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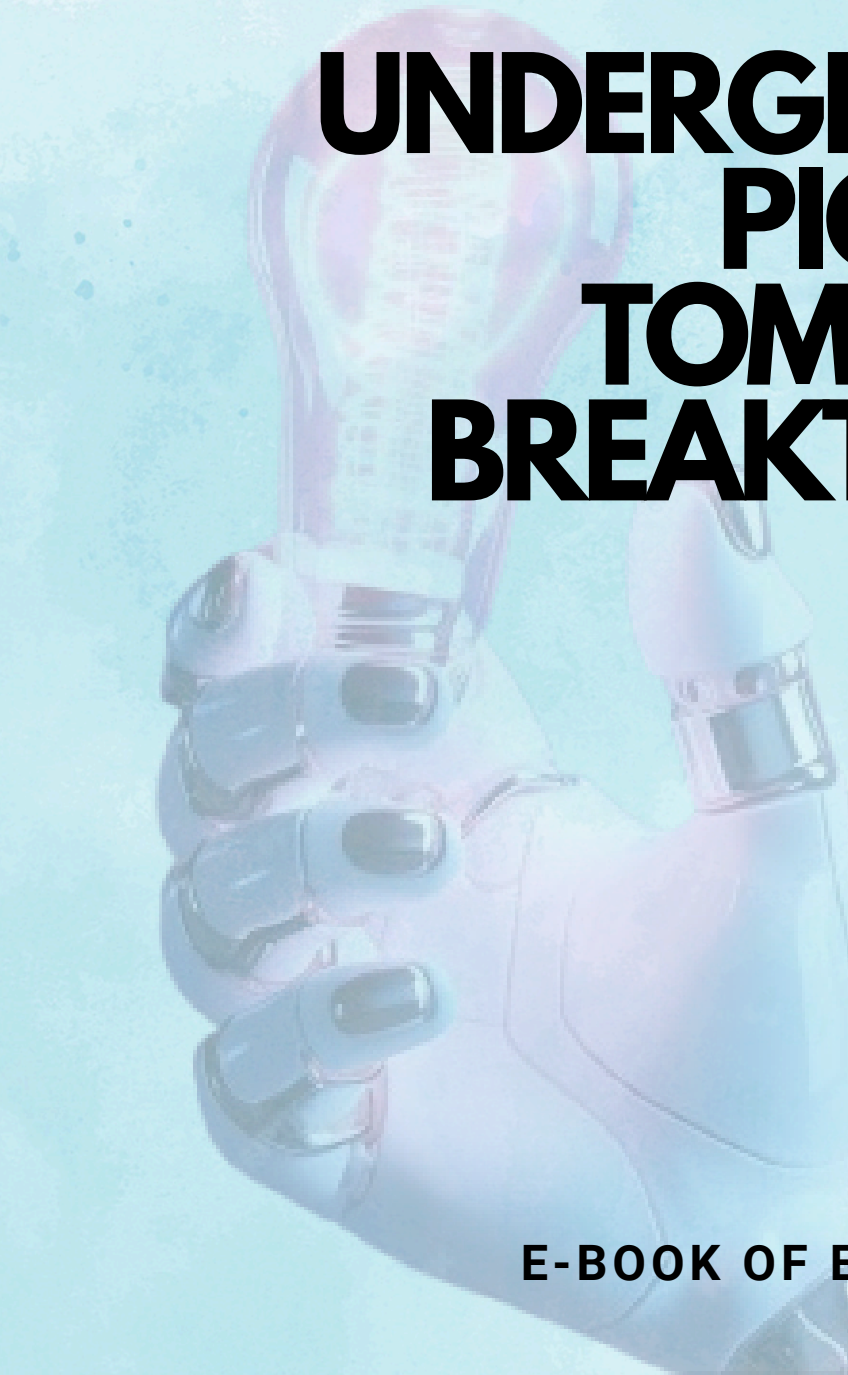

E-BOOK OF EXTENDED ABSTRACTS

RENTAL HOUSE SELECTION USING FUZZY TOPSIS

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ABSTRACT

The increasing number of students living off-campus necessitates effective decision-making tools for selecting suitable rental housing. Students frequently encounter challenges in identifying the most crucial criteria and choosing among numerous available options, as their decisions are heavily influenced by a multitude of factors. While various methods exist for multi-criteria decision-making, no prior research has specifically applied the Fuzzy Technique for Order Preference by Similarity to Ideal Solution (Fuzzy TOPSIS) method to address the problem of optimal rental house selection for students. This study bridges this significant methodological gap by establishing a novel framework for determining the most preferred rental house among students. Key input criteria, including accessibility, facilities, cost, privacy, and environment, were identified as critical factors influencing student choices. The Fuzzy TOPSIS method was then systematically applied to rank various rental house alternatives, specifically Taman Seremban 3, Taman Rasah Jaya, Taman Iringan Bayu, and Taman Desa Rasah based on these weighted criteria. The findings of this study demonstrate that Taman Seremban 3 emerged as the most preferred rental house among students of UiTM Cawangan Negeri Sembilan Kampus Seremban 3. This result confirms the efficacy of Fuzzy TOPSIS in successfully assisting the complex selection process of student rental housing. This pioneering application of Fuzzy TOPSIS provides a robust and objective decision-making tool, with future potential for developing a dedicated system for diverse selection problems and for integration with other weighting methods to further enhance its applicability across various fields.

Keywords: Rental House, Fuzzy TOPSIS, MCDM, Fuzzy Logic, Alternative Ranking

INTRODUCTION

In many countries, students' expectations concerning the quality of the accommodation have been increasing and the number of students who are living outside campus has also risen (Źróbek-Rózańska, 2022). Therefore, rental houses hold significant importance for university students who are unable to secure a place in a campus hostel or those who may live far away from campus.

The process of selecting an ideal rental house involves many criteria that must be considered. As a result, determining the most important criteria to be prioritised often leads to decision paralysis and suboptimal choices. Therefore, decision making methods such as Multiple Criteria Decision-Making (MCDM) are required since this method is known for decision makers to solve highly complex problems (Azhar et al., 2021). However, MCDM alone is insufficient to decide the best rental house because the presence of various criteria often leads to decision paralysis and suboptimal choices resulting in uncertain criteria. Hence, fuzzy logic is needed as it provides the mathematical framework that accommodates both uncertainty and precision (Sahoo et al., 2024).

Fuzzy Multi-Criteria Decision-Making (FMCDM) is a powerful development of fuzzy logic and an approach to decision-making problems. This is agreed by Sahoo et al. (2024), who stated that FMCDM solves the problems in environments with multiple criteria by providing a systematic framework for ranking alternatives. Furthermore, Junior et al. (2014) demonstrated that the Fuzzy TOPSIS is an efficient method in solving the problems of alternative selection concerning the changes in the alternatives and criteria. This study aimed to analyse the most preferred rental housing area among students at UiTM Cawangan Negeri Sembilan Kampus Seremban 3 based on the important criteria using Fuzzy TOPSIS methodology.

METHODOLOGY

In a study of renter′s preferences, accessibility, facility, cost, privacy and environment were identified as the key criteria. The alternatives for this study were four specific locations for students housing in area Taman Seremban 3, Taman Rasah Jaya, Taman Iringan Bayu and Taman Desa Rasah. The methodology for this study follows the eight steps for Fuzzy TOPSIS (Tanveer et al. 2023; Kore et al. 2017). First step is the fuzzy average weight, W is determined by calculating the weight for each criterion, j, as Equation (1), where k is number of experts, l is number of criteria, w_j^k is the weight of the criteria and j is rated by the experts, k and $j = 1, 2, \cdots, l$.

$$W = \left[W_1, W_2, W_3, \cdots, W_l\right]$$

$$W_j = \frac{1}{k}\left[w_j^1 + w_j^2 + w_j^3 + \cdots + w_j^k\right] \tag{1}$$

After that the fuzzy rating alternative, X_{ij} is constructed for all alternatives, i by using Equation (2), and x_{ij}^k, written as $\left(a_{ij}, b_{ij}, c_{ij}\right)$ represents the raw data collected from questionnaires.

$$X_{ij} = \frac{1}{k}\left[x_{ij}^1 + x_{ij}^2 + \cdots + x_{ij}^k\right] \tag{2}$$

This fuzzy rating alternative is then organized into a matrix, D as follows:

$$D = \begin{bmatrix} x_{11} & \cdots & x_{1j} \\ \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} \end{bmatrix}$$

Then, the fuzzy rating for each alternative across all criteria, r_{ij}, was normalised by using Equation (3) and Equation (4) where, $c_j^* = \max c_{ij}$ if $j \in B, B$ is for the benefit criteria and $a_j^- = \min a_{ij}$ if $j \in C, C$ is for the cost criteria.

$$r_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right), j \in B \tag{3}$$

$$r_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right), j \in C \tag{4}$$

Calculating all normalized fuzzy rating alternative, r_{ij}, is calculated to form the normalized fuzzy rating alternative matrix, R where m is number of rows for alternatives, i and n defines number of columns for criteria, j,

$$R = \left[r_{ij}\right]_{m \times n}$$

Next, the weighted normalised fuzzy matrix, V, is constructed using Equation (5) where u_{ij} is weighted fuzzy rating for each alternative across all criteria, get from $u_{ij} = r_{ij} \cdot W$ and r_{ij} is fuzzy rating for each alternative across all criteria and w_j denotes weight for each criterion

$$V = \left[u_{ij} \right]_{m \times n} \tag{5}$$

The FPIS, A^* and FNIS, A^- for each criterion, j are calculated using the following Equation (6) and Equation (7), respectively.

$$\begin{aligned} \mathrm{A}^* &= \left[\mathrm{A}_1^*, \mathrm{A}_2^*, \cdots, \mathrm{A}_l^* \right] \\ \mathrm{A}_j^* &= \left(\max_i u_{ij}^a, \max_i u_{ij}^b, \max_i u_{ij}^c \right) \end{aligned} \tag{6}$$

$$\begin{aligned} \mathrm{A}^- &= \left[\mathrm{A}_1^-, \mathrm{A}_2^-, \cdots, \mathrm{A}_l^- \right] \\ \mathrm{A}_j^- &= \left(\min_i u_{ij}^a, \min_i u_{ij}^b, \min_i u_{ij}^c \right) \end{aligned} \tag{7}$$

For each alternative, i and each criterion, j the calculation between the fuzzy weighted normalised value, u_{ij} with FPIS, $\mathrm{A}^*\left(d\left(u_{ij}, \mathrm{A}_j^*\right)\right)$ and FNIS, $\mathrm{A}^-\left(d\left(u_{ij}, \mathrm{A}_j^-\right)\right)$ is by using Equation (8) and Equation (9), respectively as follows:

$$d\left(u_{ij}, \mathrm{A}_j^*\right) = \sqrt{\frac{1}{3}\left[\left(a_1 - a_2\right)^2 + \left(b_1 - b_2\right)^2 + \left(c_1 - c_2\right)^2 \right]} \tag{8}$$

$$d\left(u_{ij}, \mathrm{A}_j^-\right) = \sqrt{\frac{1}{3}\left[\left(a_1 - a_2\right)^2 + \left(b_1 - b_2\right)^2 + \left(c_1 - c_2\right)^2 \right]} \tag{9}$$

Then, the distance between the fuzzy weighted normalised value are calculated and form the matrix $d^* = \left[d\left(u_{ij}, \mathrm{A}_j^*\right) \right]_{m \times n}$ and $d^- = \left[d\left(u_{ij}, \mathrm{A}_j^-\right) \right]_{m \times n}$. By using Equations (10) and (11), the total distance between each alternative with FPIS $\left(D_i^*\right)$ and FNIS $\left(D_i^-\right)$ is calculated as,

$$D_i^* = \sum_{j=1}^{l} d\left(u_{ij}, \mathrm{A}_j^*\right) \tag{10}$$

$$D_i^- = \sum_{j=1}^{l} d\left(u_{ij}, \mathrm{A}_j^-\right) \tag{11}$$

Calculating all the total distance between alternative with FPIS $\left(D_i^*\right)$ and FNIS $\left(D_i^-\right)$ for each alternative, i form matrix, $D^* = \left[D_1^* \quad D_2^* \quad \cdots \quad D_i^* \right]$ and $D^- = \left[D_1^- \quad D_2^- \quad \cdots \quad D_i^- \right]$ respectively. Relative closeness to the ideal solution, CC_i for each alternative, i is calculated using Equation (12).

$$CC_i = \frac{D^-}{D^* + D^-} \quad (12)$$

RESULTS AND DISCUSSION

A questionnaire was distributed to five selected students from UiTM Seremban 3 campus. These individuals were chosen as experts because they are final year students with prior experience in selecting rental houses, making their insights valuable and reliable for this study's purpose. The findings from their responses form the basis of the analysis and ranking of the rental properties. The final ranking is shown in Table 1.

Table 1: The final ranking of alternatives from Fuzzy TOPSIS

Alternative	Relative Closeness to Ideal Solution	Rank
Taman Seremban 3	0.75	1
Taman Rasah Jaya	0.57	2
Taman Iringan Bayu	0.43	3
Taman Desa Rasah	0.41	4

Based on Table 1, it shows that Taman Seremban 3 is ranked first among all alternatives with the highest relative closeness to ideal solution, 0.75. followed by Taman Rasah Jaya, 0.57 and Taman Iringan Bayu, 0.43 respectively. Taman Desa Rasah is ranked as the last, 0.41 out of all which means Taman Desa Rasah is the least preferred house. Table 2 shows the comparison for the ranking of alternatives using both Fuzzy TOPSIS and TOPSIS methodology.

Table 2: The comparison in result between Fuzzy TOPSIS and TOPSIS

Alternative	Fuzzy TOPSIS		TOPSIS	
	Relative Closeness to Ideal Solution	Rank	Relative Closeness to Ideal Solution	Rank
Taman Seremban 3	0.75	1	0.9989	1
Taman Rasah Jaya	0.57	2	0.7272	2
Taman Iringan Bayu	0.43	3	0.0033	4
Taman Desa Rasah	0.41	4	0.0035	3

The result from Table 2 shows that the ranking of Taman Seremban 3 and Taman Rasah Jaya remained its first and second most preferred rental houses. However, Taman Iringan Bayu and Taman Desa Rasah ranking have changed the position of third and fourth. Other than that, the results also show a drastic change in the value of relative closeness to the ideal solution for all alternatives. The value changed because in the TOPSIS method, the value of the rating of the criteria and alternatives is different with Fuzzy TOPSIS. The TOPSIS method relies on precise input data. Small differences in criteria or alternatives rating result in precise differences in the relative closeness to the ideal solution. Fuzzy TOPSIS works with fuzzy values so the closeness to the ideal solution reflects on the uncertainties and range. Hence, when the fuzzy value was defuzzified, the values slightly change due to the range of fuzzy numbers (Tanveer et al., 2023).

CONCLUSION

This study successfully demonstrates ranking rental houses for students by applying Fuzzy TOPSIS to a real world problem that has not been addressed by this method before. The study identifies five key criteria for the decision making process which are accessibility, facility, cost, privacy and environment. The findings confirm that Fuzzy TOPSIS is a useful tool for evaluating and ranking rental options. The results showed that Taman Seremban 3 was the most preferred rental house, followed by Taman Rasah Jaya, Taman Iringan Bayu and Taman Desa Rasah. This study also highlighted the differences between Fuzzy TOPSIS and traditional TOPSIS. While the top two rankings remained the same, the positions of the third and fourth options swapped. This change occurred because Fuzzy TOPSIS considers the uncertainty and variability in the decision making process, whereas the traditional method relies on precise data. Overall,

this study concluded that the Fuzzy TOPSIS model is an effective tool for helping renters make complex decisions when choosing a rental house.

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