Optimal Procedure for siting of Nuclear Power Plant

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1. Introduction

This study discusses on a simulation approach for sensitivity analysis of the weights of multi-criteria decision models. This approach allows simultaneous changes of the weights and generates results that can easily be analyzed statistically to provide insights into multi-criteria model recommendations[1]; and investigation of sensitivity to the form of multi-criteria decision models. The simulation procedures can also be used to aid the actual decision process, particularly when the task is to select a subset of superior alternatives[1].

This study is to identify the criteria or parameters which are sensitive to the weighting factor that can affect the results in the decision making process to determine the optimal site for nuclear power plant (NPP) site. To perform this study, we adhere to IAEA NS-R-3 and DS 433. The siting process for nuclear installation consists of site survey and site selection stages.

The siting process generally consists of an investigation of a large region to select one or more candidate sites by surveying the sites. The regions of interest (ROI) in this case study are southwest region, and southeast region of Korean Peninsula. The regions are Jeollanam-do for southwest region and Gyeongsangnam-do for southeast region as shown in Figure 1. After comparing the ROI, two candidate sites are compared for final determination, which are Wolsong and Kori site.

Figure 1. Regions of Interest (ROI) (source: Google Maps)

2. Siting Procedure

Siting should be a process of selecting suitable locations for a nuclear installation such that its characteristics inherently makes its exposure to natural and human induced hazards of external events as low as practicable. Further, the surrounding demographic setting and dispersion characteristics should enhance the mitigation capabilities against the radiological release[2].

Siting process consists of two stages; site survey stage as the first stage, and site selection stage as the second stage. Regional analysis is the first step that falls into site survey stage. Screening and, evaluation, comparison and ranking are the second and third steps that fall into site selection stage.

2.1 General procedure

The siting process consists of a series of related activities with the objective of selecting the suitable site(s) for the new nuclear installation. The process systematically should apply a series of screening criteria to screen out those sites with lesser attributes that contribute to the safety and viability aspect of the site[2].

The siting process has three distinct steps starting with given region(s) of interest. (1) Regional analysis: This is the first step, in which region(s) of interest are analysed to identify potential sites. It is important to consider all the potential sites in this phase and not to discard any. (2) Screening test: In the second step, the potential sites are screened to choose the candidate sites. Principal objective of this step is to exclude the unfavourable site from safety as well as non-safety considerations. (3) Evaluation, comparison and ranking: Purpose of the third step twofold: (i) to evaluate the site in order to assure there are no features at the sites that would preclude the construction and operation of a NPP, and (ii) to compare the candidate sites and rank them in the order of their attractiveness as a NPP site[2].

2.2 Siting criteria

Siting criteria are the bases or the principles using of which decisions are taken, during different steps of siting process, on attributes related to site characteristics, as well as site related specific issues, events, phenomena, hazards and other considerations after analyzing and/or investigating the associated data/information[2].

The screening test of potential sites should be conducted using two types of screening criteria[2]. They are exclusion criteria which engineering solution are not practicable, and discretionary criteria which engineering solutions are able to mitigate their impacts. These criteria are briefly described in Table 1.

Table 1. Screening criteria[2]

Screening criteria	Remarks
Exclusion criteria	Discard sites that are unacceptable from those attributes related to issues, or events or phenomena or hazard for which engineering solution are not generally practicable. Only a few criteria (e.g. ground rupture) fall into this category
Discretionary criteria	Associated with those attributes related to issues, or events, or phenomena or hazards, or considerations for which engineering solutions are available to mitigate their impacts. These criteria are used to facilitate the selection process through iterative screening to eliminate less favourable sites when a large number of possible candidate sites exist

2.3 Sensitivity analysis

We conduct the sensitivity analysis to determine the optimal site during the decision making process. What we want to know from sensitivity analysis is which parameter has a significant impact on the results. In sensitivity analysis, we will vary the scores, and weights of the criteria or parameter to determine the sensitivity of the results to minor changes. We will employ Logical Decisions software, a decision analysis software to help evaluate alternatives by systematically looking at the alternatives by following a series of steps. By employing this software, we will use preference assessment methods.

3. Case Study

In this study, we perform standardization process and sensitivity analysis in decision making processes. Figure 2 shows the siting process in our case study.

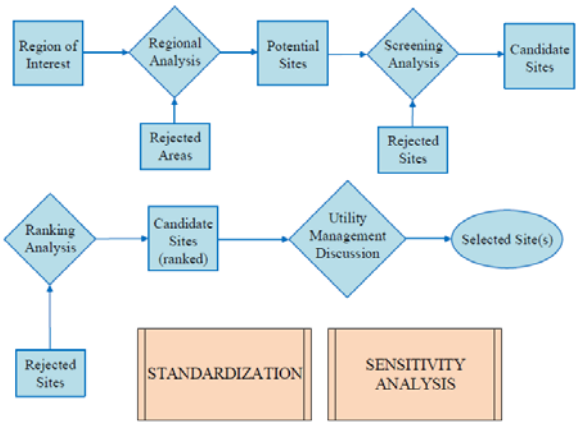

Figure 2. Siting process for optimal siting procedure

Multi criteria evaluation is a type of evaluation that we will use for sensitivity analysis in this study. In multi criteria evaluation, to meet one objective, several criteria must be considered. The objective of performing sensitivity analysis is to understand the siting process and which criteria or parameters have strong influence on assessing the candidate sites. Multi criteria evaluation is designed to assist decision makers to integrate different alternatives to select the optimal NPP site.

Multi criteria typically have varying importance and therefore, each criterion can be assigned a specific weight that reflects its importance relative to other criteria under some considerations. The value of weight is not only dependent on the importance of the criterion, but also on the possible value range of the criterion. A criterion with variability will contribute more to the outcome of the alternative and should be regarded as more important than the other criteria with no or little changes in their ranges.

Logical Decisions software provides a high degree of flexibility in how we can evaluate the alternatives. The basic steps are to structure the problem, describe the alternatives, assess the preferences, and finally rank the alternatives and determine the best. Sensitivity analysis provides scaling constants of ranking attributes. Figure 3 shows scaling constants of ranking attributes for a case example.

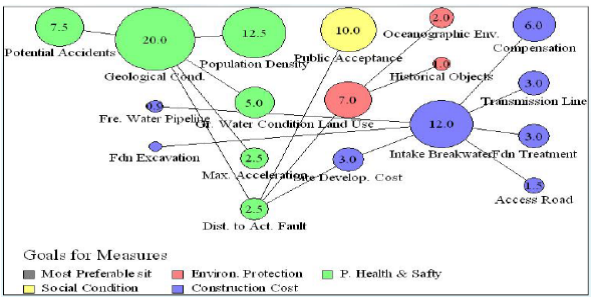

Figure 3. Scaling constants of ranking attributes for case example

4. Discussion and conclusion

Some assumptions are taken into consideration due to limitations and constraints throughout performing this study. Sensitivity analysis of multi criteria decision models is performed in this study to determine the optimal site in the site selection stage. Logical Decisions software will be employed as a tool to perform this analysis.

Logical Decisions software helps to formulate the preferences and then rank the alternatives. It provides clarification of the rankings and hence aids the decision makers on evaluating the alternatives, and finally draw a conclusion on the selection of the optimal site.

REFERENCES

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