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Positive or negative? Public perceptions of nuclear energy in South Korea: Evidence from Big Data

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ABSTRACT

After several significant nuclear accidents, public attitudes toward nuclear energy technologies and facilities are considered to be one of the essential factors in the national energy and electricity policy-making process of several nations that employ nuclear energy as their key energy resource. However, it is difficult to explore and capture such an attitude, because the majority of prior studies analyzed public attitudes with a limited number of respondents and fragmentary opinion polls. In order to supplement this point, this study suggests a big data analyzing method with K-LIWC (Korean-Linguistic Inquiry and Word Count), sentiment and query analysis methods, and investigates public attitudes, positive and negative emotional statements about nuclear energy with the collected data sets of well-known social media and network services in Korea over time. Results show that several events and accidents related to nuclear energy have consistent or temporary effects on the attitude and ratios of the statements, depending on the kind of events and accidents. The presented methodology and the use of big data in relation to the energy industry is suggested as it can be helpful in addressing and exploring public attitudes. Based on the results, implications, limitations, and future research areas are presented.

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1. Introduction

After nuclear energy was presented as an effective source of producing electricity, several nations have focused on the R&D (research and development) of nuclear technologies [1], and have employed nuclear energy as one of the key parts in their national energy and electricity plans [2]. Based on these efforts, the total cost of using nuclear energy in energy and electricity plans and policies is significantly lower than that of other energy sources, including fossil fuels and renewable energy sources [3,4].

Because of this trend, several countries such as South Korea and Japan have supported and invested in development plans for nuclear energy programs as a way of enhancing national security and the reliability of their energy systems [5,6]. However, because of several shocking nuclear accidents (i.e., the Chernobyl and Fukushima accidents), the public tends to have a lower degree of trust in nuclear energy technologies and facilities, and are suspicious of nuclear energy facilities [6–8]. Since nuclear energy is not technically more familiar or intimated than other energy sources

that are anticipated to be widely employed in the future, it is not easy to find an opportunity to present the positive effects of the public attitude towards nuclear energy [9].

As a result, a large number of academic and industrial researchers have attempted to explore public attitudes toward nuclear energy and the determinants of such attitudes [8,10]. As the determinants, various factors such as social trust or perceived costs have been considered and investigated in prior studies [11–13]. However, these studies have aimed to investigate selected motivations within a limited region. This means that it can be challenging to straightforwardly apply the findings of the studies to other regions or countries.

Moreover, predicting public attitudes toward nuclear energy for people that live near nuclear energy power plants and related facilities is one of the most difficult tasks, because of the trend of “reluctant acceptance”. This indicates the adoption of the use of nuclear energy with unfriendly perceptions in addition to an absence of alternative energy sources [14–16]. However, this trend cannot be presented in the majority of general opinion polls because it is too difficult to distinguish between an opposing opinion party and a supporting opinion party.

In order to eliminate this ambiguity, the current study collects big data from social media and network services in Korea, which

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enables the exploration of public perceptions of nuclear energy technologies and facilities. Moreover, in order to explore the effects of particular energy-related events in these perceptions, both time-based data collections and appropriate analyses were conducted.

2. Literature review: public attitude toward nuclear energy

Due to the heightened interest in climate change and fine particulate matter, nuclear energy has been considered and employed as one of the key alternative energy sources in several nations [17]. With this trend in mind, the South Korean government aims to extensively invest in several programs for the management, operation, and R&D of national electricity production [18,19]. However, because of several accidents in Korea and other nations such as the Fukushima nuclear accident, citizens' perceived degrees of potential environmental and security risks are magnified [8,20].

For example, there were notable changes in public perception towards nuclear energy technologies before and after the Fukushima nuclear accident. Moreover, the focal points of the perceptions have moved from the economic cost of these technologies and facilities to their social and environmental costs in Korea [8]. Choi and colleagues analyzed the national survey investigation data that was collected by the Korean government in 1995 and addressed the public attitude towards nuclear power [21]. They investigated the idea that perceived risk is one of the most significant factors influencing the public acceptance of nuclear energy. Song and colleagues also explored the social adoption of nuclear power facilities in Korea, and showed that perceived efficacy is one of the most notable determinants of the social adoption of these facilities [20]. With samples from 1000 citizens in Korea, both perceived trust and risk were considered as influential factors in the acceptance of nuclear energy.

Choi and Kim [22] investigated the public adoption of nuclear energy in Korea and explored the effects of minor earthquakes on the adoption in Korea. Using data from a residents' questionnaire survey, Choi and Kim [22] found that there are no crucial changes in and effects on the adoption rate in Korea. However, Kim and Cho [23] found that the perceived risk perception of nuclear energy was significantly affected by the Fukushima nuclear accident. Moreover, they also indicated that the main promotion direction of nuclear energy technologies and facilities conducted by the South Korean government has moved from the "mitigation of climate change with low-carbon" to "safer and more stable energy."

Kim and Kim [24] indicated that both regional and national relative benefits with trust and risk perceptions are significantly associated with the public acceptance of nuclear energy. By using multi-dimensional analysis on the perceived benefits, it was shown that perceived individual benefits had moderate effects on the acceptance of nuclear energy in South Korea.

Although there are notable recent studies on public attitudes toward nuclear energy technologies and facilities [10], the majority of these studies have noteworthy limitations such as the difficulty in generalizing the results due to the sample size or the fragmentary responses of the respondents. Therefore, in order to overcome the limitations of prior studies, the current study utilizes big data collected by well-known social media and network services in Korea.

3. Study methodology

3.1. Data

The current study collected the datasets of four widely used social networking services (SNSs), namely Facebook (from January 2010), Twitter (from January 2010), Naver Band (from September 2012), and Kakaostory (from April 2012) until December 31, 2017.

The datasets included roughly 4.1 million cases that mentioned nuclear energy, technologies, facilities, and related keywords in Korea.

3.2. Significant events on nuclear energy in Korea

3.2.1. Positive events

(Positive Event 1: PE1) In December 2010, the Korean consortium exported nuclear research reactors to Jordan. The consortium designed and delivered the customized nuclear reactors to Jordan, based on the comprehensive technologies, understanding, and experience of the High-Flux Advanced Neutron Application Reactor (HANARO). The Jordan Research and Training Reactor was completed in December 2016.

(PE2) In June 2014, the consortium of the Korea Atomic Energy Research Institute, Hyundai Engineering and Construction, and Hyundai Engineering in South Korea was selected as a priority negotiation company for establishing research-oriented nuclear reactors and cold neutron research facilities that were ordered by the Delft University of Technology in the Netherlands.

(PE3) In September 2015, the South Korean government revealed that the Korea Atomic Energy Research Institute and the King Abdullah City for Atomic and Renewable Energy in Saudi Arabia have made an agreement on SMART PPE (System-integrated Modular Advanced Reactor Pre-Project Engineering) in Saudi Arabia. Based on this agreement, the South Korean government and the Korea Atomic Energy Research Institute conducted the detailed design for constructing SMART in Saudi Arabia, designed education and training sessions for cultivating Saudi Arabian nuclear researchers, and prepared for the construction of SMART units one and two in Saudi Arabia.

(PE4) In June 2017, the South Korean government introduced a publicizing committee for societal corporatism on the construction of the Shin-Gori nuclear reactor units five and six. Five hundred citizens with ten venerable experts were selected as committee members for recommending the construction or scrapping of two units in July and September 2017. After the 12 general meetings and debate sessions of the final decision-making process, the committee recommended that construction of the Shin-Gori nuclear reactor units five and six resume (Agree: 59.5%; Disagree: 40.5%).

3.2.2. Negative events

(Negative Event 1: NE1) In March 2011, there was a huge nuclear accident in Japan, the Fukushima nuclear disaster. Tokyo nuclear plants were swept by 10-m-high tides. The tidal waves compromised the cooling function of the nuclear reactors which made the cores of three reactors melt down along. This was accompanied by the release of radioactive material. Moreover, four buildings on the western side of the Pacific were destroyed and exploded due to radioactive contamination.

(NE2) In June 2013 it was revealed that components that did not meet quality standards were delivered to the Korea Hydro & Nuclear Power Co. Ltd. for the building of new nuclear power plants. This was achieved with forged standard certifications. Since all process companies (KEPCO Engineering and Construction as the authorizing institute, STEP as the verification institute, and JS Cable as the manufacturing company) systematically took part in the case, there were notable effects on the nuclear and energy industry in South Korea.

(NE3) In December 2016, the Korea Hydro and Nuclear Power Co. Ltd reported the leakage of more than 800-L of cooling water from nuclear reactors in Hanul Nuclear Power Plant unit five. Since the leaked cooling water from the unit is the largest amount of leaked water in the history of South Korean nuclear accidents, a large number of press companies reported this case.

3.3. Measurements

The current study conducts both sentiment and query analysis methods, and explores how certain emotions are revealed by users by relying on positive or negative topics. In order to do this, this study conducts a sentiment investigation by employing explicit word analysis software, K-LIWC (Korean-Linguistic Inquiry and Word Count), which provides the number of identified words in psychological and cognitively validated categories [25]. With a given case, the K-LIWC provides the function of sentiment analysis, and shows the scores of the positive and negative emotions of the text [26,27]. They are computed in the form of word frequency in the given psychological and cognitive sentimental category with a percentile scale of the total number of words in the text.

4. Results

4.1. Results of positive and negative emotions with significant events

Fig. 1 presents a summary of the results. After considering positive nuclear events, the word-count ratios of positive emotions in the total text significantly increased (PE1: 3.8% → 6.9%, PE2: 3.7% → 10.9%, PE3: 6.0% → 10.2%, PE4: 4.9% → 8.8%). However, within continuous perspectives toward nuclear energy, the effects of positive nuclear events were limited in some topics that were not associated with social and national issues (PE1: 3.8% → 6.9% → 3.6%, PE3: 6.0% → 10.2% → 7.7%).

In cases of negative nuclear events, the ratios of negative emotions in the total text greatly increased (NE1: 5.7% → 22.5%, NE2: 9.4% → 14.1%). In the instance of NE3, because the event was subsequently widely reported, the effects of the event may be difficult to estimate. Moreover, the effects of negative nuclear events remained (NE1: 5.7% → 22.5% → 22.2%, NE2: 9.4% → 14.1% → 12.2%). This tendency may be caused by the fact that significant negative nuclear events are crucially related to environmental and risk issues in society. This difference can also be inferred by the highly mentioned keywords after the events (Table 1).

Table 1

Top keywords that are related to nuclear energy after positive and negative events.

Events	Rank	Keywords (English)	Keywords (Korean)
PE1	1	Export	수출
	2	Economic growth	경제성장
	3	Jordan	요르단
PE2	1	Reactor order	원전 수주
	2	The Netherlands	네덜란드
	3	Business in Europe	유럽진출
PE3	1	Korean model	한국형
	2	Success	성공
	3	Leap	도약
PE4	1	Publicizing	공론화
	2	Resumption of Construction	건설재개
	3	Shin-Gori	신고리
NE1	1	Fukushima	후쿠시마
	2	Radioactivity	방사능
	3	Cause of accident	사고 원인
	4	Damage	피해
NE2	1	Corruption	비리
	2	Delivery	납품
	3	Safety	안전
NE3	1	Contamination	오염
	2	Leak	누출
	3	Concealment	은폐

5. Discussion

Presenting public attitudes toward nuclear energy is an important issue in deciding national energy-related policies. As presented in the results, the public showed positive emotions when there were positive events related to nuclear energy, including the export of nuclear reactors to the Netherlands, Jordan, and Saudi Arabia. However, negative events related to nuclear energy, such as the Fukushima accident and the nuclear reactor components corruption scandal, have powerful and consistent effects on public emotion. Since the potential damages of nuclear energy are estimated to be irrevocable and risky to the public, this negative image will likely continue.

Moreover, as confirmed in several prior energy studies [28,29], this study also indicates that using a sentimental analysis on big

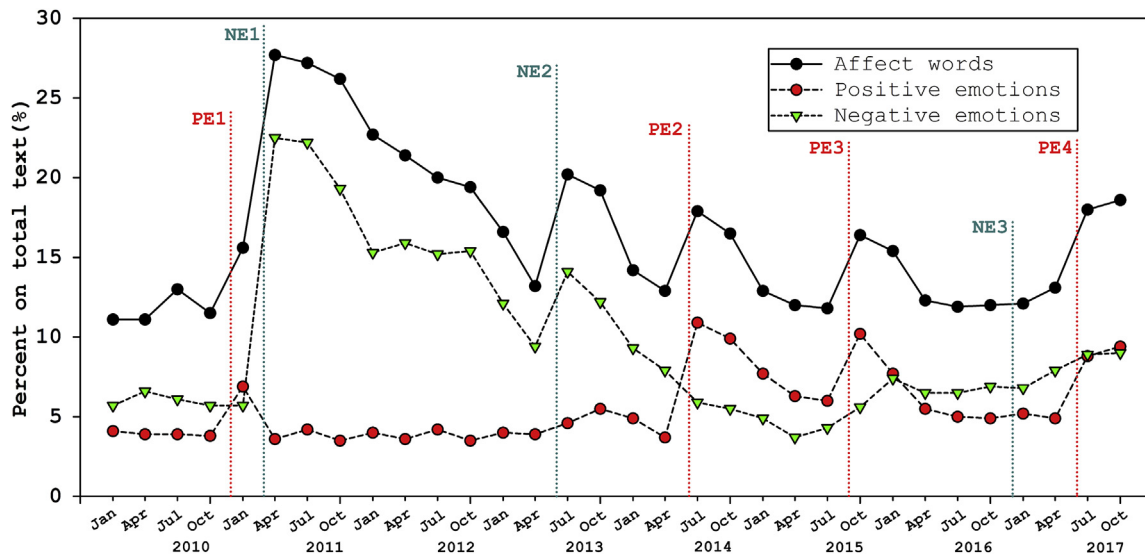


Fig. 1. Summary of K-LIWC on the collected data.

data related to nuclear energy can be useful in reading public sentiment. It means that the results of K-LIWC and extracted keywords can present the public's lurking thoughts on recent issues of nuclear energy in Korea. In addition, academic and industrial researchers in the South Korean nuclear industry should employ various means to attempt to capture the public's opinions. For example, the keyword “concealment” was listed with respect to NE3. This indicates that the public does not think that the South Korean nuclear industry and related organizations make a significant effort to be transparent regarding the truth about the industry.

Currently, despite the considerable contributions of nuclear reactors on both the energy and export status of South Korea, the average ratio of negative emotions (9.7%) from 2010 to 2017 is higher than that of positive emotions (5.6%). This has been influenced by recent events regarding units five and six of the Shin-Gori nuclear reactor. Although construction of the two units resumed, it shows that the main determinant of using nuclear energy in Korea is public acceptance and attitudes toward nuclear energy.

6. Conclusion and policy implications

As presented in this study, using big data with appropriate analyzing methods can be useful to investigate public attitudes toward nuclear energy. This study presents a possible case that shows how to investigate and explore the public's perceived emotions on nuclear energy in response to nuclear-related events. Moreover, the appropriate analysis (i.e., keyword analysis) can be useful in exploring public attitudes toward nuclear energy in order to reflect these attitudes in the decision-making processes of national energy policies and plans.

Specifically, the effects of significant events in the nuclear industry on public attitudes toward nuclear energy can be estimated and investigated with the employment of big data analysis. As presented in the results of the current study, the intensity and magnitude of each event varies according to the characteristics of the event. For example, the ratio of positive mentions in the total text increased in a short period of time after PE1 (the export of nuclear reactors to Jordan), but the ratio had decreased to a similar degree before the event.

Using big data with appropriate analyses should enable the South Korean government and nuclear-related organizations to minutely and actively reflect public attitudes toward and opinions on nuclear energy by promoting interactions between the government and organizations and the public. The national nuclear plans and policies reflected by the results of big data and appropriate analysis can be more reliable and practical for the South Korean nuclear industry.

Although the current study employs big data on nuclear energy in South Korea, there may be several limitations. First, demographic information was not considered in the analyses [30]. Since prior studies revealed that younger generations are more likely to actively use SNSs [31], the results of the current study can be presented within the focal points of the opinions of the younger generation.

Second, although the current study selects seven significant events in Korea, there can be other notable nuclear-related events in Korea. In order to select the significant events, this study employs the news-ranking systems computed by two famous portal services, Daum and Naver.

Third, despite the fact that there can be “heavy opinion leaders” in SNSs, the current study does not consider the potential effects of “heavy opinion leaders.” Several prior studies already showed that investigating and exploring the comments of these leaders can be helpful to elaborately design national energy plans and policies [32,33].

Lastly, regional differences were not considered in the analysis. Although the presented analysis with big data can be effective within a national perspective, it is too difficult to reflect public opinions in designing and providing local-oriented energy policies and plans [34]. Thus, future studies should focus on the above-mentioned limitations in order to extend the findings of the current study.

Declarations of interest

None.

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