SEISMIC STATION SITE SELECTION BASED ON MULTI-ATTRIBUTE DECISION MAKING APPROACH

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One of the most important steps in building a permanent seismic network is selecting the location of its stations. If the arrangement of the stations is not correct, it may be possible that the fault in determining the location of earthquakes increases or there's a systematic error in the earthquake location. It is best to begin the process of site selection by choosing, generally, two to three times as many potential sites as will finally be used. One can then study each one and choose the sites that meet as many desired criteria as possible.

To select the best location of the stations, there are several criteria that are:

1- Security of the location of the station deployment
2- Geographic region of interest
3- Seismo-geological considerations
4- Topographical considerations
5- Station access considerations
6- Evaluation of seismic noise sources
7- Seismic data transmission and power considerations
8- Land ownership and future land use
9- Climatic considerations
10- Structure of seismis network (distance from near stations, decrease azimuth gap...)

Each criteria have some sub-criteria, for example sub-criteria of Seismo-geological considerations are types of rocky outcrops, tectonic complications. Therefore the paper proposes a multi-attribute decision making approach for site selection of the seismic station by considering decision tree. We used the ANP and Fuzzy Topsis methods. The kernel of this approach is to establish a multi-layer decision making framework after identifying the influencing factors. The proposed approach is applied to a real site selection of seismic station in north of Iran.

The procedures of MADM can be summarized in five main steps as follows:

Step 1: Define the nature of the problem

Step 2: Construct a hierarchy system for its evaluation

Step 3: Select the appropriate evaluation model

Step 4: Obtain the relative weights and performance score of each attribute with respect to each alternative

Step 5: Determine the best alternative according to the synthetic utility values, which are the aggregation value of relative weights, and performance scores corresponding to alternatives. If the overall scores of the alternatives are fuzzy, we can add Step 6 to rank the alternatives for choosing the best one.

Step 6: Outrank the alternatives referring to their synthetic fuzzy utility values from Step 5.

Many decision problems cannot be structured hierarchically because they involve the interaction and dependence of higher-level elements on lower-level elements. Not only does the importance of the criteria determine the importance of the alternatives as in a hierarchy, but also the importance of the alternatives themselves determines the importance of the criteria.

The first step of the ANP is to compare the criteria in the whole system to form the super matrix. This is done through pairwise comparisons by asking "How much importance does a criterion have compared to another criterion, with respect to our interests or preferences?" The relative importance value can be determined using a scale from 1 to 9 for representing equal importance to extreme importance. The general form of the super matrix can be described as follows:

We show in Figure 2, a three clusters network structure, are used to demonstrate how to form the super matrix based on the specific network structures.

$$W = \begin{matrix} & C_1 & C_2 & C_3 \\ C_1 & W_{11} & W_{12} & W_{13} \\ C_2 & W_{21} & W_{22} & 0 \\ C_3 & 0 & W_{32} & 0 \end{matrix}.$$

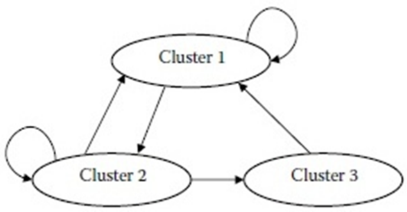

Figure 1. The network structure of 3 clusters.

After forming the super matrix, the weighted super matrix is derived by transforming all column sums to unity exactly. Next, we raise the weighted super matrix to limiting powers to get the global priority vectors or so-called weights:

$$\lim_{k\rightarrow\infty} W^k \quad (1)$$

TOPSIS was proposed by Hwang and Yoon (1981) to determine the best alternative based on the concepts of the compromise solution. The compromise solution can be regarded as choosing the solution with the shortest Euclidean distance from the ideal solution and the farthest Euclidean distance from the negative ideal solution.

For this case, we have three alternatives that should be chosen among them. We fist formed the decision tree that the security is the most important factor. If each alternative pass this option we will proceed to the next stage. At this stage, with using ANP and fuzzy topsis we chose the best alternative.

REFERENCES

Bormann, P. (2012). *New Manual of Seismological Observatory Practice (NMSOP)*. Textbook, GeoForchungsZentrum Potsdam, Germany.

Ebrahimi, M. and Mirzayi Modam M. (2015). Selecting the best zones to add new emergency services based on a hybrid fuzzy MADM method: A case study for Tehran. *Journal of Safety Science*, *85*, 67-76, Faculty of New Sciences and Technologies, University of Tehran, Tehran, Iran.

Havskov, J. and Alguacil, G. (2016). *Instrumentation in Earthquake Seismology*. Textbook, University of Bergen and University of Granada.

Kung-Ming Liu, Sheng-Hau Lin, Jing-Chzi Hsieh, and Gwo-Hshiung Tzeng (2018). Improving the food waste composting facilities site selection for sustainable development using a hybrid modified MADM model. *Journal of Waste Management*, *75*, 44–59, College of Construction and Development, Feng Chia University, Taichung, Taiwan.