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Differentiated effects of risk perception dimensions on nuclear power acceptance in South Korea

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ABSTRACT

Perceptions of risk from nuclear power generation have received considerable attention as a significant determinant of public acceptance of nuclear power—a requirement to draw social and political support for nuclear power generation. However, the distinction between the dimensions of risk perception and the differentiated effects of such dimensions has been less explored. The present study demonstrates that two distinct dimensions of risk perception from nuclear plants—perceived intrinsic risk and extrinsic risk—reveal contrasting patterns of influence on the acceptance of nuclear power. Our results, using a sample from South Korea, show that the relative effect of perceived extrinsic risk from nuclear plants on the acceptance of nuclear power (compared to that of intrinsic risk) is stronger at higher levels of such acceptance than at lower levels. This finding provides implications for public policy to encourage the acceptance of nuclear power. Such policy should selectively choose between the two approaches—reducing the public's perceived level of intrinsic risk and that of extrinsic risk—depending on whether the policy's aims is to soften opposing voices or to promote positive voices for nuclear power.

1. Introduction

Nuclear power is an electric power generation source of which the development requires social and political sanctioning, given that the double-edged nature of nuclear power—carrying great risk while offering great benefits (Rogner, 2013)—causes sharp conflicts with regard to nuclear power policies among stakeholders. Thus, the public acceptance of nuclear power exerts a significant influence on the nuclear and energy policy of the country (Glaser, 2012; Visschers et al., 2011).

As a determinant of this acceptance, perceptions of the risks stemming from nuclear power generation have received considerable attention; the extant literature shows that such perceptions by the public negatively influence their acceptance of nuclear power. Thus, reducing the risks of nuclear power generation perceived by people has been one of the main foci of public communications with regard to the development and deployment of nuclear power policies (Sjöberg, 2009; Stoutenborough et al., 2013).

Regarding such risks, the following research opportunity arises. Although the risk consequences regarding nuclear plants vary, we posit that one method by which to classify such risk consequences is to categorize the risks into two types: (a) risks that arise from the normal operation of a nuclear plant and (b) those that are caused by abnormal incidents or catastrophes, such as natural disasters or military attacks. We term the former and the latter intrinsic risk and extrinsic risk, respectively. Given that these two types of risk conceptually differ, it may be that the public perceives and reacts to them differently. However, investigations of this possibility are difficult to find in the existing literature, which currently places potentially distinct types of negative consequences from nuclear power generation into a single dimension of risk.

Using a sample from South Korea, one of the leading countries in the area of nuclear power generation (Choi et al., 2009), the present study fills this research gap. In particular, our results demonstrate that a decrease in perceived intrinsic risk from nuclear plants contributes only to preventing individuals from the strongly negative acceptance of nuclear power. In contrast, a decrease in perceived extrinsic risk is found to contribute to turning moderately negative acceptance into moderately positive acceptance and even promoting moderately positive acceptance to strongly positive acceptance. These findings imply that public policy to encourage nuclear power acceptance must vary the foci according to the goal (i.e., whether to soften strongly opposing voices or to promote strongly positive agreement).

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2. Theoretical and practical background

2.1 Risk perception measures in the extant empirical literature on nuclear power acceptance

The risk perception approach toward nuclear power acceptance refers to a model in which indicators of people's perceived risk from nuclear technology or facilities (e.g., nuclear power generation, nuclear plants, nuclear waste management, or nuclear waste repositories) are important predictors of their acceptance of such technology or facilities (Chung et al., 2008; Kunreuther et al., 1990; Sjöberg and Drottz-Sjöberg, 2001). The measures for risk perception used in this approach can largely be categorized in two groups: (1) measures that have adopted the psychometric paradigm of risk perception, and (2) nuclear-specialized measures for risk perception.

First, a group of researchers applied the risk attributes established in the psychometric paradigm of risk perception (Fischhoff et al., 1978; Slovic et al., 1980) to the measurement of perceived risk from nuclear technology or facilities. The psychometric paradigm is a universal theory about risk perception itself, rather than one focusing on risk perception from nuclear technology or facilities. This paradigm assumes several attributes/characteristics underlying the composition of risk perception (e.g., dread, control, familiarity, numbers affected, catastrophic potential, etc.), and early studies such as Fischhoff et al. (1978) used 18 attributes. The psychometric paradigm began as the representation and comparison of people's risk perceptions of multiple targets. In a typical psychometric study of risk, respondents rate a set of multiple risky targets (e.g., hazards) on a number of risk attributes. Then using psychometric scaling and multivariate analysis techniques, the researcher draws quantitative representations of the respondents' risk perceptions of the targets in the form of a ‘cognitive map’ (Slovic et al., 1986). Because these risk attributes had been found to be useful in the understanding of underlying mechanisms of risk perception (Sjöberg, 2000), researchers came to apply such attributes to the measurement of people's risk perception from nuclear-related technology or facilities in the risk perception approach toward nuclear power acceptance. Table 1A shows that measurement items or dimensions from the psychometric paradigm have a substantial level of consistency across studies. For example, the risk characteristics of newness and dread have been commonly used as items or dimensions for risk perception. Other items or dimensions than these two are also based on the comprehensive sets of risk characteristics developed by Fischhoff et al. (1978) and refined in other studies.

Second, the other category of indicators of risk perception is more specialized to the contexts/cases of nuclear technology or facilities. As aforementioned, the risk attributes and their associated factors (i.e., grouped sets of these attributes) from the psychometric paradigm are universal to various kinds of risky targets. In contrast, several studies on public acceptance of nuclear power have invented their own measures for risk perception from nuclear technology or facilities, as summarized in Table 1B. These nuclear-specialized measures have an advantage from a practical viewpoint: they can be customized to measure people's risk perceptions from specific risk sources (i.e., components or stages) accompanying nuclear technology or facilities (e.g., see the measures from Flynn et al. (1992) and Greenberg and Truelove (2011) in Table 1B). Analyses of the responses to these measures can provide understanding about the perception of which risk sources need to be improved. However, in spite of this advantage, the nuclear-specialized measures currently have room for improvement: they vary greatly across studies, unlike the measures from the psychometric paradigm. Moreover, there lacks a set of dimensions (factors) into which nuclear-specialized items for risk perception could be categorized in a more structural manner.

2.2 Subdividing risk perceptions from nuclear plants

As seen in Table 1B, nuclear-specialized measures provide descriptions of various sources of risks that might occur during the operation of nuclear technology or facilities. For example, the risk index items from Flynn et al. (1992) and the risk belief items from Greenberg and Truelove (2011) include risks that arises from abnormal events coming from outside the nuclear technology or facility (i.e., earthquake, volcanic activity, sabotage, or terrorist attack). In contrast, some items measure the respondents' perception of whether a given nuclear-related technology or facility is naturally (or chronically) safe or risky (e.g., “the buried waste will be contained in the repository so that contamination of underground water supplies cannot occur” from Flynn et al. (1992); “uranium mining degrades animals, plants, land, and water” from Greenberg and Truelove (2011)). Noticing that risks from nuclear plants also can be distinguished in a similar manner, we posit that the perceptions of risk from nuclear plants can be largely categorized according to the sources of risks, as in the following paragraphs.

First, we define intrinsic risk from a nuclear plant as the risk of negative, harmful consequences that arise chronically from the normal operation of a nuclear plant. For example, the operation of a nuclear plant can cause (or can be perceived by the public to cause) increases in morbidity or radioactive contamination of the surrounding areas, even when the plant is operating normally. We define perceived intrinsic risk as an individual's perception of the degree to which nuclear plants are prone to this intrinsic risk.

Second, we define extrinsic risk as the risk of negative consequences stemming from abnormal external catastrophes such as natural disasters or military attacks. For example, along with operational accidents, natural factors such as earthquakes and tsunamis and artificial factors such as war and terrorist events could cause major leakages of radiation or radioactive pollutants from a nuclear plant. We define perceived extrinsic risk as an individual's perception of how vulnerable nuclear plants are to this extrinsic risk.

2.3 Relative effects of the perceptions of intrinsic and extrinsic nuclear risks on nuclear power acceptance

Given that these two types of risk—intrinsic risk and extrinsic risk—conceptually differ, there is a possibility that the public perceives and reacts to them differently, as follows. In a nuclear plant context, intrinsic risk refers to the risk that such plants chronically cause negative, harmful consequences (e.g., morbidity or radioactive contamination) even if they are operating normally. In this respect, high levels of intrinsic risk are a condition that leads to guaranteed failure regarding the safety of nuclear plants. However, a low level or absence of such a risk does not guarantee safety. This is because intrinsic risk is not the only type of risk for nuclear plants; its absence does not necessarily connote overall safety if another risk type (i.e., extrinsic risk) exists or is high. In these lights, low levels of intrinsic risk from nuclear plants correspond to a must-be factor (Kano, 1984; Matzler and Hinterhuber, 1998): when not fulfilled (i.e., high levels), they result in guaranteed failure (i.e., very dangerous), but even when fulfilled (i.e., low levels), they only result in ambiguous success/failure (i.e., either dangerous or safe).

Unlike intrinsic risk, high levels of extrinsic risk do not necessarily lead to guaranteed failure regarding the safety of nuclear plants. Even if extrinsic risk is high (i.e., nuclear plants are highly vulnerable to external disasters, such as earthquakes or military attacks), nuclear catastrophes, such as major leakages of radiation or radioactive pollutants, will not be actualized unless those external disasters actually occur. In this respect, low levels of extrinsic risk are not a must-be factor for nuclear safety: their un-fulfillment (i.e., high levels) does not