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Differentiated influences of risk perceptions on nuclear power acceptance according to acceptance targets: Evidence from Korea

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ABSTRACT

The determinants of the public's nuclear power acceptance have received considerable attention as decisive factors regarding nuclear power policy. However, the contingency of the relative importance of different determinants has been less explored. Building on the literature of psychological distance between the individual and the object, the present study demonstrates that the relative effects of different types of perceived risks regarding nuclear power generation differ across acceptance targets. Using a sample of Korea, our results show that, regarding national acceptance of nuclear power generation, perceived risk from nuclear power plants exerts a stronger negative effect than that from radioactive waste management; however, the latter exerts a stronger negative effect than the former on local acceptance of a nuclear power plant. This finding provides implications for efficient public communication strategy to raise nuclear power acceptance.

1. Introduction

Nuclear power is an electric power production source that carries great risks while offering great benefits. It reduces dependency on fossil fuel, which is costly not only economically but also environmentally [1]; however, it is accompanied by potential risks of nuclear catastrophes such as those at Three Mile Island in the United States in 1979, Chernobyl in Ukraine in 1986, and Fukushima in Japan in 2011 [2]. Because of this double-sided nature of nuclear power, typically there are sharp conflicts over nuclear power policy among the stakeholders in a given country. Thus, the public's acceptance of nuclear power exerts a significant influence on a country's nuclear power policy [3,4].

Extant studies have accumulated a substantial amount of knowledge on the determinants of this acceptance. For example, individuals' psychological factors such as risk perception, trust, and knowledge [5–8] are found to be important determining factors of their nuclear power acceptance. These findings are of significance practically as well as theoretically. In particular, they provide guidelines regarding the types of public perceptions that communication should be focused on to enhance the public's nuclear power acceptance.

However, in order to leverage the efficiency of communication efforts, the following question, which has been relatively unexplored, should be answered: how do the relative effects of different types of perceived risks regarding nuclear power generation differ across acceptance targets? In terms of acceptance targets, an individual's nuclear power acceptance can be broadly grouped into two categories: the acceptance of nuclear power in the country (national acceptance) and that in the individual's own residential area (local acceptance) [9]. If the relative effects of different types of perceived risks on nuclear power acceptance differ across these two types of acceptance, the focus of a public communication strategy to raise nuclear power acceptance will need to be varied according to the goal.

Building on the literature of the effects of psychological distance between the perceiver (i.e., individual) and the object [10,11], the present study investigates the relative effects of different types of perceived risks regarding nuclear power generation, being contingent on acceptance targets. Using a sample of Korea, one of the leading countries in terms of nuclear power generation, our results demonstrate that, with respect to national acceptance of nuclear power generation, perceived risk from nuclear power plants exerts a stronger negative effect than that from radioactive waste management; however, the latter exerts a stronger negative effect than the former on local acceptance of a nuclear power plant.

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2. Theory and Methods

2.1. Theory and hypotheses development

2.1.1. Effects of risk perceptions on national acceptance of nuclear power generation

In elaborating on what acceptance refers to, the targets of an individual's nuclear power acceptance can be largely grouped into two categories: nuclear power generation at the national level and the establishment of a nuclear power plant in the individual's residential area. An individual perceives a group that he/she does not belong to (vs. does belongs to) as more distant (vs. proximal) [12]. To an individual, the country is an in-group at a broader level; however, it also includes not only his/her affiliated local community (i.e., in-group at local level) but also nonaffiliated local communities (i.e., out-groups at local level). Thus, to an individual, whether to accept nuclear power in the country is an issue that is psychologically more distant, whereas nuclear power in his/her residential area is psychologically more proximal.

Literature on psychological distance states that when an object is distant from an individual, the individual focuses more on the primary aspect of the object than on the secondary aspect in the perception and evaluation of that object [10,11]. Among risks accompanying nuclear power generation, those that occur directly during the operation of a nuclear power plant, rather than those from (postuse) radioactive waste management [13], have been the major source of nuclear catastrophes (e.g., the well-known disasters of Three Mile Island, Chernobyl, and Fukushima) [2]. In this sense, we can assume that, among risks from nuclear power, the public will generally regard the risk from nuclear power plants as a relatively primary factor compared with the risk from radioactive waste management. Thus, when the individual evaluates the acceptability of nuclear power generation at the national level (i.e., high psychological distance), perceived risk from nuclear power plants (i.e., a primary risk factor) will have a stronger influence than that from radioactive waste management (a secondary risk factor).

Hypothesis 1. For national acceptance of nuclear power generation, perceived risk from nuclear power plants will exert a stronger negative effect than that from radioactive waste management.

2.1.2. Relative effects of risk factors contingent on acceptance target

Compared with the case of whether to accept nuclear power generation at the national level, the issue of whether to accept it in the respondent's area is psychologically more proximal to the individual. Regarding perception or evaluation of a target that is more proximal, the literature states that the individual focuses relatively more on the secondary aspect of the target than on the primary aspect [10,11], compared to when the target is more distant. Thus, when the individual evaluates the acceptability of a nuclear power plant in his/her own residential area (i.e., low psychological distance), compared with when evaluating the acceptability of nuclear power generation at the national level (i.e., high psychological distance), the relative influence of perceived risk from radioactive waste management (i.e., the secondary aspect) compared with perceived risk from nuclear power plants (i.e., the primary aspect) will be greater. Thus, we arrive at our next hypothesis.

Hypothesis 2. For local acceptance of a nuclear power plant, compared with national acceptance of nuclear power generation, perceived risk from radioactive waste management will exert a stronger negative effect than that from nuclear power plants.

2.2. Methodology

2.2.1. Sample and data collection

We excerpted the data from a secondary survey dataset built by the Korea Nuclear Energy Agency (KNEA)—a Korean government-affiliated organization. The survey, targeting the population of adult residents aged 19 and older in South Korea, was conducted in 2015. The survey used a quota sampling method—selecting subjects or units from each segment based on a specified proportion of demographic and geographic subpopulations so that the sample could represent the population well. Out of the original sample of 1,009 respondents, we used 894, excepting those who gave a "don't know/would not answer" response regarding any of our study variables. Table 1 summarizes the characteristics of the sample.

2.2.2. Measures

Independent variables: Perceived risk from nuclear power plants was measured using a four-point scale: "Do you think nuclear power plants in our country are safe or not?" (1 = very safe and 4 = not safe at all). Perceived risk from radioactive waste management was also assessed: "Do you think radioactive waste in our country is managed safely or not?" (1 = very safely and 4 = not safely at all).

Dependent variables: National acceptance of nuclear power generation was measured by asking the respondents the following question: "Considering the situation of our country, do you think nuclear power generation is necessary or not?" Respondents answered using a four-point scale (1 = very necessary and 4 = not necessary at all) and the responses were reverse-coded. Local acceptance of a nuclear power plant was assessed by asking, "If a nuclear power plant is to be built in your residential area, will you agree with or oppose it?" Respondents answered using a four-point scale (1 = strongly agree and 4 = strongly oppose) and the responses were also reverse-coded. Table 2 provides correlations and descriptive statistics of the independent and dependent variables.

Control variables: Gender, age, educational level, and household income level were measured as general socio-demographic control variables. As control variables that might be particularly related to the respondent's perception of power generation, the following were measured: monthly household electricity consumption and residential area (i.e., we classified the areas *a posteriori* according to whether the area had a nuclear power plant or not).

2.2.3. Common method bias

Our focus is the contingency of difference between two risk–acceptance relationships (i.e., perceived risk from nuclear power plants and that from radioactive waste management are related to nuclear power acceptance to different degrees) on the acceptance target, not the relationships themselves. Although common method variance [14] might positively bias the relationships between the variables overall, it is unlikely that the contingency of relationship differences would also be a result of such bias. Thus, common method bias is not likely to be a serious concern to our research goal.

3. Results

3.1. Model specifications

We adopted multivariate regression [15], which jointly runs multiple regressions with the same independent variables and different dependent variables, as in Eq. (1): the dependent variables are correlated to each other.

$$\mathrm{Accept}_{\mathrm{National}} = a_1 + \beta_{11}\,\mathrm{Risk}_{\mathrm{NPP}} + \beta_{12}\,\mathrm{Risk}_{\mathrm{RWF}} + \mathbf{d_1 C} + \varepsilon_1$$

Table 1
Sample profile.

Variables	Description		Proportion (%)
Gender	Respondent's gender	Male	48.41
		Female	51.59
Age	Respondent's age	19–29	15.15
		30–39	19.70
		40–49	23.12
		50–59	19.82
		60–69	13.78
		70–	8.43
Educational level	Respondent's education degree	Middle school diploma or lower	15.72
		High school diploma	36.45
		Undergraduate student or degree	43.85
		Graduate student or degree	3.99
Income level	Respondent's monthly household income	< 1.0 million Korean Won	5.69
		1.00–1.99 million Korean Won	7.06
		2.00–2.99 million Korean Won	12.76
		3.00–3.99 million Korean Won	22.44
		4.00–4.99 million Korean Won	20.73
		5.00–5.99 million Korean Won	17.20
		6.00–6.99 million Korean Won	7.06
		7.00–7.99 million Korean Won	3.19
		8.00–8.99 million Korean Won	1.71
		9.00–9.99 million Korean Won	0.68
		> 10.0 million Korean Won	1.48
Residential area	Whether the respondent's residential metropolitan city or province has a nuclear power plant or a radioactive waste facility	Does not have such plant or facility	81.55
		Has such plant or facility	18.45

$N = 878$.

Table 2
Correlations and descriptive statistics of key variables.

Variable	1	2	3	4
1. $Risk_{NPP}$				
2. $Risk_{RWM}$	0.52***			
3. $Accept_{National}$	−0.26***	−0.19***		
4. $Accept_{Local}$	−0.38***	−0.45***	0.26***	
M	2.65	2.93	3.09	1.77
SD	0.64	0.70	0.60	0.83

$N = 878$.
***$p < 0.001$.
$Risk_{NPP}$, perceived risk from nuclear power plants; $Risk_{RWM}$, perceived risk from radioactive waste management; $Accept_{National}$, national acceptance of nuclear power generation; $Accept_{Local}$, local acceptance of a nuclear power plant; M, mean; SD, standard deviation.

$$Accept_{Local} = a_2 + \beta_{21}\, Risk_{NPP} + \beta_{22}\, Risk_{RWF} + \mathbf{d_2 C} + \varepsilon_2 \quad (1)$$

where

$Accept_{National}$ = national acceptance of nuclear power generation,
$Accept_{Local}$ = local acceptance of a nuclear power plant,
$Risk_{NPP}$ = perceived risk from nuclear power plants,
$Risk_{RWM}$ = perceived risk from radioactive waste management,
$\mathbf{C}$ = vector of the control variables
ε_j = error term; ε_1 and ε_2 are correlated to each other, following a multivariate normal distribution.

3.2. Results

Table 3 presents the multivariate regression results. The highest variance inflation factor (VIF) was 1.40, far below the 10.0 threshold for multicollinearity [16]. Each submodel revealed relatively substantial explanatory power for the dependent variable ($R^2 = 0.11$ and 0.26, respectively). The constant regarding $Accept_{National}$ was greater than that regarding $Accept_{Local}$ to a marginally significant level (Clogg et al's [17] coefficient difference test: $a_1 - a_2 = 0.10$, $z = 1.85$, $p = 0.06$), implying that people are more opposed to a nuclear power plant in their residential area than at the national level. This is consistent with the common sense that people respond more negatively to a risk that exists close to them.

Table 3
Multivariate regression estimates.

	$Accept_{National}$[a]	$Accept_{Local}$[a]
Constant	0.08 (0.04)	−0.02 (0.04)
Control Variables		
Gender[b]	−0.07 (0.03)*	−0.12 (0.03)***
Age[a]	0.10 (0.04)**	−0.05 (0.03)
Education level[c]	−0.07 (0.04)	−0.09 (0.03)*
Income level[a]	0.03 (0.04)	−0.04 (0.03)
Electricity consumption level[a]	−0.01 (0.03)	0.06 (0.03)*
Residential area[d]	0.13 (0.04)**	−0.03 (0.04)
Interested independent variables		
$Risk_{NPP}$[a]	−0.21 (0.04)**	−0.19 (0.03)***
$Risk_{RWM}$[a]	−0.07 (0.04)*	−0.35 (0.03)***
Model F	12.92**	37.42***
R^2	0.11	0.26
Residual correlation	0.16***	

$N = 878$.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
$Risk_{NPP}$, perceived risk from nuclear power plants; $Risk_{RWM}$, perceived risk from radioactive waste management; $Accept_{National}$, national acceptance of nuclear power generation; $Accept_{Local}$, local acceptance of a nuclear power plant.
[a] The variable has been standardized.
[b] Contrast-coded: −1 = male, 1 = female.
[c] Contrast-coded: −1 = high school diploma or lower, 1 = college student or higher.
[d] Contrast-coded: −1 = the respondent's metropolitan city or province does not have a nuclear power plant or a radioactive waste facility, 1 = it has such a plant or facility.

3.2.1. Effects of control variables

Gender (contrast-coded: −1 = male, 1 = female) was found to affect both types of acceptance. The negative coefficients mean that

females, compared with males, are less likely to accept nuclear power generation, both at the national level ($Accept_{National}$) and in their residential areas ($Accept_{Local}$). This result is consistent with a previous finding that females are generally more risk-aversive than males, and are less likely to accept nuclear power generation than males [18–22].

Age was found to exert a positive effect regarding only $Accept_{National}$. However, it is difficult to draw a generalized interpretation from this result, as the existing literature has been divergent with regard to the effects of age on nuclear power acceptance (e.g., positive effect, [18–20]; negative effect, [23]). This is also true for cases on the effects of the education level (e.g., positive, [18]; negative, [23]; insignificant, [19]) and income level (e.g., positive, [18,23]; insignificant, [19]). The electricity consumption level was found to have a positive effect regarding only $Accept_{Local}$.

The effects of residential area (−1 = the respondent's metropolitan city or province does not have a nuclear power plant or a radioactive waste facility, 1 = it has such a plant or facility) revealed an interesting point. The insignificant coefficient of residential area on $Accept_{Local}$ means that people currently living in an area with a nuclear-related facility are neither more nor less resistant to hosting a nuclear power plant in their area than those in areas currently without one. However, the significantly positive coefficient of residential area on $Accept_{National}$ implies that the former are more likely to accept nuclear power generation at the national level than are the latter. This can be interpreted as people with a nuclear-related facility already in their area demanding that the whole nation share the risk of hosting nuclear power plants.

3.2.2. Effects of risk perceptions

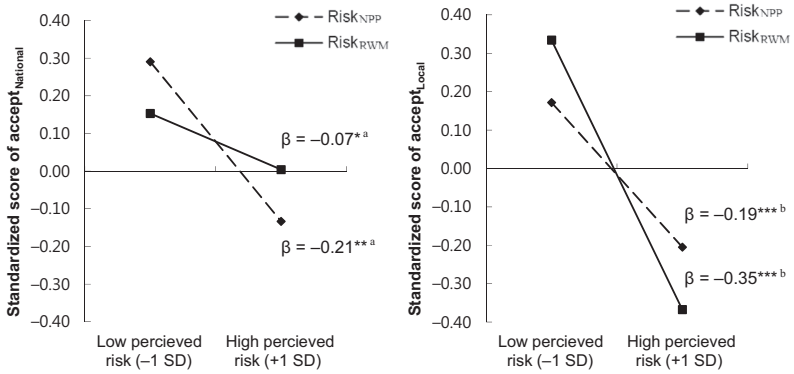
We compared the effect sizes of the control variables to those of the risk perceptions, based on the criteria suggested by Cohen [24]. For example, as we contrast-coded the categorical control variables (as −1 and 1) while standardizing the control variables that were measured using interval scales, the coefficient of gender (= −0.12) on $Accept_{Local}$ means that females are lower than males in $Accept_{Local}$ by 0.24 standard deviation (SD), which corresponds to a small size (≅0.20). Similarly, the effect size of residential area on $Accept_{National}$ (0.26) and that of the education level on $Accept_{Local}$ (−0.18) correspond to a small size. The effect of age, which was standardized, on $Accept_{Nation}$ is of a small size (0.10). Overall, the effect sizes of the control variables range up to small sizes. Differently from this, the risk perception variables had effect sizes ranging from small-to-medium ($\beta_{12} = -0.19$) to medium ($\beta_{22} = -0.35$), with the exception of the effect of $Risk_{RWM}$ on $Accept_{National}$. Thus, with this exception, risk perceptions can generally be stated to be more influential than the control variables on the acceptance variables. In the sense that the public's risk perceptions can be changed through policy efforts and social consensus, they need to be systematically managed in the process of public communications for nuclear power generation.

Both $Risk_{NPP}$ and $Risk_{RWM}$ revealed significantly negative effects on $Accept_{National}$. The coefficient difference test by Clogg et al [17] showed that $Risk_{NPP}$ had a stronger negative effect than $Risk_{RWM}$ ($\beta_{11} - \beta_{12} = -0.14$, $z = -2.10$, $p < 0.05$), in support of Hypothesis 1. Fig. 1A illustrates this.

However, for $Accept_{Local}$, the relative strength is opposite: $Risk_{RWM}$ had a stronger negative effect than $Risk_{NPP}$ ($\beta_{21} - \beta_{22} = 0.16$, $z = 2.72$, $p < 0.01$). Fig. 1B illustrates this. Taking this together with the result of $Accept_{National}$ ($\beta_{11} - \beta_{12} < 0$, $p < 0.05$ while $\beta_{21} - \beta_{22} > 0$, $p < 0.01$), Hypothesis 2 is supported.

4. Discussion

In countries operating nuclear power generation, raising national acceptance (many studies just refer to this as public acceptance) and local acceptance of such power comprise important pillars of communication activities for public's nuclear power acceptance (see Annex Table 1 in [25]). For example, in Korea, such public communication programs targeting all people are being



A. On $Accept_{National}$ B. On $Accept_{Local}$

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

[a] Coefficients are different at the 0.05 level.

[b] Coefficients are different at the 0.01 level.

SD, standard deviation.

$Accept_{National}$, national acceptance of nuclear power generation; $Accept_{Local}$, local acceptance of a nuclear power plant; $Risk_{NPP}$, perceived risk from nuclear power plants; $Risk_{RWM}$, perceived risk from radio active waste management.

Fig. 1. Effects of risk perceptions on different targets of nuclear power acceptance.

conducted mainly by KNEA and the head office of the Korea Hydro & Nuclear Power Co. Ltd (KHNP). At the same time, local sites of KHNP deploy communication programs targeting their local residents. These national and local communication programs try to raise the efficiency of communication by differentiating their communication strategies (e.g., considering the profiles of the communication targets and customizing communication media and channels according to these profiles). However, how the communication efforts regarding different types of risk perceptions should be varied according to the communication goals has been less commonly studied (source: interview with a publicist of KNEA). The present study fills this lacuna of knowledge in the field by demonstrating that the relative importance of different types of perceived risks differs across acceptance targets. Our finding implies that, for national consensus regarding general nuclear power policy, communication efforts should be focused relatively more on improving the public perception of the risk from nuclear power operation. On the contrary, in improving local acceptance of a nuclear power plant for the siting of new or additional construction of nuclear power plants, the focus should be more on improving local residents' risk perception regarding (postuse) negative byproducts.

In its theoretical perspective, the present study calls on researchers to contemplate the possibility that the effects of other drivers of nuclear power acceptance (e.g., benefit perceptions, knowledge, and trust) are also contingent on acceptance targets. If such a possibility is verified, it will deepen our understanding of the contingency of the effects of the determinants of nuclear power acceptance, which will serve as base knowledge for an efficient communication strategy for such acceptance.

Conflicts of interest

The authors have no conflicts of interest to declare.

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