evaluating the scientific validity of empirical work, models, and theories in the wider safety science(s). They also stress the value and importance of being reflective and critical about the current state of safety science, with a view to improve its foundations. The need for increased focus on foundational issues in risk research has also been highlighted e.g. by [Aven and Zio \(2014\)](#). [Hale \(2014\)](#) also commented on the issue of the quality of proof supporting safety science theories, methods and approaches, arguing that the evidence base that interventions actually improve safety generally is weak and that more attention to this issue should be given.

While risk analysis and management can focus on a variety of possible outcomes and actions, safety is often a major consideration justifying the need for risk management activities. Understanding risk analysis and management as mechanisms to support decision making related to implementing measures for improving the safety for people exposed to potential hazards, as suggested by [Aven \(2014\)](#), there is a clear link between risk research and safety science. This link is clear also from the fact that several leading safety related journals include various risk related topics within their scope ([Li and Hale 2016](#)). It also is evident from the knowledge communication between journals focusing on safety and/or risk ([Li and Hale 2015](#)). Hence, the validity of risk analysis both with respect to its theoretical underpinnings as well as in regards specific practical applications, and the mechanisms involved in ensuring the trust in the decision making process and its outcomes, are directly relevant for safety research and practice.

Considering the above, this special issue “Risk analysis validation and trust in risk management” aims to increase scientific attention to these foundational issues. State-of-the-art reviews, critical analyses and discussions on theoretical issues or specific applications, as well as original research focusing on potential solutions for specific topics were invited in the call for papers. The only restriction made on the scope of the submissions, apart from the need for a clear focus on validity and/or trust, was that the work should be relevant for human and industrial safety, to foster a strong connection to the overall aims and objectives of Safety Science.

### 2. The articles of this special issue

This special issue consists of eleven papers and a postscript written by Terje Aven. We asked him to give us his reflections on validation and trust in risk research, based on the issues raised in the papers, situating these within some of his views on risk analysis as a scientific discipline. Being the current president of the Society for Risk Analysis and chair of the European Safety and Reliability Association, and having published widely on foundations of risk analysis, we are very happy that he accepted this task.

The articles approach the issue of validity and trust in a variety of ways. In [Fig. 1](#), an overview is given of the main themes covered by the articles. It is not our intention to comment on each of the articles as we have asked Terje Aven to provide his reflections on those in his postscript, see [Aven \(2017\)](#). We limit ourselves to making a thematic classification of the papers, briefly introducing the main themes of the articles making up this special issue.

A first cluster of papers provides **critical reviews** on selected issues related to validity of risk analysis. [Goerlandt et al. \(2017\)](#) present a comprehensive review on the validity and validation of safety-related quantitative risk analysis (QRA). Theoretical, methodological and empirical work related to conceptual validity, i.e. the extent to which the operationalization measures what it intends to measure, and pragmatic validity, i.e.

THEME	AUTHORS	KEYWORDS
CRITICAL REVIEWS	Goerlandt et al. (2017)	Risk analysis, Validation, Foundational issues, Quantitative risk analysis, QRA
	Pasman et al. (2017)	Process hazards, Consequence analysis, Hazard identification, Risk management
	Rae and Alexander (2017)	Expert opinion, Risk assessment, Validation, Forecasting, Ontology of risk
RISK ANALYSIS METHOD IMPROVEMENT	Khastgir et al. (2017)	Hazard, HARA, ISO 26262, Functional safety, Reliability
	Brocal et al. (2017)	Emerging risk, Industrial process, Lifecycle, Occupational risk
FRAMEWORKS FOR VALIDATING, ESTABLISHING TRUST, OR AUDITING	Lathrop and Ezell (2017)	Risk analysis, Risk analysis validation, Trust, Risk management, Systems approach, Culture of analysis quality
	Moura et al. (2017)	Risk studies validation, Learning from accidents, MATA-D, Human factors, Organisations, Self-organising maps
	Zeng and Zio (2017)	Quantitative risk analysis (QRA), Validity, Reliability, Trustworthiness, Naive Bayes classifier
	Jespersen and Hasle (2017)	Evidence, OHS management system standards, PAS 1010, Qualitative methods, Realistic evaluation, Wicked problems
TRUST IN RISK MANAGEMENT	Nakamura et al. (2017)	Local community, Communication, Disaster prevention, Community-based meetings
	Durodié (2017)	Risk, Culture, Trust, Values, Strategy, Engagement

Fig. 1. Thematic classification of articles included in the special issue.

the extent to which the method meets its intended requirements in terms of the results obtained, are addressed. Theoretical issues concern conceptual validity in light of different risk perspectives and in relation to the realist-constructivist continuum. The methodological review covers the available approaches for establishing pragmatic validity, i.e. benchmark exercises, reality checks, independent peer review, and quality assurance. Empirical work addresses the available evidence for claims made about QRA, particularly the accuracy, cost-effective usefulness and usefulness claims. Pasman et al. (2017) focus on risk analysis in context of industrial processing of oil, gas, and chemicals. Their critical review of the state-of-art in this application area focuses on weaknesses of available methods and tools, covering hazard identification, quantification of consequences and probability of events, risk reducing measures, and risk metrics, perception and judgment. The importance of uncertainty treatment and future development paths, including method improvements and dynamic risk analysis approaches, are highlighted. Rae and Alexander (2017) perform a critical synthesis of evidence addressing the validity of expert judgments. Issues such as what defines an expert, the accuracy of expert judgements, and the elicitation and combination techniques for obtaining and processing these, are addressed. Several paths to improving expert judgment validity are outlined, and recommendations made.

A second cluster focuses on specific **improvements of risk analysis methods**, based on validity concerns about available methods. Khastgir et al. (2017) focus on Hazard Analysis and Risk Assessment (HARA) in the automotive domain in line with the ISO 26262 standard, proposing an approach for improving the reliability of the determination of the Automotive Safety Integrity Level (ASIL) through establishing a rule-set for severity, exposure, and controllability. Brocal et al. (2017) focus on occupational risks. Identifying a number of validity concerns with existing techniques, they develop a theoretical framework to model new and emerging risks, allowing risk monitoring through the technology lifecycle.

A third cluster of articles proposes **frameworks for establishing validity and/or trust, or for auditing** management systems. Lathrop and Ezell (2017) propose a systems approach to risk analysis validation for ensuring trust in risk management, based on extensive practical experience. A flowchart connects these four aspects, and highlights sixteen critical elements with associated validation tests. The flowchart also covers three domains of activities, associated with analysts, users and the analysis community, where the first and last of these are central to establish a culture of analysis quality. Moura et al. (2017) aim to enhance stakeholder's trust in risk management by developing an attribute list to validate risk analysis studies. This list is based on common patterns in major accidents, identified using a data mining technique applied to a dataset of accidents in high-technology industrial domains. Zeng and Zio (2017) develop a method for classifying the trustworthiness of a QRA, based on six criteria. These criteria are then applied in a classification problem, implementing through a Naïve Bayes Classifier, constructed using training data based on expert assessments. This method is subsequently cross-validated and a consistency check for the input data is implemented. Thus, this method aims to assess the trustworthiness of a given QRA, mimicking the expert views on earlier assessed QRAs. Jespersen and Hasle (2017) focus on the auditing of psychosocial risk management in occupational health and safety management systems. Recognizing the complexity of psychosocial risks and the limited validity of available approaches for auditing these, a new conceptual model is proposed for this purpose. The approach integrates general scientific knowledge regarding psychosocial risks with local contextual knowledge. Key tools for the application of the model are realistic evaluation and qualitative interviews.

The fourth and final cluster of papers focus on the issue of **trust in risk management**. Nakamura et al. (2017) perform empirical research concerning participant satisfaction (which relates to trust) in community-based disaster prevention meetings. This particular risk management activity is studied using questionnaire surveys, the data of which is analysed using Structural Equation Modelling. The results indicate that knowledge about disasters and understanding of the community are important for stakeholder satisfaction, while especially the relationship and communication with local communities are essential. Durodié (2017) makes similar arguments in a discussion paper, utilizing examples from various case studies and insights from the risk research literature. He stresses that the effectiveness of risk analysis and management relies on the effectiveness of communication with non-specialist audiences, in particular policy-makers and the public. Clarity of purpose through the language used, partners engaged and proposed ends of risk control measures are essential elements, where attention to the specific cultural contexts in which these are embedded are crucial to ensure trust.

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