The Correlation of Stable NPP Operation with the State of Democracy

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1. Introduction

The total net capacity of nuclear power in operation was 394GWe [1]. Despite the increase of nuclear fleet, the net generated electricity was nearly stagnated from 2016. After Fukushima accident in 2011, the net nuclear generation capacity increased. The percentage of nuclear generation capacity from the NPP not operating, including the Japanese reactors, is around 10% since 2011.

Fortunately, the global average capacity factor for operating reactors are consistent for preceding three years. Low capacity factor greatly degrades the economic feasibility of nuclear power. The global average capacity factor in 2017 recorded 81.1%. Capacity factor has no significant correlation with the reactor age and the reactor type, but has significant correlation with the region. Roh [2] reported that the social index (tolerance index) contributed the public acceptance, which closely related to the continuous operation of nuclear power plant (NPP). In this study, we discuss about the correlation between NPP operation and the state of democracy that indirectly explain the stance toward nuclear power from society or government.

2. Methods

2.1 NPP Operation Data

Three NPP operation data were selected to conduct the analysis: EAF (energy availability factor), UCF (unit capability factor), and UCL (unplanned capability loss factor). Those three parameters were widely used to show the record of individual NPP or NPPs in certain country. EAF is the ratio of the energy that the available capacity could have produced over a specified period to the energy that the reference unit power could have produced during the same period. UCF is defined as the ratio of the energy that the unit was capable of generating over a given time period considering only limitation under the plant management control, to the reference energy generation over the same time period, expressed as a percentage. And UCF is defined as the ratio of the unplanned energy losses during a given period of time, to the reference energy generation, expressed as a percentage.

NPP operation data for all NPP operating countries were obtained from PRIS and Operating Experience Reports [3-5] published by IAEA

2.2 Democracy Index

There are 5 grouped categories that evaluate democracy index: electoral process and pluralism(EP), civil liberties(CL) the functioning of government(FG) political participation(PP) and political culture(PC). Individual categories were utilized in the analysis. The Economist Intelligence Unit's index of democracy, on a 0 to 10 scale, is based on the ratings for 60 [6-8]. Those indicators were grouped into the five categories. The scoring system were used to classify countries into four types of regime: Full democracies, flowed democracies, hybrid regime and authoritarian.

2.3 Simple Linear Regression Analysis

In this study, simple linear regression analysis was used to show the correlation between NPP operation and the state of democracy in certain country. For the dependent variable, EAF, UCF and UCL were analyzed. For the independent parameter, five categories of democracy index were used. We assumed that one the categories of democracy index may have correlation with history of NPP operation performance and statistical hypothesis testing was conducted by SPSS.

3. Results and Discussions

In this paper, the correlation of NPP operation and democracy index is studied. The dependent variable UCL was used for the representative parameter for NPP operation, because UCF is the direct indicator that shows unplanned shutdowns, outage extensions, or unplanned load reductions [4]. The UCL and five categories of democracy index were compared to find out the presence of correlation between the variables.

First, meaningful correlation between EP and UCL was observed by the statistical hypothesis testing for 2017 data. The result was shown in Fig. 1. On the other hands, four other categories have not shown meaningful correlation. Moreover, in case of data from 2018, FG and UCL have meaningful correlation, and the result was displayed in Fig. 2. To conduct statistical test of

model and evaluate test statistical significance of regression coeffieients, ANOVA analysis and coefficient analysis were summaries in Table I, II, III.

The result of simple regression model (2017 data) shows that the 33.8% of variance of dependent variable (UCL) can be explained by explanatory variable (EP). Table II shows that F value, defined as the ratio between regression variance and residual variance, is evaluated to be 3.6. Since P value is 0.068, the hypothesis is valid within the significance level of 0.1. (Beta =0.338 and t=1.897)

On the other hand, the result from the 2018 data shows that the 34.1% of variance of dependent variable (UCL) can be explained by explanatory variable (FG). ANOVA analysis presents that F value is equal to 3.677. Since P value is 0.068, the hypothesis is valid within the 10% of significance level. (Beta =0.338 and t=1.897)

The results indicated that the society with authorized electoral process and limited pluralism showed the low occurrences of shutdown in 2017. Then, in 2018, the degree of the enforced administration of government became a variable of the NPP operation, not observed before 2018. Russia and China, the authoritarian regime, were expected to record low UCL in the future, but the possibility of enforced operation without proper regulation and inspection was concerned.
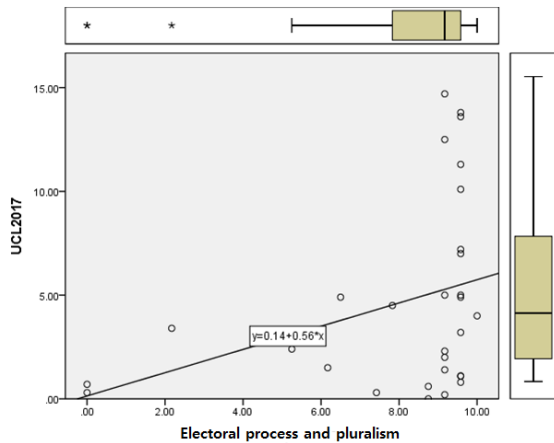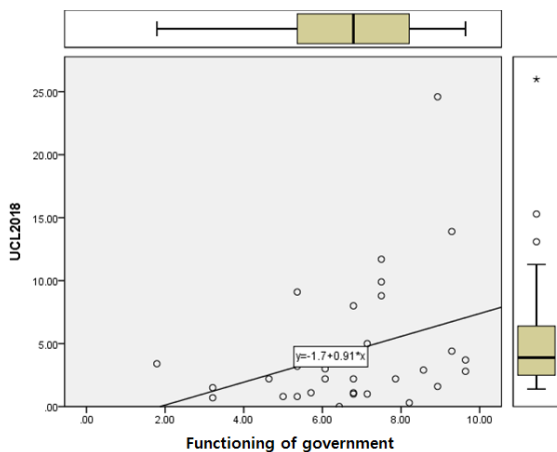

Fig. 1. Correlation between UCL and EP (2017)

Fig. 2. Correlation between UCL and FG (2018)

Table I: Summary of regression model

Model	Predictor	R	R Sq.	Adj. R Sq.	Std. E
2017	EP	.338	.114	.082	4.38
2018	FG	.341	.116	.085	5.03

Table II: ANOVA analysis

Model		Sum of Squares	df	Mean Square	F	Sig.
2017	Reg.	69.062	1	69.062	3.600	.068[b]
	R	537.210	28	19.186		
	Total	606.272	29			
2018	Reg.	93.165	1	93.165	3.677	.065[b]
	R	709.385	28	25.335		
	Total	802.550	29			

Table III: Coefficients information

Model		Unstd. Coeff.		Std. Coeff.		
		B	Std. Error	Beta	t	Sig.
2017	(Const.)	.141	2.512		.056	.956
	EP	.560	.295	.338	1.897	.068
2018	(Const.)	−1.696	3.328		−.510	.614
	FG	.909	.474	.341	1.918	.065

ACKNOWLEDGEMENT

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