FUZZY ANALYTIC HIERARCHY PROCESS (FAHP) AND TOPSIS FOR BUSINESS SITE SELECTION

ABSTRACT

The location of a business site is one of the main factors that can determine the success of the business. Many criteria are taken into consideration when selecting the location of the business site, therefore decision makers will need to achieve an agreement when evaluating the criteria. The decision-making process involving multiple criteria is a complex task and over the years, many multi-criteria decision-making (MCDM) methods were researched upon and developed. In this paper, a model combining the Fuzzy Analytic Hierarchy Process (FAHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for site selection is discussed. This model is used to rank six utility payment points in Selangor, Malaysia to determine the effect of the business site on the sales performance.

Keywords: Fuzzy AHP, TOPSIS, Business Site Selection, Utility Payment Point.

1. Introduction

The selection of a business site is one of the most vital strategic decision as it can determine the success or failure of the business. Failure to select an optimal site will cause financial difficulties as the site will not be able to generate the amount of profit needed to cover the cost of operating the site. In addition, the failure of the business can stain the image of the business. Hence, the decision of selecting a business site must be done with care.

The decision process involving multiple criteria is a complex task. The task is even made more difficult when multiple decision makers have their own views and ideas of the criteria. Therefore, many MCDMs have been developed over the years in order to aid decision makers in the decision-making process.

The use of the combination of FAHP and TOPSIS for site selection has been researched upon previously for areas such as managerial staff selection, supply chain management and plastic recycling method. However, very few literature focused on the use of the FAHP – TOPSIS approach for business site selection, and more specifically for a utility payment point. This study will prove to be beneficial for the decision makers of the utility company as an aid in the selection of the optimal site to set up the utility payment point.

2. Literature Review

Past literature show that the combination of FAHP and TOPSIS methods have been deployed in various fields of study.

In 2014, a study on the selection of the best plastic recycling method using the FAHP-FTOPSIS method was done. The use of Fuzzy TOPSIS in the study has eliminated many steps that are only performed in AHP-Fuzzy AHP situations hence providing the results of the process in a shorter period of time.

In another study in 2014, the FAHP-TOPSIS model was researched on for the ranking of the Knowledge Management adoption in Supply Chain. In the study, FAHP was used to obtain the weights of the barriers of the adoption of the knowledge management while FTOPSIS was used to rank the solutions.

In 2015, a study on the use of the combined methods for the selection of a human resource manager was done. The study concluded that the FAHP-TOPSIS model gave satisfactory results in general with the limitation that the decision makers must have excellent understanding of the criteria to be evaluated.

The application of the FAHP-TOPSIS method for business site selection is unheard of. This study is the first study focusing on a specific type of business site which is the utility payment point for a utility company.

3. Hypotheses/Objectives

The objectives of the study are:

1) To identify the set of criteria that affect the selection of a utility payment point.

2) To develop a FAHP–TOPSIS model that will aid decision makers in selecting a site for a utility payment point.

4. Research Design/Methodology

This study proposes a methodology that is broken down into four phases namely data collection phase, criteria and alternatives evaluation phase, experiment phase, and lastly, validation phase.

Data collection phase

The data collection phase involves collecting the real-world sales data of the existing utility payment points. Using this data, the top six performing utility payment points in terms of their sales output were taken as the alternatives for the model. Besides the sales data, trips to the actual utility payment points were done to collect physical data based on the criteria that have been chosen as part of the model. The criteria to be evaluated were determined based on past literature as well as an initial meeting with the decision makers prior to the second phase.

Criteria and alternatives evaluation phase

The evaluation of the criteria and alternatives were done by the decision makers. In the second meeting, the decision makers were given a questionnaire. The questionnaire was designed to be simple and straightforward.

The first part of the questionnaire required the decision makers to perform a pairwise comparison between two criteria. This pairwise comparison was used to determine the weights of each of the criteria using the FAHP method. Once the weights of the criteria have been determined for each decision maker, the weights are then aggregated using geometric mean to obtain a single set of criteria weights.

The second part of the questionnaire required the decision makers to determine how much does each of the alternatives satisfy the requirement of the criteria. These satisfaction values are also aggregated using geometric mean.

The TOPSIS method was used to rank the alternatives using the weights obtained from the first part via FAHP and the satisfaction evaluation from the second part of the questionnaire.

Experiment phase

Once the questionnaires are completed, the averaged values were used together with the F AHP package in R and TOPSIS calculation in Microsoft Excel to compute the results of the model.

Validation phase

The validation of the model was done by comparing the result of the model and the ranking of the utility payment points based on their sales data.

5. Data/Model Analysis

The model consists of criteria to be evaluated that are easily understood. The set of criteria consists of (i) number of counters in the site, (ii) number of parking spaces in the premise, (iii) the type of entrance to the site, (iv) population density, (v) visibility of the site from the major road, (vi) traffic density, and (vii) accessibility to the site by public transportation. Figure 1 shows the breakdown of the criteria and alternatives.

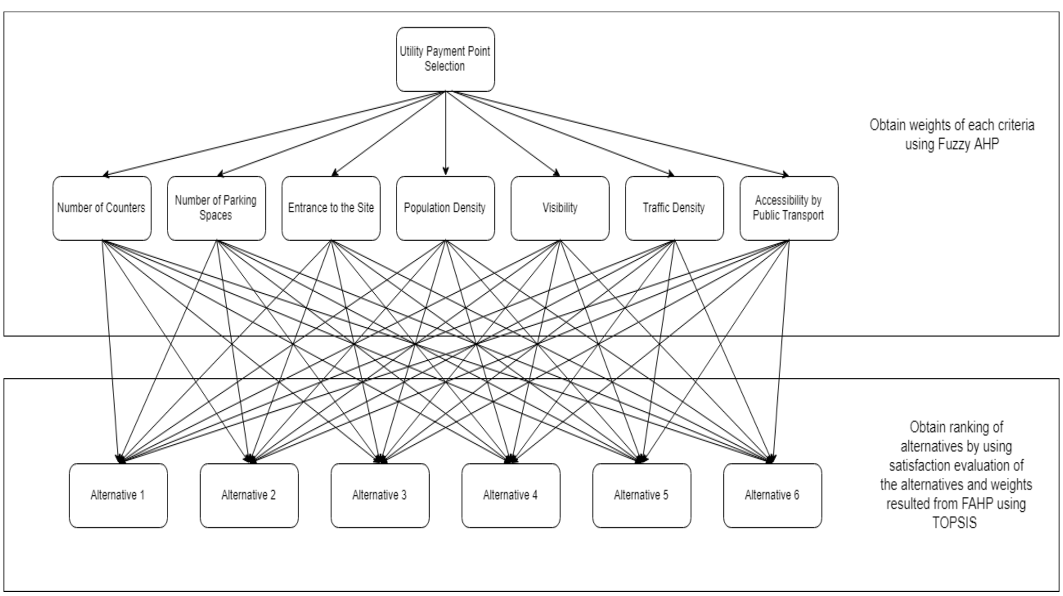

Figure 1: Proposed model of FAHP and TOPSIS

The results of the model are as shown in Table 1.

Table 1: FAHP + TOPSIS vs Real-world Ranking

Rank	FAHP + TOPSIS model	Real-World	Sales (RM)*
1	A1	A1	1289336.00
2	A6	A2	1051042.00
3	A2	A3	971436.30
4	A5	A4	990810.60
5	A4	A5	899448.30
6	A3	A6	889080.20

*Sales data are masked

Table 2 shows the weights of the criteria obtained from FAHP.

Table 2: Weights of criteria obtained from FAHP

Criteria	Weight
Number of Counters	0.045493
Number of Parking Spaces	0.138505
Entrance to the Site	0.094065
Population Density	0.204029
Visibility from major road	0.276077
Traffic Density	0.020403
Accessibility by Public Transport	0.135969

Table 3 shows the comparison of the rankings of the alternatives comparing the usage of TOPSIS alone and the combined methods

Table 3: FAHP+TOPSIS vs TOPSIS

Rank	FAHP + TOPSIS model	TOPSIS
1	A1	A1
2	A6	A6
3	A2	A3
4	A5	A4
5	A4	A5
6	A3	A2
Spearman's Rho	**0.2**	**0.085714**

The Spearman's Rho is a rank correlation method to determine how similar the rankings are with 0 being very dissimilar and 1 being the exact match. It can be seen here that by combining the FAHP and TOPSIS methods, the similarity of the ranking is much higher.

6. Limitations

The first limitation to the study is that the results from the proposed model did not reflect the actual real-world ranking of the alternatives. This could be due to the fact that the uncertainties and fuzziness of the evaluation were not captured and handled correctly.

The second limitation is that the decision makers were not attentive to the questionnaire. It was noted that one of the decision makers was too pre-occupied with other matters and that may have skewed the results of the model.

7. Conclusions

This study aims to develop a model combining both the FAHP and TOPSIS methods to aid the decision makers of a utility company to select the optimal location for the next utility payment point.

From the results obtained from FAHP, it can be seen that the visibility of the site from the major road is the criteria with the highest weight in the evaluation. This means that in order to select the best site for the utility payment point, its visibility should be given priority. This could mean that there should not be any natural obstructions (e.g. trees blocking the site from view) or a tall signage can be set up in the premise.

In the future, the FAHP-TOPSIS model can be revised and reevaluated to obtain a more accurate and reliable model. The distance measure used in the TOPSIS portion can also be adjusted to obtain the more accurate and reliable model.

8. Key References

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