Research Policy 40 (2011) 487–499

Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

# Academic discipline and risk perception of technologies: An empirical study

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ARTICLE INFO

*Article history:*
Received 26 June 2009
Received in revised form 10 March 2010
Accepted 13 December 2010
Available online 26 January 2011

*Keywords:*
Technologies
Risk perception
Career choice
Academic disciplines
Self-selection
Socialization

ABSTRACT

This article brings together two areas of research: studies on risk perception of technologies and studies on vocational/career choice. This is an important link since decisions concerning technologies are influenced by decision makers' risk perceptions and these in turn may be related to educational and career paths.

We analyze students of different academic disciplines with regard to their risk perception of four technologies. The aim is to find out whether there is a relationship between area of study (as a precursor of vocational and career choice) and risk perception of technologies regarding health, environment and society. The four technologies under study are renewable energies, genetic engineering, nanotechnology and information and communication technologies (ICT). Key results are: irrespective of academic discipline risk of genetic engineering on average is rated highest and renewable energies lowest. This holds for all the risks studied (environmental, health, societal risks). On average, students from different academic disciplines differ in their risk perception. Factor analyses show that common dimensions of risk are the technologies and not the kind of risk. Regression analyses show that the variables influencing perceived risks vary between the technological fields.



## 1. Introduction

Research on risk perception has become increasingly important for technology management since risk perception affects decision making of people involved in activities related to the research, development, introduction, regulation and use of technologies. Decisions regarding technologies affect various stakeholders (researchers, a company's managers of different functions, customers, 'the public') whose risk perceptions may differ to a great extent and are subject to many influences. While the psychometric paradigm has produced cognitive maps of hazards on an aggregate level, it is the individual predisposition towards various risks that influences behavior. Perceptions, based on a frame of reference and on (incomplete) information, will be influenced by e.g. additional information[1] (Chatterjee and Eliashberg, 1990; Roberts and Urban, 1988), affect-laden imagery (Peters and Slovic, 1996) and socialization processes (Chatard and Selimbegovic, 2007). Culture moulds individuals' beliefs about risk (Kahan, 2009). Furthermore, the relationship between knowledge and risk perception has to be taken into account. If people are overconfident, i.e., they think they are more knowledgeable than they actually are,[2] that overconfidence may lead to an overly optimistic or pessimistic view on a technology. For example, being familiar with renewable energies on account of reports in the media that it is a desirable approach to energy generation may lead to people thinking that they know a fair amount about the technologies involved and attributing low risk to the respective technologies. Similarly, being aware of the controversial discussions around genetic engineering may lead to attributing high risk to the technology.

In the future, many of today's students will be involved in activities and decisions concerning new technologies. Especially top management positions, engineering and high positions in regulatory institutions are associated with university degrees. Hence knowledge about technologies, risk perception and risk attitude of the students will affect innovation processes and thus technology developments. Since in the long run the technological development also affects growth and welfare of entire economies, risk perception of today's students might well be interpreted as one key factor in shaping future technology development.

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[1] The expectation that knowledge (relevant information) plays a key role in risk perception has led to numerous studies with mixed results (Schütz et al., 2000) and to initiatives such as the Public Understanding of Science campaign launched by the British government.

[2] Alba and Hutchinson (2000, p. 123) analyze that proposition with respect to consumers: "Are consumers overconfident?"

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doi:10.1016/j.respol.2010.12.003

Earlier studies have shown that students in various academic disciplines differ regarding motives, career expectations and cognitive abilities (Windolf, 1995), socio-political attitudes (Haley and Sidanius, 2005) or (political) worldviews (Kemmelmeier et al., 2005). We propose that those expectations and worldviews may relate to risk perceptions and thus, students choosing different topics at a university will differ with regard to their perceptions and attitudes of technologies (self-selection) and that within an area of study, risk perception will be different between beginners and advanced students (socialization).

This article addresses antecedents of potential actors' and stakeholders' behavior by analyzing the effects of *self-selection* into an academic discipline and subsequent *socialization* on the perceived risks of four important new technologies: renewable energies, genetic engineering, nanotechnologies, and ICT. These technologies are part of the so-called high technologies sector. They are key change drivers and possible convergence of them is expected to "bring about tremendous improvements in transformative tools, generate new products and services, enable opportunities to meet and enhance human potential and social achievements, and in time reshape societal relationships" (Roco, 2007, see also Lipsey et al., 1998). For each technology we distinguish between risks in three areas: health, environment, and society.

The analysis focuses on student groups in Germany. They all have acquired a certain educational degree (usually 'Abitur' or 'Fachabitur', a prerequisite to enrol at university or polytechnic) that makes them a more homogeneous group regarding knowledge compared to the general public, thereby providing the opportunity to look for other influencing factors on risk perception. The analysis differentiates between students in several academic disciplines (i.e. with different majors), namely Cultural Sciences, Business Administration and Economics, Social Work, Environmental Sciences, Teaching, and Technical Studies (engineering), on the one hand, as well as between first term students (beginners) and advanced students, on the other hand.

The remainder of the paper is as follows. Section 2 summarizes key findings in the area of risk perception and Section 3 describes vocational or career choice and the associated processes of self-selection and socialization as potentially important factors in the explanation of attitudes and behaviours. Section 4 gives a short description of the four technologies investigated here. Section 5 presents the empirical study and Section 6 provides a discussion of results. Section 7 draws conclusions.

## 2. Risk perception

There is no perfect knowledge about the development and use of technologies. Owing to high complexity, there is a lack of information at any point of time. Different people have different bits of knowledge, leading to asymmetry of information. If one were to collect all the information, things would be already in the process of changing which involves uncertainty. Thus, information asymmetry (varying information about the status quo) and uncertainty (lack of information about the future) lead to risk being an ubiquitous phenomenon. Technologies create environments and new risks, and the resulting complexity and uncertainty make technological developments less and less predictable and manageable. Of major importance for future technology development is therefore the stakeholders' risk perception which is influenced by various factors and which evolves over time.

'Experts' often assess risk as the expected value of the negative outcomes (the harms) of a decision. This process involves judgement (Fischhoff et al., 1978), and thus the results will vary between individuals, across contexts, and over time. Information is incomplete and developments are uncertain, hence predictions are based on assumptions. Experts might differ on account of different (scientific) judgement, different reference systems, or their dissent might involve politics. Even if there was a consensus amongst experts: the technical concept of risk is of limited use for policy making (Kasperson et al., 1988), rather, the perception of risk is influenced by other factors next to probabilities and magnitudes of risks. To outline the research context, we briefly review the psychometric paradigm, cultural theory and cultural cognition, and individual factors such as an individual's knowledge or socio-demographic variables.

The *psychometric paradigm* posits that, "risk is subjectively defined by individuals who may be influenced by a wide array of psychological, social, institutional and cultural factors" (Slovic, 2000, p. xxiii). Analyses of hazards with different characteristics (*inter-hazard variation*) produce a cognitive map with a limited number of risk dimensions such as voluntariness of taking a risk, controllability and familiarity with risk (Slovic, 1987; Renn, 1990). Risk perception of hazardous technologies involve dread as a key psychological factor (Peters and Slovic, 1996) in 'risk as feelings' (Loewenstein et al., 2001). The social amplification or attenuation of a particular risk (Kasperson et al., 1988) may change public perceptions of that risk.[3]

While the psychometric paradigm differentiates between different *types of risks* (and provides no information on individual or group behavior), cultural theory and its variants differentiate between *types of groups*. With *cultural theory*, Douglas and Wildavsky (1982) put forward the idea that worldviews (positions in the so-called group-grid) describe sets of attitudes that reflect ways of life and that are relevant in risk perception. Thus, there are groups of people with different worldviews (or cultural biases) holding or developing predictable risk perceptions, i.e. there is *inter-group variation*. People attend selectively to risks in a way that reflects their way of life: an individual with a certain worldview will pay attention to one type of risk but dismiss another.[4] A key question is how to assess cultural worldviews. Dake (1991) proposed different scales for cultural biases (hierarchy, individualism, egalitarianism), possibly resulting in individuals scoring high on competing scales. Kahan et al. (2007) use two scales to assign each individual one position within the group-grid, possibly leading to many positions scattered over the group-grid instead of clearly separable groups. Further problems are the failure to categorize respondents that show no cultural bias[5] (Marris et al., 1998) and low scale reliabilities.[6] Measuring cultural worldview and risk perception in one questionnaire using the same rating scale format may lead to inflated correlations.[7]

In *cultural cognition*[8] as one conception of cultural theory, social and psychological mechanisms are expected to shape individuals' beliefs about risk, that is, the conception incorporates aspects of

[3] Amongst the four technologies chosen, genetic engineering in particular is subject to affect-laden imagery and amplification of risk (Frewer et al., 2002).

[4] "Common values lead to common fears (and, by implication, to a common agreement not to fear other things)", Douglas and Wildavsky (1982, p. 8).

[5] "Our results suggest that world views are not innate attributes of individuals and/or that they cannot be measured using a psychometric instrument, since it was impossible to categorize (most) respondents according to their world view" (Marris et al., 1998, p. 646).

[6] As reported e.g. in Peters and Slovic (1996, p. 1434).

[7] Sjöberg (2004, p. 49) suggested such a methodological problem regarding the assessed relationship between risk perception and trust: "In those cases, perceived risk and trust were both measured by attitude scales that were formally similar and had the same response scale".

[8] "Cultural cognition refers to the tendency of individuals to conform their beliefs about disputed matters of fact (e.g., whether global warming is a serious threat; whether the death penalty deters murder; whether gun control makes society more safe or less) to values that define their cultural identities." http://culturalcognition.net/ (accessed 15.06.09).