Risk

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Generally, "risk" is defined as a possibility of an event with potentially negative consequences to occur. However, it is difficult for individuals to discriminate, objectively, risky events from safe situations, because of the intricacy in the measure of what is *possible*. As a consequence, it is more correct to talk about subjective risk. Subjective risk perception has been broadly studied, and different approaches of its investigation captured specific facets of it. For example, two prominent theoretical frameworks focus one on the investigation of the cognitive and emotional characteristics of risk (i.e. psychological approach), the other on the socio-cultural aspects (i.e. Cultural Theory). The research on risk perception is important because it has a significant impact both on society and individuals. In fact, it influences the level of societal acceptance of different kind of dangers and the risky or safety behaviors of people when exposed to hazards.
This chapter will discuss the several layers that characterize the definition of risk; it will examine different approaches to the study of risk. An analysis of important elements of the research methodology on risk perception will follow, and finally, it will highlight the connection between risk and *the possible*.

Keywords: risk, risk perception, subjective risk, possible.

Definition

[T]here is no such thing as "real" risk, or "objective risk".

(Slovic, 1999, pp. 63)

The definition of risk is complex and far from univocal. In fact, different definitions of risk exist both in the scientific world and in the layperson's understanding of the concept. A careful analysis of risk as a concept uncovers different layers regarding its meaning,

created by the different contexts in which it has been studied, and the ways in which it has been characterized, conceptualized, and operationalized over the years.

Laypeople usually associate the word "risk" to the possibility that an unpleasant or unwelcome event can happen. From a scientific perspective, risk is defined by taking into consideration all the elements that compose the idea behind the word "risk", providing a complete explanation of the concept. The Stanford Encyclopedia of Philosophy offers an example of technical definitions widely used across scientific disciplines.

The first element can be conceptualized as risk as a *consequence*; it is described as "an unwanted event which may or may not occur". For example, a fatal car accident is a risk that can occur when driving a car under the effect of alcohol. Another definition frames risk as a *probability*, describing it as "the probability of an unwanted event which may or may not occur". The risk of being involved in a fatal car accident when drinking and driving is 45% exemplify this definition of risk. Those two definitions are part of a bigger categorization of risk, specifically *risk as analysis*, which "brings logic, reason, and scientific deliberation to bear on hazard management", and *risk as feeling*, which "refers to our fast, instinctive, and intuitive reactions to danger" (Slovic, 2004, p.311). These two macro-categories belong to the idea that we perceive reality in at least two different ways (Epstein 1994; Evans, 2008, Kahneman 2003; Stanovich & West 2000). One way is intuitive and fast, more primitive and belief-based. The other is rational, more recent and slower. The perception of risk and its interpretation depend on how information is processed.

Another characterization of risk, referring back to the opening quote, differentiates between objective and subjective risk. Objective risk is described as an actual probability of an unwanted or unpleasant event and this probability is usually quantitatively measurable. For example, statistics regarding immigrants drowning in the sea while crossing the ocean provide an objective measure of risk. The survival of these refugees depends on the type of boat, the winds, how rough the sea is, and the probability of finding a safe place to land, among other factors. Although the probabilities and the specific consequences of these aspects are calculable we, as humans, almost always give a subjective value to them. Indeed, the perception of risk depends on how the risk is framed and how subjectively it is perceived. An example of the subjectivity of "objective risks" is given below. The United Nations High Commissioner for Refugees (https://data2.unhcr.org/en/situations/mediterranean) report that the absolute number of immigrants that died trying to reach Europe by crossing the Mediterranean Sea diminished from 2016 to 2017. This statement could lead to the conclusion that trying to cross the sea became less risky for refugees. However, data show

that the deaths of refugees in the sea per number of people that tried to migrate increased in the same year. This statement, on the other hand, leads to the conclusion that crossing the sea became riskier for refugees. The two statements are both factually true, but they elicit a different perception of the same risk. It is clear, then, that there is no such thing as objective risk (Slovic, 1999) and it is more correct to use the word risk in its subjective connotation. Specifically, the subjective risk concerns personal thoughts, beliefs and values that determine how we perceive risk and how we subjectively judge risky situations.

Subjective judgments of risks occur frequently. Individuals must assess the threats with which they come into contact every day. However, when making these assessments, most people do not have the appropriate knowledge, skills or time to objectively deal with those risks. Instead, they adopt subjective assessments based on information cues that allow people to draw conclusions. The cues refer to the characteristic of the risk itself, exemplified by several dichotomies when judging a risky situation (Slovic & Fischhoff, 1985). For example, the perception of risk varies if people expose themselves *voluntarily* to the risk or if the exposition is instead involuntary, and if the risk is *chronic* or *catastrophic*. Moreover, subjective risk assessments depend on whether i the risk is seen as *common*, such that people are used to it and react calmly in front of it, or *dreadful*, causing people to respond in a visceral and impulsive way. Other factors influencing subject risk assessments include whether the risk is seen as *certainly fatal* or *certainly not fatal*, if it is *known* or *not know* to the exposed, if it is *immediate* or *delayed*, *known to science* or *not known to science*, *controllable* or *uncontrollable* and *new* or *old*. These characteristics make it is possible to create profiles of the perceived risk and compare them on different dimensions.

Different theoretical approaches to the study of risk

The different definitions of risk are accompanied by different schools of thought on risk perception. Two relatively prominent approaches focus on how individuals perceive risk (i.e. the psychological approach) and how risk is influenced by culture (i.e. Cultural Theory). In this chapter, we will predominantly focus on the psychological approach. However, we also briefly describe and discuss the central tenets of the cultural theory of risk.

The main goal of Cultural theory is to illustrate that the study of the perception of risk must necessarily take into consideration the social context. In the frame of this theory, risk perception and risk acceptance are strictly related to cultural adherence and social learning. Thus, people's value system and judgements belong to social groups and do not happen in a social vacuum. In this frame, risk is defined as "a joint product of knowledge of future and

consent about the most desired prospect" (Douglas, & Wildavsky, 1983, p. 5). The framework of Cultural Theory is based on the group-grid theory. It posits two dimensions (grid and group) to create typical social positions to represent most of the cultural diversity (Mamadouh, 1999). The underlying hypothesis is that these two dimensions have a significant impact on people's worldviews. *Group* is defined as "the outside boundary that people have erected between themselves and the outside world" (Douglas, & Wildavsky, 1983, p. 138). This signifies the belongingness of an individual to social groups and his or her degree of involvement in them. *Grid,* instead, refers to "all the other social distinctions and delegations of authority that they use to limit how people behave to one another" (Douglas, & Wildavsky, 1983, p. 138). This indicates how restrictive and regulated a social context is. The two dimensions then generate four types of social environment or worldwide views that represent the four possible filters to a various number of judgments, values and beliefs: Collectivism, egalitarian, individualism and fatalism. The attitudes of people toward risk are filtered by these views and similarly, their social trust in the institutions that regulate risks. Individuals tend to trust people or institutions more when they share the same worldwide view.

The psychological approach to the study of risk, on the other hand, focused more on the cognitive and emotional aspect of risk perception. One of the main ideas behind the psychological approach is the *psychometric paradigm* (Slovic, Fischhoff, & Lichtenstein, 1985). It is explained as a "theoretical framework that assumes 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). The goal of this idea was to use behavioral measures to quantify and model psychological factors in order to provide a better understanding of how people perceive and respond to hazards. The methodology used by Slovic and his collaborators are experiments and surveys created to measure the perception of risks and benefits of several hazards (e.g. natural, technological, behavioral hazards) as well as judgments of the annual fatalities related to specific dangers and the level of acceptability of risks.

Early results show that the concept of risk "meant different things for different people" (Slovic, 2000, p. xxiii) and that laypeople and experts estimate risks differently. The two groups were similar in assessing statistical frequencies of deaths. However, while experts' risk perception corresponded relatively well to the statistics, laypeople's perception differed significantly (Slovic, Fischhoff, & Lichtenstein, 1981).

Moreover, the relationship between the acceptability of a risk and its perceived risk and benefit is influenced by various characteristics such as knowledge of the risk, the dread it causes, and how much control one has. A factor analysis of the dichotomies mentioned above (e.g. familiar vs unfamiliar, chronic vs, catastrophic, controllable vs. uncontrollable) led to a model of risk perception that utilizes a two-factor space (Slovic, 2000*).* One factor represents how new, uncontrollable, unknown, delayed and involuntary risks are perceived to be. The other factor indicates how fatal, dreadful, and catastrophic the risk was perceived to be (Fischhoff et al., 1978). In this space, for example, bicycling was judged to be relatively controllable, known, and at the same time having a low probability of being associated with death. Nuclear power, on the other hand, was perceived as a hazard that is involuntary, uncontrollable, and potentially fatal.

More recent research associated with this approach aimed to show which characteristics of people's traits, beliefs and ideologies influence risk perceptions. Results shows that worldwide visions, gender, ethnicity and trust have an impact on the perception of risk. Specifically, people with an egalitarian preference for power have a higher perceived risk of several hazards than people preferring a hierarchical social order (Slovic, 1999) and white males perceive risks to be smaller than women and non-white people do (Finucane at al., 2000). Lastly, trust in scientific risk assessments and in the government seems to be essential in explaining the relationship between risk communication, risk management and risk perception (Slovic, 1999; Slovic et al. 1991).

Research on risk

The concept of risk is multifaceted, which is mirrored by the scientific research conducted on the topic. In this section, we will present and discuss different methodologies and findings related to research on risk. It is important to note that this research evolved and changed over time. The first attempts of measuring attitudes related to risk were done a century ago in the '1920s (Thurstone, 1928) and subsequently went through methodological. In the initial approaches, risk perception was mainly studied using qualitative methods such as semi-structured interviews with open questions conducted in person or by phone. However, the limitations of these methodologies have turned the research on risk perception towards quantitative measurements (Sjöberg, 2000). These still represent the predominant methods of the psychological approach in the study of risk nowadays.

The elements that characterize the quantitative research on risk perception can be listed as the type of risk (i.e., the hazard), the dimensions of risk and the sample used.

The hazards considered in the research on risk perception are various and diversified. They can be categorized according to the kind of source, which can be personal (i.e., depending on people's own decisions and actions,) societal (i.e., risky choices made by politicians and the society), and environmental (related to natural and uncontrollable events). The type of hazards, instead, that can be behavioral (i.e. related to an individuals' actions) or technological (e.g., industrial and high-tech products) and natural (i.e. biological and physical consequences of changes in nature). Finally, hazards can also be distinguished depending on who bears the consequences of the risk (e.g., whether hazards impact individuals or groups). Examples of the combination of these elements are the risks of unprotected sex or skydiving that both represent a personal, behavioral risk that has consequences mostly on the self. Nuclear power and pollutions are, instead, risks considered societal, technological and with consequences that involve many people (Wilson, Zwickle, & Walpole, 2019). Some of the most common risks studied are large-scale new technologies (such as nuclear power), natural disasters (e.g., floods) and diseases (e.g. AIDS) (Rohrmann, & Renn, 2000).

The dimensions of risk perception examined in research are more difficult to conclusively identify due to a large number of studies on the topic. Firstly, it is important to note that most of the studies to test risk perceptions primarily used surveys and questionnaires. As a consequence, the dimensions of the risk analyzed depend on the type of questions used in the various studies. A recent paper proposes an overview of the most used dimensions in the study of risk perception (Wilson, Zwickle, & Walpole, 2019). The first approach is on general risk perception, and usually measured by items such as "How risky is *X*?" or "Indicate the level of risk *X* presents to *Y*." A second approach includes looking at affective reactions, measuring feelings (e.g. worry) related to risk perception. Examples of the items used in this approach are "How concerned are you (if at all) about X? "or "When you think about X for a moment, to what extent do you feel fearful? ".

Two other dimensions are *probability* and *consequences*. Perceptions of probability are measured using words such as chances, likelihood, and probability of realizing a risk. For measuring consequences, people are typically asked about the severity or seriousness of an event. Two examples of items are "How likely is it that *X* (e.g. an earthquake) will occur this year where you live?" for the probability and "If I did experience *X* (e.g. an earthquake), it is likely that it would negatively impact me" for the examination of the consequence. The last dimension comprises evaluations of *risks and benefits,* that implies a trade-off in which participants weigh the risks and the benefit of something and then judge which one is more important. In order to measure this characteristic of risk, scales like the Domain Specific Risk

Taking Scale (DOSPERT; Blais & Weber, 2006) can be used. In the majority of the cases, research investigates more than one dimension in order to address the multidimensionality of risk perception. Moreover, the complete way of testing risk perception includes using separate items for *affect*, *consequence* and *probability* (Wilson, Zwickle, & Walpole, 2019).

The last element that characterizes the studies on risk perception is the sample. The type of respondents used in a large number of studies seem to come from ad-hoc samples, especially university students. However, research on risk used also cross-cultural samples to test hypothesis related to the cultural differences in risk perception. Other research used instead samples of experts compared to sample of laypeople in order to understand how the expertise impact the risk assessments. It is possible to use as participants different group people but is important to note that the characteristics of the sample are important to answer different research questions and to properly generalize the findings of experiments.

In conclusion, it is possible to delineate a progression in the methodology and to have an overview of the various elements that compose the more recent approaches of the study on risk.

3. Risk and the possible

By now it should be transparent that risk is a complex concept that can be approached from several viewpoints and studied using different methodologies. However, it is important to clarify the key to its complexity. The definition of risk itself contains a concept that links to the notion of *the possible*. For example, risk is also defined as "the possibility of an unwanted event which may or may not occur". *The possible*, understood in the context of the word risk, refers to the uncertainty associated with two of its elements, namely the *probability* and the *consequences*. A risky event is an occasion that has a specific *probability* of happening; for example, an earthquake can have a 5% probability of occurring in a specific region. Moreover, its *consequences* are themselves possible. For example, an earthquake can cause the destruction of houses in 30% of the cases, the death of people in 10% of the cases, and damage to industries in the affected area in 2% of the cases. Thus, the occurrence of an unwanted event has a specific probability, and the consequences themselves are also probabilistic. It is evident, then, that dealing with the assessment of risk means dealing with *the possible* expressed as probabilities or likelihoods. However, a substantial body of research has shown that individuals, when they make choices or estimate the possible occurrence of events, are often suboptimal in dealing with probabilities. The possibility of an

event or its consequence are calculations that require an in-depth knowledge of a specific risk domain, which is not always present. Additionally, calculations of probabilities, like many other reasoning strategies, are constrained by cognitive limitations. It is virtually impossible to process all possibilities and their corresponding consequences. For this reason, when dealing with uncertainty, people usually rely on heuristics, instinctive assumptions, beliefs and feelings. While this saves cognitive resources, it can also lead to systematic errors that can have severe consequences. Many studies have analyzed specifically how these shortcuts affect risk perception and estimations of the probabilities related to risks.

One of the most common mistakes in the estimation of the probability of occurrence of a risky event is due to the *availability bias* (Tversky, & Kahneman, 1973). This bias refers to a decision making and judgment strategy that can lead to errors because people tend to judge the frequency of an event depending on how easily that specific event comes to their mind. However, it can lead to overestimating the frequency of events that were personally experienced more often or that are more covered by the media. For example, individuals tend to judge as more probable a death due to a terrorist attack then a death due to climate change (Sunstein, 2007). However, official reports show that for example, in 2012, the deaths per year due to climate changes were 400,000 (Climate Vulnerability Monitor), compared to the 12,000 deaths due to terroristic attack (the estimation is 2,000 dead people without considering the deaths in Syria, Iraq, Nigeria Afghanistan and Pakistan; Global Terrorism Index). Two other cognitive mistakes are the *optimism bias* (Weinstein & Klein, 1996) and the *illusion of control* (Langer, 1975). It was shown that people tend to be more of an optimist about themselves and believe to be less at risk than other people for several adverse events such as getting divorced, cancer or becoming addicted to drugs (Weinstein, 1980). Research also demonstrated that people tend to evaluate risks that are considered under personal control and over-evaluate the risk of events which are not controllable personally. For example, individuals generally judge taking a plane as riskier than driving a car, possibly due to an overestimation of control when driving (Langer, 1975).

Furthermore, an essential role in risk perception and misinterpretation of risks is, also, due to their strong connection with emotional reactions. The *affect heuristic* illustrates that individuals evaluate risks and benefits based on feelings (Finucane et al., 2000). Positive feelings usually lead to a lower perceived risk and higher perceived benefit, while negative feelings have the opposite effect. In people's minds, risks and benefits are often negatively related (i.e., a high risk is perceived to have low benefit, and vice versa). However, in real life risks and benefits can also be positively correlated (i.e. activities with high risk can also result

in high benefits). For example, nuclear power is a technology that involves high risks such as nuclear incidents, but it also has high benefits such as being a potent source of energy. Studies show that people tend to perceive high risks related to nuclear power, but as a consequence, they also tend to judge the technology as not very beneficial.

Evidently, it is difficult for people to correctly estimate both the probability of an event and the possibilities related to its consequences. It is precisely this element of possibility, characterized in the definition of risk, that gives it complexity and demonstrates how difficult it is to speak about objective risk. Finally, it shows the importance of considering and understanding the intrinsic subjective nature of risk assessment, risk management, and risk communication.

Conclusion

Risk is in people's everyday life, and a proper understanding of the mechanisms underlying risk perception is important on various levels. Research on risk can influence a societal and individual acceptance of several hazards and can have an impact on behaviors toward risky situations. However, despite the great interest in the topic, studying risk must take into consideration the complexity of the concept. For this reason, have been created, over years, several approaches on the investigation of risk perception and that captured different parts of its vast facets. Some, such as Cultural Theory, emphasize more the social and cultural influences and others, as the psychological approach, addressed the psychological, cognitive and emotional aspects of risk. The methodological approach to the study of risk evolved too during the relatively long time. It is thanks to this evolution and refinement at a methodological level that risk research has succeeded in explaining more and more aspects of this interesting and vast concept. One of the more fascinating conclusions regards the connection between the risk and its intrinsic relationship with the *possible*. The research highlighted the humans' difficulty in the elaboration of the potentiality of the risky events' occurrence and their negative consequences, theorized in various cognitive biases. However, these findings allow laypeople and professionals that need to asses or manage risks to take into consideration all those individuals' distortions in the perception of objective risks. In conclusion, a better understanding of risk perception and its several facets leads to the safest decisions and behaviours at the individual and societal level.

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