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Original Article

Examination of different socioeconomic factors that contribute to the public acceptance of nuclear energy

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ABSTRACT

Public acceptance is a major issue that will determine the future of nuclear energy. In this article, we review relevant studies and identify several common patterns of nuclear public acceptance. Based on these patterns and four categories of factors, we propose hypotheses on the impact of different socioeconomic factors on the public opinion of nuclear energy. These factors were demographic and social influences, politico-economic, energy conditions, and nuclear accidents and natural risks. We tested these hypotheses using a data set including survey results on public opinion of nuclear energy in 59 countries from 1987 to 2014. Results of the regression analysis generally verified the proposed hypotheses, especially regarding the positive impact of education or geological suitability and the negative effect of improved living standards and democracy on nuclear acceptance. We propose policy recommendations, including a better focus on education and communication and a thorough consideration of the social and geological conditions a country needs to make before deciding to go nuclear. Potential weaknesses of this study are also discussed, including the possible causal relation between independent variables and the binary nature of the dependent variable.

1. Introduction

The success or failure of a civil nuclear power program strongly depends on the acceptance of nuclear technology by the public. Even before the nuclear accidents at Three Mile Island and Chernobyl, public perception was already identified to be the most critical factor affecting the future of nuclear power [1,2]. Arising from such a need to study and enhance the public acceptance of nuclear energy, characterization of nuclear risk perception was initiated in the 1970s through numerous psychometric studies. These studies found that the American public considered nuclear power the riskiest technology in terms of both consequence and uncontrollability [3]. However, more recent studies in the United States (US) showed that the difference in the level of negative opinion between nuclear and other types of electricity generation like coal or wind has been largely reduced, especially taking into account the environmental advantages of each type [4]. To explain such a changing attitude toward nuclear energy, structural understanding of nuclear perception has been proposed, in which perceived risk, perceived benefit, and trust in institutions have often been found to be major components [5]. It is essential to recognize the interdependence between, and the different weighting factors of, such components. In this article, we present a review of the literature on the formation of the public perception or acceptance of nuclear energy. This qualitative discussion is followed by a quantitative analysis of identifying key factors affecting public acceptance of nuclear energy (also called public nuclear acceptance) as part of the effort to examine public nuclear acceptance patterns in different countries.

2. Literature review

2.1. Demographic, social, and politico-economic aspects of public acceptance

There is a consensus that women tend to have higher perceived risk attitude against technology such as nuclear technology. Such high risk perception may come from a gender-based biological factor like maternity or from a relatively lower familiarity with technology than men have due to the lower percentage of women who study engineering subjects [6]. From this observation, we can assume that gender is a major factor in the formation of public

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nuclear acceptance. Researchers have also identified age as another factor in explaining public nuclear acceptance, with the younger population showing more support for new nuclear plants than the older generation [7]. Regarding the role of education, people unfamiliar with science and technology tend to have more risk-averse attitudes, whereas people with a sufficient level of knowledge were found to have more favorable opinion about nuclear energy [8]. Similarly, scientists were found to have far lower perceived risk of nuclear energy than laypeople [9]. Consequently, numerous studies have argued that education plays an important role in increasing public understanding of nuclear energy [10]. Others, while agreeing on the positive impact of education, noted that the contribution from education is strongly affected by other factors like personal beliefs or preexisting convictions of people with such education [11].

The robustness of a country's democracy, which can be reflected through the freedom of expression and of the press, has been considered a major factor influencing the public perception of nuclear energy [12]. For example, it was found that the media has contributed to the increasingly negative public perception of nuclear risk, as nuclear-related subjects often contain powerful messages about nuclear dangers, painting a gloomy picture about nuclear power while ignoring the benefits of nuclear power in the mitigation of global climate change [13]. This negative depiction of nuclear energy by the media has been further aggravated by a lack of trust by the public in the authority along with activities of special interest groups, even in the presence of scientific information about the safety of the technology [14]. On the other hand, the prevalence of technocrat culture in countries like France, China, or India, where scientists are well respected, was identified to be a major reason behind the relatively positive attitude of the public toward nuclear energy [15]. Finally, economic conditions also affect the public perception of nuclear energy, as people with better living standard tend to disfavor nuclear energy [16].

2.2. Energy-related, natural, and other technological risk factors

Energy security has been considered a major contributor to the public support and government policy for nuclear energy development [17]. In the Republic of Korea, for example, the public concern of underdevelopment caused by the lack of energy was thought to be the reason for the support for the Republic of Korea nuclear program [18]. Furthermore, it was argued that people in countries with established nuclear programs tend to be well informed about nuclear benefits and risks and thus have favorable views about the technology [19]. Similarly, as proximity to nuclear facilities often leads to familiarity with the technology and direct benefits, nuclear energy often enjoys stronger support from the local communities near the plant sites [20]. As the fluctuation of oil price has a major impact on energy security, it can also indirectly influence the public perception of nuclear power development [21]. The availability of renewable resources is another factor that can potentially lower the support for nuclear energy [22]. Recently, the positive impact of nuclear energy on climate change, thanks to its negligible emissions, has become a new push for acceptance of this technology, even among former antinuclear activists [13].

As discussed in the introduction, perceived risk of nuclear power was found to be exceptionally high among the public in comparison with other types of technologies. In addition, numerous studies have shown that the nuclear accidents at Three Mile Island (1979), Chernobyl (1986), or Fukushima (2011) have significantly damaged the public acceptance of nuclear power [14,23]. However, results of longitudinal surveys conducted before and after the accidents showed that public opinion of nuclear energy was only temporarily affected by these events before returning to the preaccident trend within a year or two [24]. Furthermore, it was noted that such stabilization was more remarkable in established nuclear countries, as the public was able to identify positive features of nuclear energy to compensate for its negative image brought by the accidents [14]. Geological conditions can also affect the public opinion on the development of nuclear-related facilities, such as plant sites, final disposal sites, and reprocessing plants. For example, the seismic stability of the available bedrock in Sweden and Finland has helped maintain the public support for the construction of geological disposal repositories; whereas, the negative public opinion in Japan about spent fuel management has been partly attributed to the unstable geology of this country [25].

3. Methodology and data

3.1. Research hypotheses

One observation made from the literature review is that public acceptance of nuclear energy may vary year to year and also differ geographically from one country to another. Such variation exists because the public support for this technology is heavily conditioned by the distinctive sociological and cultural characteristics of, or related events occurring in, each country. However, similar patterns of nuclear acceptance have been found in country-specific studies done in different periods [26]. Accordingly, based on the above qualitative discussion, we propose four hypotheses about universal patterns of nuclear public acceptance:

Hypothesis 1. Essential demographic and social characteristics, such as the proportion of females in the population, the level of public education, and the prevalence of working-age population, have a correlation with nuclear public acceptance across countries and periods.

Hypothesis 2. There is also a correlation between nuclear public acceptance and the politico-economic conditions of a country, such as the level of democracy or the living standards.

Hypothesis 3. Energy security, including oil prices and the availability of alternative energy sources, and the existence of a nuclear power program have a universal impact on public acceptance of nuclear energy.

Hypothesis 4. Countries' exposure to natural disasters, seismic concerns, and the occurrence of nuclear accidents negatively affect the public acceptance of nuclear energy, although such impact is short-lived.

3.2. Nuclear acceptance data set

To examine these hypotheses, we needed to develop a data set for public acceptance of nuclear energy that covers multiple states through consecutive years. However, such data gathering is difficult because of the lack of longitudinal studies that reflect the changing perceptions of nuclear energy by the public through time. In addition, because of the complex and costly nature of surveys, studies of this type are available only in a limited number of countries. With an understanding of these limitations, we developed a data set of nuclear public acceptance worldwide by collecting survey data from academic papers and reports by agencies specialized in opinion polls. Covering 1987–2014, the data includes nationwide public opinion of nuclear energy from 59 countries, including all 28 states with operating nuclear power plants (NPPs), four former nuclear states, 16 aspiring states planning their first NPP, and another 11 countries with relevant data. It is important to note that, despite the obvious differences between countries with

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