Analysis on government policy and public opinion on spent nuclear fuel

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1. Introduction

A spent nuclear fuel is a high-level radioactive waste that is discharged after being used as a reactor fuel. It is inevitably generated as long as the nuclear power plant is in operation. In Republic of Korea(ROK), there is a continuous debate on the pros and cons of how to deal with spent nuclear fuel. Public opinion plays an important role in energy policy. It can effect on determining the direction of national policy. we may see policy shifts in Congress, often matching the policy preferences of the public. Especially, the current government is actively collecting public opinion and reflecting it in national policies. For these reasons, analysis of public opinion on spent nuclear fuel is important. In this paper, we used text-data analysis methods to investigate social perceptions regarding spent nuclear fuel in ROK.

2. Research Methods

The purpose of analyzing text is diverse spanning from identifying the main concepts and sub-topics contained in the documents, reading the trends through its temporal changes. In this section, some of the Methods used to analyze web news articles and public opinion text data about spent nuclear fuel are described. To analyze Korean social perception about Spent nuclear fuel, Korea's representative domestic web platform www.naver.com. was selected as the data collection scope. For the keywords 'Spent Nuclear Fuel', we obtained search results from NAVER News. From the search results, we extracted 5,747 articles, 109,242 comments and 33,445 reply to comments during the president Moon's administration (2017.05~2020.12). The analysis methods include Term Frequency, Term Frequency-Inverse Document Frequency (TF-IDF) and Semantic Network Analysis (SNA).

2.1 Term Frequency (TF)

Term frequency (TF) often used in Text Mining is how frequently a term occurs in a document. Term frequency is the measurement of how frequently a term occurs within a document. Term frequency covers that aspect by capturing the number of times each word occurs in the text. The easiest calculation is simply counting the number of times a word appears.

2.2 Term Frequency-Inverse Document Frequency (TF-IDF)

The problem with using Term Frequency is that relevance does not increase proportionally with usage. For instance, there are lots of pronoun, definite and indefinite articles that are meaningless in text. To downgrade the relative importance of words that occur all too frequently, an inverse weighting is introduced to scale down the words that occur too frequently. This inverse weighting is referred to as Inverse Document Frequency. Together, TF-IDF captures the relative importance of words in a set of documents or a collection of texts. (equation. 1.)

$$w_{i,j} = tf_{i,j} \times \log\left(\frac{N}{df_i}\right) \qquad (1)$$

$tf_{i,j} = number\ of\ occurrences\ of\ i\ in\ j$
$df_i = number\ of\ documents\ containing\ i$
$N = total\ number\ of\ documents$

2.3 Semantic Network Analysis (SNA)

Semantic Network is a network of words that is organized to the proximity of words that are extracted from unstructured text through morphological analysis. Semantic Network Analysis (SNA) allows you to import unstructured text data to automatically extract words in documents, paragraphs, and sentences, and to organize interword networks based on adjacency between words. Therefore, nodes in a semantic network are words, and links are adjacent relations between words. The size of the nodes of the important words that were extracted beforehand are bigger.

3. Results

3.1 articles

We collected a total 5,747 articles from 2017 to 2020. Table. 1. shows TF/TF-IDF results the noun words that appeared most from 2017 to 2020. As you can see, words like 'Policy', 'President', 'Construction' that weren't emphasized in terms of frequency can be discovered. According to the SNA result, the keywords such as "temporary storage facility", "safety", and "policy" are connected around "management of spent nuclear fuel"

(Fig. 1). we were able to confirm that the Korean media covered 1) temporary storage facilities for waste management, 2) communities near nuclear facilities, and 3) energy policies extensively about nuclear spent fuel.

Table. I. Top 5 keywords for TF/TF-IDF results of articles

Rank	TF	TF-IDF
1	Nuclear power plant	Safety
2	Nuclear spent fuel	Construction
3	Government	President
4	Safety	Nuclear power
5	Technology	Policy
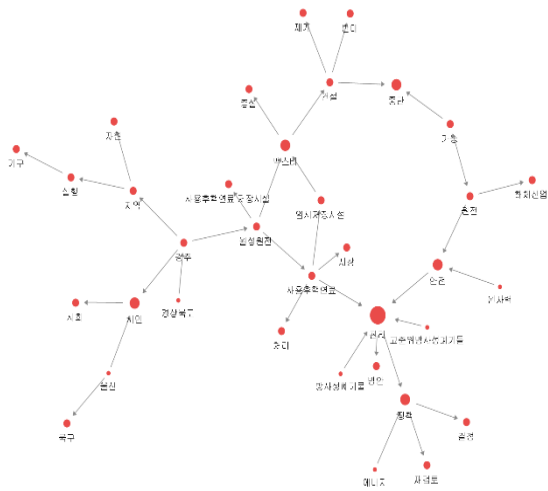
Fig. 1. Semantic Network Analysis of NAVER articles, related to 'Nuclear Spent Fuel' (2017-2020)

3.2 comments / Reply to comments

A total 109,242 comments and 33,445 Reply to comments were analyzed. Unlike the results of the article analysis, new keywords such as 'Solar power', 'Panel', 'Wind Power' appeared in SNA (Fig. 2, 3.). We assume that the public is very interested in government's energy policy which is reducing the use of nuclear power plants and recommending the use of renewable energy. Also, keywords such as "agreement" and "disagreement" appeared around the "nuclear power plant" keyword, indicating that there was a pros and cons controversy over nuclear power plants in the comments. Top ranked keywords in Reply to comments such as 'electricity bill', 'electricity', 'money', 'cost', 'tax', 'increase' were derived from TF/TF-IDF/SNA. Considering these results, it can be inferred that the public is more paying attention to nuclear power policies that directly affect their lives than attention to spent nuclear fuel.

Table. 2. Top 5 keywords for TF/TF-IDF results of comments

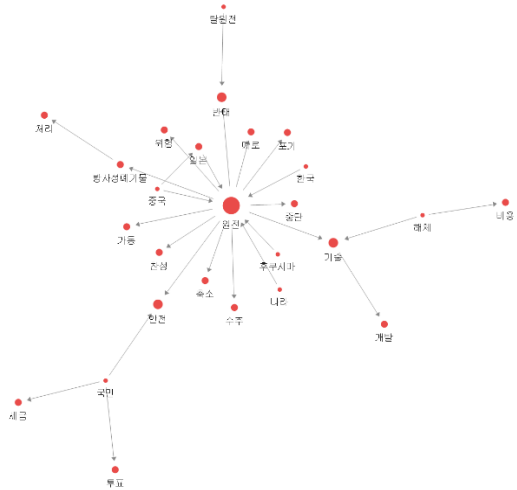| Rank	TF	TF-IDF
1	Nuclear power plant	Nuclear power plant
2	President	President
3	Nation	Nation
4	Phase-out	Phase-out
5	Citizen	Citizen

Fig. 2. Semantic Network Analysis of comments, related to 'Nuclear Spent Fuel' (2017-2020)

Table. 3. Top 5 keywords for TF/TF-IDF results of Reply to comment

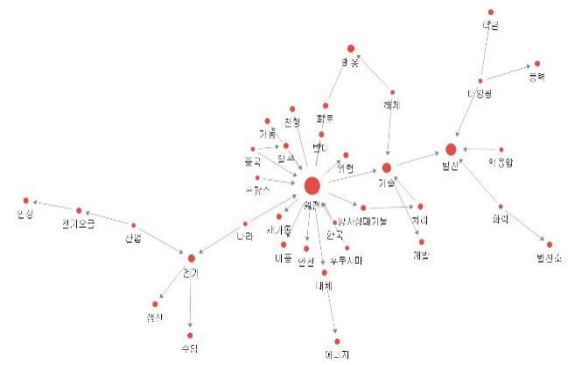| Rank	TF	TF-IDF
1	Nuclear power plant	Nuclear power plant
2	President	President
3	Nation	Nation
4	Electricity	Thought
5	Thought	Electricity

Fig. 3. Semantic Network Analysis of reply to comment, related to 'Nuclear Spent Fuel' (2017-2020)

3.3 Additional Analysis

Public opinion on spent nuclear fuel during the Moon Jae-in government is closely related to the government's nuclear policy. Through analyzing the trends in the number of articles, comments/reply and likes/dislikes, the response to articles and public opinion increased to the same trend at the time of discussing the nuclear phase out policy (June, October 2017). However, in Fig. 4, there was not much response from public on issues which are not related to nuclear energy policy, such as the republication of spent nuclear fuel (Nuclear Spent Fuel Review committee launched in May 2019, Review committee concluded in July 2020).
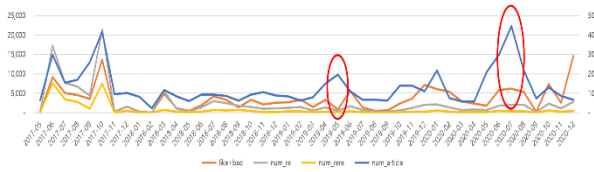

Fig. 4. Trends in the number of articles, comments/reply and likes/dislikes

Fig. 5 and 6 are SNA results of comments on articles in May 2019 and July 2020. During that period, there was a lot of press, but there were few comments and reply. Keywords such as 'electricity bill', 'electricity', 'tax', 'increase' were derived from analysis results of May 2019 (Fig. 5). Despite the continued reports on the spent nuclear fuel policy, public opinion was still discussing the pros and cons of the nuclear power plant which is more familiar topic to people.
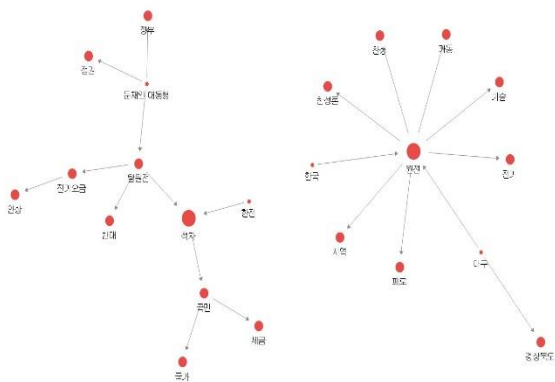

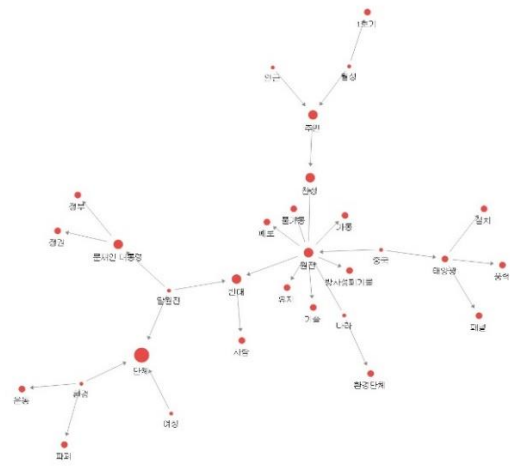Fig. 5. Semantic Network Analysis of comments, related to 'Nuclear Spent Fuel' (May 2019)

Fig. 6. Semantic Network Analysis of comments, related to 'Nuclear Spent Fuel' (July 2020)

4. Conclusions

From this study, we confirmed that the public opinion on nuclear spent fuel in ROK. The public is 1) more interested in nuclear power plant policy than in the spent fuel policy issue, and 2) there are arguments for and against nuclear power regardless of the report of the spent fuel article. 3) Especially they are interested in new government's energy conversion policies. And it's because 4) energy policy is related to familiar topic such as 'economy' and 'stability of supply and demand' which is much discussed issue in today's society. Our results suggest that nuclear-related organizations should endeavor to provide sufficient information to the public regarding spent nuclear fuel. In addition, in order to get the public's active interest in the spent fuel policy, it is necessary to connect it to the nuclear power plant policy issue.

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