Medusa and Pandora meet the Web 2.0: How risk types influence the communication in social media

Draft to appear in Proceedings of the IEEE International Professional Communication Conference (ProComm) 2014

Claas Digmayer
RWTH Aachen University
c.digmayer@tk.rwth-aachen.de

Bianka Trevisan
RWTH Aachen University
b.trevisan@tk.rwth-aachen.de

Eva-Maria Jakobs
RWTH Aachen University
e.m.jakobs@tk.rwth-aachen.de

Risk communication is an important branch of technical communication: Innovative technologies need to be communicated to the general public; concerns of relevant stakeholders need to be addressed. Such concerns can be identified in topic-related comments in social media. This paper presents the results of a study on how people evaluate technologies that are characterized by as different risk types. Two examples of technology-induced risks types are examined: (1) The ubiquitous and persistent impacts of hydraulic fracturing (risk type: Pandora). (2) The consequences with high exposure but little damage potential of a local infrastructure project aiming at the introduction of a light-rail system (risk type: Medusa).
Risk-relevant comments were identified automatically using a topic tracking approach based on dictionaries of risk-related terms. The identified comments were analyzed quantitatively and qualitatively with regard to comment types, formulation styles, evaluation types, evaluated aspects and objects of comparison. The results show that the type of risk influences which aspects of a technology users evaluate and how they formulate evaluations. The findings are discussed with respect to implications for risk communication.

Index Terms – Evaluation of risks, discussion of risks in the web 2.0, linguistic web mining, perception of risk types.

INTRODUCTION

"Being at global risk is the human condition at the beginning of the twenty-first century" [1:330] – citizens are confronted with technologies that potentially impact their lives in negative ways. Due to shortened innovation cycles and pervasiveness, technological changes emerge frequently [2] and affect human cultures on different levels, such as the design and use of material artifacts (material level), the knowledge about technologies (cognitive level), the evaluation of technology-related knowledge (normative level) and economic aspects of handling technology (economic level) [3].

Which facets of public life are affected in which ways – especially regarding long-term consequences – is often difficult to measure for domain experts as well as for concerned citizens [2]. Some types of risks may have high and persistent impact, while others are characterized by a high exposure yet little damage potential [4].

Therefore, the communication of innovative technologies requires a knowledge transfer between stakeholder groups (e.g., science, industry, the general public) that addresses risk-

related concerns to foster technology acceptance [5]. Risk communication is part of the management of risks and should inform "individuals about the existence, nature, form, severity, or acceptability of risks." [6:6]. Inadequate risk communication can entail serious consequences ranging from civic movements to the broad rejection of technology-related projects [7]. However, technology-related dialogs often focus on aspects such as production and finances neglecting questions about side effects resulting from the development and use of technologies [5].

Inadequate risk communication is due to several reasons: Firstly, domain experts are often not trained as risk communicators: Either they do not communicate as long as risks are kept on acceptable levels [8] or tend to reduce risk communication to evidence and probabilities, which is not sufficient for the information needs of the general public [9]. Secondly, guidelines for risk communicators are often difficult to put into practice [10] and do not address issues such as communicating through the Internet [11]. Thirdly, risk communication is often based on a deficit model: Individuals are treated as unknowing and dependent on information from authorities. Resulting awareness-raising campaigns simply inform citizens instead of creating dialogs [12].

Effective risk communication should take the affected citizens seriously; their concerns and fears need to be addressed. Social media are a valuable source to identify such opinions: Discussions about technology-induced risks are held in the Web 2.0 by posting comments in topic-related websites (e.g., blogs) and hence shape the public perception.

This paper presents the results of a study on how people formulate and discuss their view of risks online at the example of two technologies: Hydraulic fracturing and light-rail systems. The study is guided by two research questions:

- RQ1: How do social-media users comment on risks?
- RQ2: Does the risk type have an impact on which aspects of technologies are discussed online?

Related Work

I. Risk

Risk is a multidimensional construct that has been researched in various disciplines with varying foci, e.g. as calculable phenomenon in the field of mathematics, as objective reality in the field of medicine, as story in the field of history, as act of faith in the field of religion or as societal phenomenon in the field of social sciences [13]. Definitions span from risk as formula (R=W*S, where R is the risk, W the probability of damage occurrence and *S* the expected magnitude of the damage [9] to risk as the anticipation of a future catastrophe in the presence [14].

In the field of linguistics, topics of interest regarding risks are the terminology and meaning of risk [13]. Rothkegel [15] defines events as superordinate for the definition of risk: An event (e.g., loss, accident, attack, catastrophe) is a transition from an initial to a result state triggered by processes or (intended/not intended) actions. The result state is desired or not desired for various reasons. Situations that may lead to undesired results are called risk situations.

II. Risk Types

Beck states that modern society faces new types of risks induced by science and technology which seem unmanageable by common approaches and affect members of all

social classes [16]. Such *complex unbound* risks are more abstract than the ones previously known and „permanent rather than temporary, global rather than local, and manufactured by us in practical and ideological ways“ [17:120]. A more precise differentiation between types of risks by the German Scientific Advisory Counsel on Global Change [4] is based on the distinguishing features *probability of occurrence*, extent of loss, *certainty of measuring the occurrence* and *certainty of measuring the damage*. The resulting risk types are named after Greek gods. Two risk types are relevant for this paper: The *Pandora* risk type has persistent, ubiquitous und irreversible effects. Possible consequences are often unknown or assumed. Examples are persistent organic pollutants. The *Medusa* risk type is characterized by a low occurrence and damage potential as well as a low certainty of measuring the occurrence and a rather high certainty of measuring the damage – in the opinion of domain experts, risks of this type are normal risks of the daily live. Nevertheless, the general public regards the Medusa type as threat resulting in massive rejection and civic mobilization. Examples are the effects of electro-magnetic fields.

III. Risk Perception and Evaluation

Two different ways of how humans perceive and act on risks are described in the literature [18, 19]: Technical approaches evaluate risks as estimation of costs and benefits based on rationality and logic. Other approaches evaluate risks using *affect heuristics* which are guided by instinctive and intuitive reactions.

In linguistic evaluation theory, evaluating is conceptualized as an act in which a subject evaluates an object with a certain purpose at a certain time by a comparison with other objects. Every object has various attributes. Some are relevant for the evaluation, while and others are not. Attributes are evaluated by a ranking on scales. The outcomes are compared to the expected results and weighted [20, 21]. Attributes that are relevant for the evaluation of risks are based on factors influencing risk perception [22]. Risk perception depends on the context of the risky situation and is influenced by factors such as the catastrophic potential, familiarity, newness, understanding, uncertainty, controllability, effect manifestation, future effects, reversibility and origin of risks as well as the voluntariness of exposure, the distribution of benefits and risks, trust in institutions, knowledge about the risk possessed by the affected person and possessed by science [23-26]. These factors can cause intense feelings and are therefore referred to as *outrage factors* [27].

Scientific research on risk perception is usually conducted on the basis of surveys (cf. [23]). Approaches from corpus linguistics examine the use of the word *risk* in newspapers or transcripts of spoken dialogues [28]. In contrast, insights about how people evaluate risks via Web comments are rather limited. Anderson and colleagues [29] found that individuals are more likely to perceive nanotechnology as risky if they are exposed to uncivil blog comments. Reimer and colleagues [30] examined Web comments about deep heat mining. Impacts of the technology were found to be the most important aspect with regard to the public perception.

Trevisan and colleagues reconstruct user perspectives on technology [31] and arguments [32] from comments in social media with methods of text mining. At the example of mobile communication systems [33], they show that users tend to discuss only certain aspects of a technology with regard to risks (transmitters, radiation, electromagnetic fields). Text mining is a promising approach to investigate risk perception. Nevertheless, the automated identification of user-generated evaluations in Web comments is hampered by the

formulation of comment contents, especially by varying formulation styles and various means of evaluation acts.

Varying formulation styles: Web comments are often written informally and colloquially in dialog form, make use of irony and social media language (e.g., emoticons, 'leetspeak'), alter idioms and may contain linguistic irregularities (e.g., shortened or merged words). [33, 34]. Due to such differences between Web comments and formal texts (e.g., news paper articles), common text mining tools are inadequate for examining user generated risk evaluations in the Web 2.0.

Means of evaluation acts: A single tool is unable to identify all different types of evaluation means. Especially the use of irony complicates the interpretation of evaluation acts [31].

To date, there is no examination regarding the influence of risk types on the evaluation of technologies in Web comments.

METHODOLOGY

I. Objects of Investigation

The perception of two technologies – hydraulic fracturing and an infrastructure project aiming at the introduction of a light-rail system – is investigated in this paper.

Hydraulic fracturing is a technology enabling the production of unconventional natural gas reservoirs with the help of hydraulically pressurized liquids that contain toxic chemicals. Persistent and long-term repercussions for the environment as well as for human life and health are plausible, but nevertheless difficult to estimate and thus remain controversial [35]. Therefore, hydraulic fracturing is classified as risk type *Pandora*.

The second technology is the light-rail system *Campusbahn*. The system was planned to be completed by 2018 in Aachen, Germany. Construction projects such as Campusbahn affect citizens and the environment (cf. [36]). However, possible side effects are confined to a small area and have a rather low damage potential. Experts did not estimate the Campusbahn project as risky for the city and its residents. This opinion was not shared by major parts of the local citizens which led to massive protests and civic movements. The project was finally canceled in 2013. Due to the high mobilization potential [4], the Campusbahn project is classified as risk type *Medusa.*

II. Data Collection

Online news blogs were manually searched for articles about risks related to the Campusbahn project. 20 articles were selected randomly. User generated comments referring to the articles were extracted automatically with Web mining tools and stored as text-files containing the date of creation, author name and comment content. In total, 355 comments related to the Campusbahn project were extracted. The process was repeated for hydraulic fracturing resulting in 1703 extracted comments.

III. Data Preparation

The collected comment corpus is processed semiautomatically in four steps using the methodology described in [37]: First, the TreeTagger tokenizer is applied to tokenize the data. Second, the TreeTagger is used for part-of-speech (POS) tagging of the tokenized data. Third, the automatically processed data is corrected by hand. Fourth, the corpus is annotated according to the multi-level annotation model described in [31]. The annotation of

tokens on the graphematic, lexicosemantic, and syntactic level as well as the distinction of word-related polarities is carried with help of the AutoAnnotator tool [32].

IV. Data Analysis

The annotated corpus was searched automatically for risk-related comments using a topic tracking approach [38] based on a dictionary of risk-related terms: Relevant nouns and adjectives were extracted from risk lexica and enhanced with entries from synonym dictionaries. In total 285 nouns and 326 adjectives were used. Relevant comments were searched with patterns combing the risk-related terms and variations of the term *hydraulic fracturing* (e.g., fracking, fracturing, frac) respectively *Campusbahn* (e.g., tram, train, light rail).

The identified comments were analyzed quantitatively and qualitatively with regard to comment types, formulation styles, evaluation types, evaluated aspects and objects of comparison.

RESULTS

I. Quantity and Types of Comments

In total, 134 risk-related comments were identified (6.5% of the complete corpus). 89 comments belong to the hydraulic fracturing subcorpus (5.22%), 45 comments are part of the Campusbahn subcorpus (2.1%). The comments related to hydraulic fracturing consist of 13368 tokens (on average 150.2 tokens per comment), the Campusbahn comments of 8056 tokens (on average 179 tokens per comment).

In the analysis, three types of comments were identified: Refusing, neutral and approving comments. Refusing comments focus solely on negative aspects of a technology. The author of the following example states reasons against hydraulic fracturing:

> There are some additional dangers arising from hydraulic fracturing: - High water use and stabilization ponds en masse - Use of carcinogenic substances - Radioactive substances can reach the surface. […]

Neutral comments relativize or negate negative aspects of a technology, but do not state any positive aspects and are often replies to refusing comments. The following example is a reaction to statement that hydraulic fracturing poisons the groundwater:

> You do not provide evidence supporting your claim. Otherwise you would need to justify why hydraulic fracturing has been used for decades in Germany and has not led to any groundwater contamination to a significant extent.

Approving comments relativize or negate negative aspects of a technology and state one or multiple positive aspects in addition. Alike neutral comments, approving comments tend to be replies to refusing comments. As an example, the following part of an approving comment is a reaction to the statement that the Campusbahn project would require to take out a large loan:

> Loans are nothing bad, but a common mean of financial funding. It is important to use the funding for something which the city and its citizens can profit from and that is the case for

the Campusbahn project. […] Reasons for the Campusbahn are its comfort and speed. […]

The distribution of comments types between the subcorpora is as follows: 71 refusing (79.78%), 17 neutral (19.1%) and one approving (1.12%) comments were found in the hydraulic fracturing corpus. The Campusbahn corpus consists of 33 refusing (73.33%), one neutral (2.22%) and 11 approving comments (24.44%).

Comments are formulated in two ways: Emotional and objective. Emotionally formulated comments are characterized by an expressive writing style that is close to colloquial language and makes excessive use of exclamation marks and rhetoric questions. The tone is aggressive including means such as swearing, insults, sarcasm and words written in capital letters to mark screaming. The author of the following example is addressing another commentator stating that there are no reports about significant side effects resulting from hydraulic fracturing:

[…] The damage is the contaminated groundwater. You idiot. This is marketing, you RETARD. So that some jerks can claim that there is something like environmentally friendly hydraulic fracturing. […]

Objective comments are formulated factually, reservedly and concisely. The focus of such comments lies on the use of logic and reasoning. In the following example, the Campusbahn is rejected due to economical reasons:

The advantage of the Campusbahn concerning the number of passengers remains marginal. One could deploy two busses during highly frequented periods. The financial expenditure cannot be justified merely by the ride comfort. […]

The distribution of writing styles between the subcorpora is as follows: The hydraulic fracturing corpus includes 55 emotionally written comments (61.8%), the Campusbahn corpus 23 comments written in this style (51.11%). The distribution of writing styles between comment types of the hydraulic fracturing corpus is summarized in the following table.

TABLE 1. DISTRIBUTION OF WRITING STYLES BETWEEN COMMENT TYPES OF THE HYDRAULIC FRACTURING CORPUS.

Style	**Comment Types**		
	Refusing	**Neutral**	**Approving**
Emotional	54 (76.06% of refusing comments)	1 (5.88% of neutral comments)	0 (0% of approving comments)
Objective	17 (23.94% of refusing	16 (94.12% of	1 (100% of approvin

Style	Comment Types		
	Refusing	Neutral	Approving
	comments)	neutral comments)	g comments)

For the Campusbahn corpus, only refusing comments were found to be written in an emotional style (69.7% of refusing comments). 30.3% of the refusing comments as well as 100% of both, neutral and approving comments are written objectively.

II. Quantity and Types of Evaluations

A comment consists of one or multiple evaluations. 146 evaluations are included in the hydraulic fracturing corpus (maximum of evaluations per comment: 5, 1.64 evaluations per comment on average). The Campusbahn corpus comprises 72 evaluations (maximum of evaluations per comment: 8, 1.6 evaluations per comment on average).

In the analysis, objects evaluated in the comments were categorized inductively. Two objects were identified: The technology and consequences resulting from the deployment of the technology. Regarding the first object, evaluations focus on the technology as a whole as well as on particular aspects of the technology. The second object can be distinguished into three subtypes: Consequences for the environment, consequences for humans and consequences for cities. Table two illustrates the distribution of the evaluated objects of both corpora. For each object, the number of evaluations is stated. The percentage in brackets is the relation of evaluations concerning the given object and all evaluations identified in the corresponding corpus.

TABLE 2. DISTRIBUTION OF EVALUATED OBJECTS BETWEEN COMMENTS OF THE HYDRAULIC FRACTURING AND THE CAMPUSBAHN CORPUS

Object	Corpus	
	Hydraulic Fracturing	Campusbahn
Technology	52 (35.62%)	15 (20.83%)
… as a whole	16 (10.96%)	6 (8.33%)
… particular aspect	36 (24.66%)	9 (12.5%)
Consequences	94 (64.38%)	57 (79.17%)
… for the environment	66 (45.21%)	2 (2.78%)
… for humans	14 (9.59%)	6 (8.33%)
… for	14 (9.59%)	49 (68.06%)

Object	Corpus	
	Hydraulic Fracturing	**Campusbahn**
cities		

The most frequently evaluated aspects of the hydraulic fracturing technology are the *chemicals used in the fracturing process* (14 evaluations), *the danger potential of hydraulic fracturing* (2), *old drillings* (2), *energy expenditure* (2), *cost efficiency* (2) and *sustainability* (2). Regarding the Campusbahn, aspects such as the *politicians responsible in the decision making process* (4) and the *constructors of the Campusbahn* (2) were evaluated most frequently.

Regarding environmental consequences, most risk evaluations concerned *groundwater contamination* (18), *earthquakes* (16) and *toxic gases released during the fracturing process* (7) in the case of hydraulic fracturing. Evaluations related to the Campusbahn referred only marginally to ecological aspects (*noise pollution* and *eco balance*).

Regarding consequences for humans, aspects such as *the pollution of drinking water* (7) as well as *individual follow-up costs* (5) received the most evaluations in the hydraulic fracturing corpus. In the same category only five aspects mattered for the Campusbahn: *Smoke generation of defect rechargeable batteries, risk of accidents, rising taxes, rising ancillary leasing costs, problems due to vibrations* and *problems due to noise caused by the Campusbahn* (one evaluation each).

Regarding consequences for cities, *supply water containing methane* was evaluated most frequently in the hydraulic fracturing corpus (4). *High costs* (15), *follow-up costs* (4), *rising taxes* (4) and *construction sites* (4) were focused in evaluations of city-related consequences of the Campusbahn.

While refusing comments evaluate aspects of all categories, neutral and approving comments focus on particular aspects: In the case of hydraulic fracturing, 3 comments relativize risks of aspects of the technology and 14 comments weaken consequences for the environment caused by hydraulic fracturing. The approving comment refers to advantages for cities (little need for energy imports, jobs). In the case of the Campusbahn, one approving comment evaluates the technology as a whole. 10 approving and one neutral comment focus on consequences for the city.

The type of comment influences how a risk is evaluated (ranging from high risk to no risk at all). Furthermore, the writing style has an impact on how evaluations are formulated: While objective comments evaluate risks as (not) dangerous, (not) foreseeable or (not) significant, emotional comments use expressions such as *insanity, mess* or *befouled*.

In addition, uncertainty seems to influence the formulation of evaluations: In most comments, the riskiness of technological aspects and the occurrence of consequences is claimed doubtlessly. However, some formulations indicate that the author is not sure whether his/her claims can be evaluated as actual risks. Such comments make us of the conjunctive, questions, modal particles or particular adjectives (e.g., controversial, unclarified, uncertain). The following example is an extract from a comment showing uncertainty:

A danger has not been mentioned. Through to old drillings, frac fluids and gases could rise to the ground. […]

Markers of uncertainty are found in 30 comments from the hydraulic fracturing corpus (33.71%) and in 4 comments from the Campusbahn corpus (8.89%). The use of uncertainty differs depending on the type of comment: In neutral comments, uncertainty is assumed to weaken the perceived danger of consequences resulting from a technology, while in refusing comments, uncertainty is perceived as intensifier of risks.

In some cases, the evaluation of risks is based on comparisons with other objects. In the case of hydraulic fracturing, such objects are different energy forms such as wind generators, nuclear and coal-fired energy or catastrophes such as the nuclear accidents of Chernobyl and Fukushima (found in 13 comments). The Campusbahn is compared to local infrastructure projects that failed as well as to large construction sites suffering from significant problems, e.g., Stuttgart 21, the airport Berlin-Brandenburg International, the city tunnel of Leipzig, the Elbphilharmonie (found in 3 comments).

The analysis shows, that web commentators backed up their statements with references to scientific studies, blog articles, Wikipedia entries or sites of civic movements. Regarding hydraulic fracturing, the movie *Gasland* (2010 by Josh Fox) was often referenced as proof for negative impacts of the technology.

Discussion and Conclusion

I. Limitations

The topic tracking approach used for the data preparation is based on a dictionary of risk-related terms which may has an impact on the quantity of identified risk-related comments: Implicit risk evaluations, ironic risk evaluations or risk evaluations using terms that do not occur in the dictionary could have been missed in the selection process. Thus, an efficiency check of the method and an extension of the dictionary are planned next steps.

The data used in the study was collected from comments of two news sites. Further research should focus on a larger amount of sites, comments and different forms of socials media to confirm the findings and to rule out influences that could stem from particular styles of interaction applied in the communities of the two news sites.

Furthermore, the method provides only few insights into the identity of Web commentators – e.g., neither if they are involved in civic movements nor if they are actually confronted with the technology (as residents for instance). A combination of the method used in this study and a stakeholder analysis described in [39] could achieve valuable benefits on this subject.

II. Research Questions

RQ1: How do social-media users comment on risks? The results show that risks are focused in a rather small amount of comments. In such comments only few aspects of a technology (between 1.6 and 1.64 evaluations per comment on average) are evaluated elaborately (between 150.2 and 187.35 tokens per comment on average). The findings indicate that the two approaches to risk perception (technical approach and affect heuristics

[18, 19]) can also be found in objective and emotional comments related to risks in the Web 2.0. The strong feelings caused by outrage factors reported in the literature [27] are reflected by the formulation style of emotional comments.

In a majority of comments, risks are not perceived as a possible transition between two states. Negative side effects are rather claimed to be direct and guaranteed consequences in refusing comments by opponents of the technology. Such statements are objected by proponents leading to emotionally charged and often aggressive discussions.

However, the function of neutral comments is rather unclear in comparison. As neutral comments are found mainly in the hydraulic fracturing corpus, an explanation could be that authors of neutral comments are not satisfied with the biased presentation of the topic in refusing comments but are not aware of any advantages the technology offers to the general public that could be used as counter-argument. Further research is necessary to examine the existence and function of neutral comments in other contexts.

RQ2: Does the risk type have an impact on which aspects of technologies are discussed online? The results indicate that the risk type does not only influence which aspects of a technology are discussed but also how aspects are evaluated and how evaluations are formulated. Regarding aspects, users tend to evaluate consequences of a technology more frequently than the technology itself. The category of consequences differs between the Pandora (hydraulic fracturing) and Medusa risk type (Campusbahn): The finding indicates that the ubiquitous effects of the Pandora risk type mainly manifest as concerns regarding environmental pollution resulting in statements such as “The groundwater is befouled”. Conclusions from such claims for the daily live of citizens are seldom drawn. In contrast, the consequences of the known effects of the Medusa type can be anticipated and related to the public life. Furthermore, the unpredictability of the Pandora type becomes evident in the formulation style of evaluations: Markers of uncertainty can be found in one third of all comment related to hydraulic fracturing. In contrast, such markers are used only in four comments related to the Medusa type.

III. Implications for Risk Communication

The results of this study provide valuable insights for professionals engaged in the introduction and communication of innovative technologies (e.g., methods of energy production such as hydraulic fracturing, infrastructure projects such as Campusbahn or even innovative energy transportation means such as smart grids): Social media can be utilized as a source for opinions and evaluations about risks of innovative technologies. Such information can be accessed in high quantities within short time periods. Web comments reflect the unbiased opinion of citizens – in contrary data collected in interviews or questionnaires, which can be influenced by social desirability.

However, the results indicate that the risk type influences which aspects the users perceive as being highly risky and how they evaluate such aspects. Therefore, Web mining for risk communication should always take the risk type into consideration and should not generalize evaluations: As the findings indicate, risks resulting from hydraulic fracturing cannot be applied to the evaluation of the Campusbahn.

Instead of using information for a one-way risk communication with stakeholders (e.g., via printed information materials), communication professionals should engage in a direct dialog with citizens affected by innovative technologies. *Direct* means that risk communicators should participate where users express their opinions – in social media applications.

Establishing strong ties on a long-term basis to stakeholders through this channel requires special training that should consider how to communicate different types of risks: Communication professionals should know the relevant aspects of a technology evaluated by the stakeholders, the objects of comparison and the sources users refer to as proof of their claims. On the basis of this knowledge, risk communicators can address information needs, reduce uncertainty and discuss on par with the stakeholders.

In conclusion, more research is needed in order to develop a communication concept for professionals that provides useful information regarding all types of risks.

ACKNOWLEDGEMENTS

Funded by Bundesministerium für Bildung und Forschung, Forschungscampus Elektrische Netze der Zukunft (FKZ 03FS0488).

REFERENCES

[1] U. Beck, “Living in and coping with World Risk Society: The cosmopolitan turn,” *Deutschlands Perspektiven*, vol. 10, pp.1–12, 2012.

[2] Organisation for Economic Co-operation and Development, *Emerging Systemic Risks in the 21st Century: An Agenda for Action*. Paris: OECD, 2003.

[3] L. Belyová and G. Banse, “Sicherheit und Sicherheitskultur,” *Sitzungsberichte der Leibniz-Sozietät der Wissenschaften zu Berlin*, vol. 116, pp.21–31, 2013.

[4] German Scientific Advisory Counsel on Global Change, *Welt im Wandel: Der Umgang mit globalen Umweltrisiken.* Berlin: Springer, 1999.

[5] G. Banse and R. Hauser, “Technik und Kultur. Das Beispiel Sicherheit und Sicherheitskultur(en),” in *Technik und Kultur,* O. Rösch, Ed. Berlin: News&Media, 2008, pp.61–83.

[6] A. Plough and S. Krimsky, “The emergence of Risk Communication Studies: Social and political context,” *Human Values,* vol. 12, issues 3 & 4, pp.4–10, 1987.

[7] W. Leiss and H. P. Douglas, *Mad Cows and Mother's Milk: The Perils of Poor Risk Communication*. New Baskerville, Quebec: Mcgill Queens University Press, 2005.

[8] B. Fischhoff, “Risk perception and communication unplugged: Twenty years of process,” *Risk Analysis*, vol. 15, pp.137–145, 1995.

[9] J. Hampel, “Different concepts of risk – A challenge for risk communication,” *International Journal of Medical Microbiology,* vol. 296, no. 1, pp.5–10, 2006.

[10] G. M. Breakwell, *The Psychology of Risk*. Camebridge: Cambridge University Press, 2014.

[11] T. Abraham, “Lessons from the pandemic: The need for new tools for risk and outbreak communication,” *Emerging Health Threats Journal,* vol. 4, pp.1–4, 2011.

[12] A. Chong, “A risky business: Professional and public scientific communication after the L’Aquila Verdicts,” in *Proceedings of the Professional Communication Conference* (IPCC), 2013.

[13] C. E. Althaus, ”A disciplinary perspective on the epistemological status of risk,” *Risk Analysis*, vol. 25, no. 3, pp. 567–588, 2005.

[14] U. Beck, “Critical theory of World Risk Society: A cosmopolitan vision,” *Constellations,* vol. 16, no 1, pp.3–22, 2009.

[15] A. Rothkegel, “Sicherheitsmodelle und Kommunikationsrisiko,” in *Sicherheitsforschung – Chancen und Perspektiven,* P. Winzer et al., Ed. Berlin: acatech/Springer 207-220. acatech/Springer, 2010, pp.207–220.

[16] U. Beck, *Risk Society: Towards a New Modernity*. New Delhi: Sage, 1992.

[17] J. Handmer and P. James, “Trust us and be scared: The changing nature of contemporary risk,” *Global Society*, vol. 21, no. 1, pp.119–130, 2007.

[18] R. J. Bord and R.E. O’Connor, “Risk communication, knowledge, and attitudes: Explaining reactions to a technology perceived as risky,” *Risk Analysis*, vol. 10, no. 4, pp.499–506, 1990.

[19] P. Slovic and E. Peters, “Risk perception and affect current directions,” *Psychological Science*, vol. 15, no. 6, pp.322–325, 2006.

[20] B. Sandig, “Formen des Bewertens,” in *Anabasis. Festschrift für Krystyna Pisarkowa*, I. Bobrowski, Ed. Kraków: Lexis, 2003, pp.279–287.

[21] M. Ripfel, “Was heißt bewerten?“ *Deutsche Sprache*, vol. 15, pp.151–177, 1987.

[22] H. Schütz and P.M.Wiedemann, “Risikowahrnehmung
in der Gesellschaft,” *Gesundheitsschutz,* vol. 7, pp.549– 554, 2003.

[23] B. Fischoff et al., “How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits,” *Policy Sciences*, vol. 9, pp.127-152, 1978.

[24] H. Jungermann and P. Slovic, “Die Psychologie der Kognition und Evaluation von Risiko,” in *Risiko und Gesellschaft*, G. Bechmann, Ed. Opladen: Westdeutscher Verlag, Opladen, 1993, pp.167–207.

[25] A. Klinke and O. Renn, “A new approach to risk evaluation and management: Risk-based, precaution-based and discourse-based management,” *Risk Analysis,* vol. 22, pp.1071–1994, 2002.

[26] J. Nerb et al., “Kognition und Emotion bei der Bewertung von Umweltschadensfällen: Modellierung und Empirie,” *Zeitschrift für Experimentelle Psychologie*, vol. 45, pp.251–269, 1998.

[27] P. M. Sandman, “Risk communication: Facing public outrage,” *EPA Journal*, vol. 13, pp.21–22, 1987.

[28] C. Hamilton et al., “The meanings of ‘risk’: A view from corpus linguistics,“ *Discourse & Society,* vol. 18, no. 2, pp.163–181, 2007.

[29] A. A. Anderson et al., “The ‘Nasty Effect:’ Online incivility and risk perceptions of emerging technologies,” *Journal of Computer-Mediated Communication*, vol. 19, pp. 373–387, 2014.

[30] E. Reimer et al., “ Tiefe Geothermie in den sozialen Medien - Zwischenergebnisse aus dem Forschungs-Vorhaben TIGER,” in *Proceedings of the Geothermie Kongress 2014 (DGK),* 2014.

[31] B. Trevisan et al., “A multi-level annotation model for fine-grained opinion detection in blog comments,” in *Proceedings of KONVENS 2012*, 2012.

[32] B. Trevisan et al., “Indicators of argument-conclusion relationships: An approach for argumentation mining in German discourses,” in *Proceedings of the First Workshop on Argumentation Mining (ACL),* 2014, pp. 104–105.

[33] B. Trevisan and E.-M. Jakobs, “Talking about mobile communication systems: Verbal comments in the Web as a source for acceptance research in large-scale technologies,” in *Proceedings of the IEEE International Professional Communication Conference (IPCC),* pp. 93–100.

[34] M. Neunerdt et al., “Part-of-speech tagging for social media texts,” in *Language Processing and Knowledge in the Web,* I. Gurevych et al., Ed. Heidelberg: Springer, 2013, pp. 139–150.

[35] A. Vengosh et al., “A critical review of the risks to water resources from unconventional shale gas development and hydraulic rracturing in the United States,” *Environmental Science & Technology*, vol. 48, no. 15, pp.8334 – 8345, 2014.

[36] P. X. W. Zou et al., “Understanding the key risks in construction projects in China,” *International Journal of Project Management,* vol. 25, pp.601–614, 2007.

[37] B. Trevisan, *Bewerten in Blogkommentaren. Mehrebenenannotation sprachlichen Bewertens*, Aachen: RWTH Aachen University, 2014

[38] J. Allan, *Topic Detection and Tracking. Event-based Information Organization*, *The Information Retrieval Series*. Norwell, MA: Kluwer Academic Publishers, 2002

[39] B. Trevisan et al., "Communication of new energy forms: Ways to identify topics and stakeholders," in *Proceedings of the IEEE International Professional Communication Conference (ProComm),* 2015.