

## Does Restarting the Operations of Nuclear Plants Improve Public Evaluations in Utility Companies? A Factorial Survey Experiment in Post-Fukushima Japan

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### EXTENDED ABSTRACT

One of the well-known factors for public acceptance of nuclear power generation is positive evaluations toward nuclear operators such as trust, as past studies have shown. Those who trust nuclear operators tend to show positive attitudes toward nuclear power generation. However, the relationship between positive evaluations and public support is associative because these studies were based on observational studies, and to identify the causal relationship, further explorations are needed. In addition, even if positive evaluations among the public toward nuclear operators are accepted as a vital condition for the acceptance of nuclear power generation, some antecedent factors of these evaluations or dynamic relationships between the evaluations and public support have not been sufficiently investigated. It is urgent to fill these research insufficiencies when considering the energy situation in Japan. In Japan, public support for nuclear power generation decreased sharply after the accident at the Fukushima Daiichi Nuclear Power Plant in 2011. Because of that, not only public support but also trust toward nuclear operators were both damaged. Once trust is lost, it is almost impossible to restore it immediately as past social psychological studies have clarified. Therefore, questions arise as to whether or not and to how evaluations of nuclear operators can be improved.

After the 2011 accident, a new regulatory regime was begun. The Nuclear Regulation Authority (NRA) has imposed rigorous screenings on nuclear operators. While some reactors located mainly in western Japan have passed strict reviews and restarted their commercial operations, others have not restarted yet. In other words, more than ten years after the accident, there are two groups of utility companies: those who could restart operations of their nuclear power plants and those who could not restart them. Having these two groups of utility companies or nuclear operators makes it necessary to reconsider the above findings. Because it is stated that positive evaluations toward nuclear operators are the vital condition for the public to support nuclear power generation, the differences among the groups of nuclear operators based on actual nuclear operations indicate another possibility or the opposite logic. Then, the question becomes: “Does restarting the operations of nuclear power plants correspond to better or poorer evaluations of utility companies?”

To investigate the question, this study formed several hypotheses and conducted a factorial survey experiment. When utility companies or nuclear operators restart the operations of nuclear power plants, the capacity utilization rate of nuclear power plants per year increases. Although the operation must be stopped during the periodic inspection required by law, the capacity utilization rates never arrive at 100 %. But restarting the operation contributes to increasing the rates. If restarting the operation could change public attitudes toward utility companies, it is considered that capacity utilization rates have roles to play. In addition to the capacity utilization rates, this study also focuses on the number of employees which utility companies hire for nuclear power generation because local governments or communities which host nuclear power plants expect the companies or operators to provide economic stability through employment.

Both the capacity utilization rates and the number of employees constitute economic aspects and benefits which utility companies and nuclear operators can provide. On the other hand, there are some restricting factors for accepting nuclear power generation which relate to nuclear safety and risks, as in general risk perception, contrary to benefit perception, negative emotions can be provoked. In this study, the types of safety professionals, the numbers of problems which are legally required to be reported, and the frequencies of information releases are also considered.

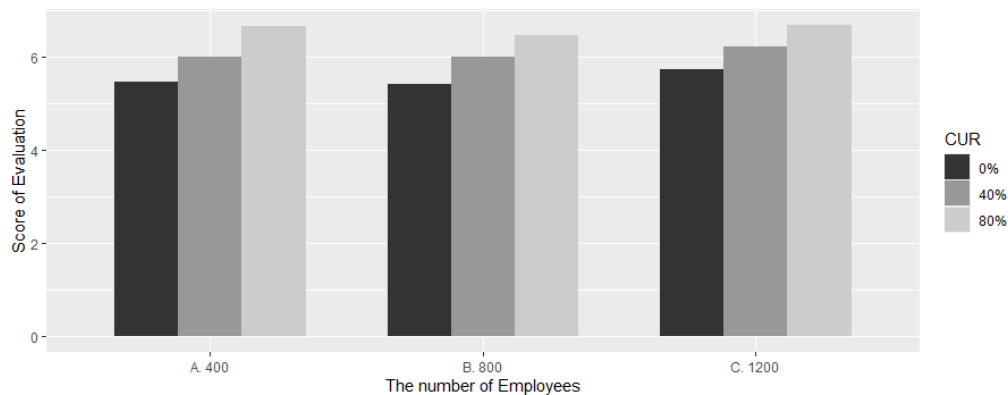
Data for this study were obtained through a factorial survey experiment conducted in March 2024. Factorial survey experiments are a suitable method for detecting people’s judgements based on situations like those in the “real world”. Respondents evaluate hypothetical utility companies after being shown vignettes describing information including the capacity utilization rates, the numbers of employees, the types of safety professionals, the numbers of problems which are legally required to be reported, and the frequencies of information releases. For example, the information in the vignettes is framed like this: “The capacity utility rate of a nuclear power plant last year operated by a utility company was **40%**...(omitted)”. The levels of these five factors are determined systematically manipulated as shown in Table I. Then, contributions of these factors to outcome are estimated statistically. The outcome is measured by 10-point scale which evaluates hypothetical utility

companies from 1 (very bad) to 10 points (very good). Respondents were required to answer eight vignettes. This factorial survey experiment was carried out through the web and the web-site was prepared by a professional web-survey institution. Socio-demographic backgrounds of respondents were allocated by sex, age, and educational attainment which are proportional to nation-wide Japanese statistics. In addition, 20 % of the sample included residents who live in prefectures that host nuclear power plants. After excluding those who skipped reading the experiment instructions and answered carelessly, a total of 500 respondents completed the experiment. Therefore, there were 4,000 cases for statistical analyses.

**TABLE I. Factors and Levels of the Experiment**

Factor / dimension	Levels
Capacity utilization rates	0% / 40% / 80%
Numbers of employees	400 / 800 / 1200
Types of safety professionals	Safety professional in university / Engineer in utility company
Numbers of problems	0 / 1 / 2
Frequencies of information releases	Several times in a week / Several times in a month / several times in a half year

As a result, by considering hierarchical structure of the obtained data, effects of each factor were estimated through the random effects model. Four models from the simplest one which includes only main effects to the most complex model which includes two interaction terms were fitted. According to the estimates obtained from the model which includes the interaction terms, the capacity utilization rates had statistically significant positive effects in evaluation and these effects did not depend on other factors. As shown in Fig. 1, the more the capacity utilization rates increased, the better the evaluation became and this relationship did not depend on the numbers of employees. On the other hand, the numbers of problems which are legally required to be reported had a statistically significant negative effect on the evaluation. The more problems there were, the worse the evaluation became but this effect depended on the frequencies of information releases because a small but statistically significant interaction effect was found.



**FIGURE 1. Estimates in Evaluation Predicted from the Random Effects Model**

This study shed light on the hidden mechanism behind which evaluations in utility companies depend in the post-Fukushima Japanese context on actual nuclear operations measured by the capacity utilization rates. The finding implies that differences of operating experiences themselves have roles to play beyond just the agreement or disagreement toward utilization of nuclear energy. In addition, the effects of other variables such as the number of problems or the frequency of communications also provide some insights into the strategies of risk communication especially employed by nuclear operators because the effect in the frequency of information releases depended on the number of problems as found in the interaction effect. In recent years, ensuring energy security, balancing the energy mix, and diversifying electricity sources have come to be important issues not only in Japan but also in countries worldwide. The extension of the operational period of nuclear power plants and the construction of new plants are also topics discussed in many countries. The findings of this study will facilitate these discussions.

## REFERENCES

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