Application of TOPSIS Method in Finding the Best Property House

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Abstract
Nowadays, we are very familiar with most of software application such as Mudah.my, Traveloka and many more application that founded in Apple store and Playstore. While making decisions, consumers are often confronted with choosing between multiple product and brand alternatives that may be viewed as specific bundles of attributes/criteria. In choosing an ideal property house, an appropriate criteria or attribute is needed to be adopted on the evaluation of each property house. The buyers can analyze the criteria of the house scientifically for their investment by using a multi criteria decision making model which is TOPSIS model. The objectives of this study are to evaluate, compare and rank the overall performance of the house is evaluated in with a few criteria involve which are the price, category of house, title type, size, bedroom, bathroom, facilities and accessibility. In this study, the data consists of five houses located in Kota Kinabalu, Sabah. The alternative involved in this study are Element Utara Kota Kinabalu, KK Alam Puteri House, Country Shangri La, Townhouse Luyang, and Riverside Residence Kepayan. The results show that Townhouse Luyang, Riverside Residensi Kepayan and Elemen Utara Kota Kinabalu achieve the top three ranking among the alternative involved. This study is significant to the buyers since its able to evaluate and rank the overall performance of the property house by considering all criteria by using TOPSIS mathematical model.
Keywords: TOPSIS, MCDM, Property Selection, Normalized decision matrix, Positive and Negative ideal solution, Relative closeness, Ranking.

1   Introduction

In choosing the best property is very difficult when a lot of criteria is considered in once decision making. The many options available in the market can be a confusing thing in choosing the best. For the purpose, this research will discuss decision support system which is expected to assist the owner in accordance with predetermined criteria.

Property is an item that a person or any business has legal title over. Property can be tangible items, such as houses, cars or appliances. Else, it also can be referred to intangible items that carry the promise of future worth, such as stock and bond certificates. The popular have been introduce with us and well known as mudah.my where people can found the details much easier. Nevertheless, it is hard for the consumer to make a good decision.

2   Literature Review

Based on previous study, there are many studies that use TOPSIS method as their initiative to make a better decision. It is widely use in many sector such as finance, economical, sustainable management and even in property investment.

In 2014, (Srikishna S, Sreenivasulu Reddy A, & Vani S, 2014) proposed the study of selecting a new car with limited number of choices but each has large number of attributes. The criteria that involved are style, life span, fuel economy, and cost while the attributes that involved are Maruta Ertiga, Swift, Tata Indica and last Alto 800. As a result, they identified that Tata Indica as the best car among the considered ones which has the best relative closeness value.

In 2018, (Jollyta, 2018) says that in property development, selecting the best location is one of the crucial factor in making a decision. The location that does not meet the criteria will pose problems such as large cost incurred in development, long construction completion time and marketing difficulties. Thus, they came out will solution by using TOPSIS method to find the best location based on more criteria that would be involved. There are three location involve which are A, B, and C. Final result show that location A is the best choice.

There are also some studies that investigate the comparative study of Multi Criteria Decision Method. A master student from University of Manitoba, (Zhang, 2014) is one of the researcher who wrote the comparative between for different method of MCDM. His thesis compares and contrast four types of MCDM model within a laptop brand choice. The method that involved are Multi Attribute Attitude Model (MAAM), Analytical Hierarchy Process (AHP), Technique for Order Preference By Similarity to Ideal Solution (TOPSIS), and mixed AHP-TOPSIS method. The advantage and disadvantage of each of the method are reviewed and a mixed AHP-TOPSIS method is proposed in the main paper.

In 2018, (Jozaghi, et al., 2018) noticed that the application of multi criteria decision-making (MCDM) techniques has been increased in recent years. He proposed to build an advanced decision model with higher capabilities that can support decision-making in abroad spectrum of applications. In the paper, it presents a comparative analysis of TOPSIS method and AHP in context of decision-making using GIS for dam site selection in Iran. The results show that TOPSIS method is better suited to the problem of dam site selection.

3   Methodology

3.1   Data Collection

Data collection is obtained from the website of mudah.my and Facebook marketplace. Besides, the information also can be got from agent of property that live in Kota Kinabalu Sabah by interviewing them. Table below shows the data collection.

Table 3. 1 Data Collection

Attributes	Alternatives				
	Elemen Utara Kota Kinabalu	KK Alam Puteri House	Country Shangri La	Townhouse Luyang	Riverside Residence Kepayan
Price (RM)	433 500	685 000	850 000	680 000	450 000
Category	Single storey	Two and half storey	Double storey	Double storey	Condominium
Title type	Leasehold	Leasehold	Leasehold	Leasehold	Freehold
Size (sq. ft.)	1055	2408	2792	1347	955
Bedrooms	3	4	5	3	3
Bathrooms	2	3	5	3	2
Facilities	Swimming pool, Gymnasium, Playground, 24 Hour Security, Car park/Garage	Playground, Jogging park, Balcony/Patio, Car park/Garage	Balcony/Patrio, Car park/Garage	Swimming pool, playground, Jogging park, 24 hour security, Cable TV, Car park/Garage	Swimming pool, Chidren's playground garden, BBQ area, Gymnasium
Accessibility	Opposite road has KFC and Pizza hut drive thru, Next to CKS supermarket, 20 minutes to Klinik Kesihatan Luyang, 15 minutes to KK centre	In front Tang Dynasty Hotel, Nearby Customs Hotel and Indah Permai, 8 minutes to One Borneo, Near Mydin Hypermall	10.1 km to KK City Centre 11.9 km to KK International Airport 3.5 km to Pekan Donggongon 3.4 km to St Michael Secondary School 4.1 km to Kinabalu International School 5.4 km to Sabah Golf & Country Club	Damai Lintas Kepayan Luyang Penampang KK City	2.1 km drives to Kota Kinabalu International Airport (KKIA) 6.7 km drives to Queen Elizabeth Hospital Elizabeth 8.3 km drives to City Mall 8.7 km drives to Imago Shopping Mall

3.2 Selection Criteria and Finding Weight each Criterion

Buying a new house is a big decision-making problem and reflection of customer preference. Customer choice must be made among several houses for a given application, it is necessary to compare their performance characteristics in proper manner. Some of the main criteria's house

were price, category of house, title type, size, bedroom, bathroom, facilities and accessibility. The importance of these criteria is commonly known and thus it is not elaborated. To find the weight for each criterion, AHP method was used.

3.3   Technique of Order Preference by Similarity to an Ideal Solution (TOPSIS)
The method used in making the best property house alternative decision is Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The method is chosen because the TOPSIS method is a form of decision support method based on the concept that the best alternative not only has the longest distance from the ideal solution but also has the longest distance from the ideal solution which in this case will give the best wood recommendation according to the expected.

The TOPSIS model consists of seven steps shown below illustrated by (Ab. Halim, Jaafar, Osman, & Haniff, 2012).

Step 1: Create a decision matrix consisting of m alternatives and n criteria, with the intersection of each alternative and criteria given as x_{ij}, where therefore have a matrix $(x_{ij})_{m \times n}$

Step 2: The matrix $(x_{ij})_{m \times n}$ is then normalized to form the matrix $R = (r_{ij})_{m \times n}$, using the normalized method

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{k=1}^{m} x^2_{kj}}}, \qquad i = 1,2,\dots,m, \qquad j = 1,2,\dots n \qquad (3.1)$$

Step 3: Calculate the weighted normalized decision matrix

$$t_{ij} = r_{ij} \cdot w_{ij}, \qquad i = 1,2,\dots,m, j = 1,2,\dots,n \qquad (3.2)$$

Where the weight was calculated by using AHP method illustrated by (Zhang, 2014)

Step 4: determine the worst alternative (A_w) and the best alternative (A_b)

$$A_w = \{\langle \max(t_{ij}|i = 1,2,\dots,m)|j \in J_-\rangle, \langle \min(t_{ij}|i = 1,2,\dots,m)|j \in J_+\rangle\} \qquad (3.3)$$

$$A_b = \{\langle \min(t_{ij}|i = 1,2,\dots,m)|j \in J_-\rangle, \langle \max(t_{ij}|i = 1,2,\dots,m)|j \in J_+\rangle\} \qquad (3.4)$$

Where,
$J_+ = \{j = 1,2,\dots,n|j\}$ associated with the criteria having a positive
$J_- = \{j = 1,2,\dots,n|j\}$ associated with the criteria having a negative

Step 5: Calculate the L^2 distance from the target alternative to the worst and best condition A_w

$$(3.5)$$

$$d_{iw} = \sqrt{\sum_{j=1}^{n}(t_{ij} - t_{wj})^2}, \quad i = 1,2,\dots,m$$

And the distance between the alternative I and the best condition Ab

$$d_{ib} = \sqrt{\sum_{j=1}^{n}(t_{ij} - t_{bj})^2}, \quad i = 1, 2, \dots, m \tag{3.6}$$

Where d_{iw} and d_{ib} are L^2 -norm distances from the target alternative i to the worst and best conditions, respectively

Step 6: Calculate the similarity to the worst condition by using the formula.

$$s_{iw} = \frac{d_{iw}}{d_{iw} + d_{ib}}, 0 < s_{iw} < 1, \quad i = 1, 2, \dots, m \tag{3.7}$$

Step 7: Rank the alternative according to s_{iw} (i = 1, 2, ..., m).

4   Result Analysis and Discussion
INPUT TABLE

Table 4.1 Multi Criteria Decision Making Matrix

	C1	C2	C3	C4	C5	C6	C7	C8
A1	9	6	5	5	6	5	9	7
A2	7	9	5	8	7	8	5	3
A3	4	8	5	7	8	7	3	5
A4	7	8	5	6	6	8	7	8
A5	8	5	6	3	6	8	6	9

Table 4.2 Normalized Decision Matrix

	C1	C2	C3	C4	C5	C6	C7	C8
A1	0.3127	0.1333	0.1838	0.1366	0.1629	0.0940	0.4050	0.2149
A2	0.1892	0.3000	0.1838	0.3497	0.2217	0.2406	0.1250	0.0395
A3	0.0618	0.2370	0.1838	0.2678	0.2896	0.1842	0.0450	0.1096
A4	0.1892	0.2370	0.1838	0.1967	0.1629	0.2406	0.2450	0.2807
A5	0.2471	0.0926	0.2647	0.0492	0.1629	0.2406	0.1800	0.3553

Table 4.3 Weighted Normalized Decision Matrix

	C1	C2	C3	C4	C5	C6	C7	C8
A1	0.0518	0.0112	0.0087	0.0217	0.0027	0.0101	0.0572	0.0599
A2	0.0313	0.0252	0.0087	0.0557	0.0036	0.0259	0.0177	0.0110
A3	0.0102	0.0199	0.0087	0.0426	0.0047	0.0198	0.0064	0.0306
A4	0.0313	0.0199	0.0087	0.0313	0.0027	0.0259	0.0346	0.0783
A5	0.0409	0.0078	0.0125	0.0078	0.0027	0.0259	0.0254	0.0991

Table 4.4 Positive Ideal (A_b)

	C1	C2	C3	C4	C5	C6	C7	C8
A_b	0.01022	0.02522	0.01250	0.05568	0.00474	0.02586	0.05720	0.09909

Table 4.5 Negative Ideal (A_w)

	C1	C2	C3	C4	C5	C6	C7	C8
A_w	0.05175	0.00777	0.00868	0.00783	0.00267	0.01010	0.00636	0.01101

Table 4.6 The L^2 distance

Alternative	d_{ib}	d_{iw}
A1	0.069799	0.072006
A2	0.098905	0.05821
A3	0.086762	0.059704
A4	0.045032	0.081795
A5	0.067439	0.092209

Table 4.7 The Proximity relative to the positive ideal solution

Alternative		s_{iw}
Elemen Utara Kota Kinabalu	A1	0.50778
KK Alam Puteri House	A2	0.370494
Country Shangri La	A3	0.407631
Townhouse Luyang	A4	0.644934
Riverside Residence Kepayan	A5	0.577577

Table 4.8 Final Rank

s_{iw}		Alternative
0.644934	A4	Townhouse Luyang
0.577577	A5	Riverside Residence Kepayan
0.50778	A1	Elemen Utara Kota Kinabalu
0.407631	A3	Country Shangri La
0.370494	A2	KK Alam Puteri House

TOPSIS model is a mathematical model which involves multi-criteria assessment in providing useful information to decision makers to evaluate the criteria performance of the alternatives. In this study, criteria performance of five different house located at Kota Kinabalu Sabah were analyzed by using the TOPSIS method to find the best ideal house. Based on the results in this study, KK Alam Puteri House is the most significant house as compared to the other property

house in Kota Kinabalu City. In summary, the top three best houses are Townhouse Luyang followed by Riverside Residensi Kepayan and Element Utara Kota Kinabalu. This study is very crucial to the property buyers because it is able to evaluate and rank the overall performance of each house that involved in this study by considering more criteria in their decision making.

The distance of all alternatives from positive ideal solution (d_{ib}) and the distance of all alternatives from negative ideal solution (d_{iw}) are calculated by using the (3.5) and (3.6) respectively. The distance of all alternatives from positive ideal solution (d_{ib}) for Elemen Utara Kota Kinabalu, KK Alam Puteri House, Country Shangri La, Townhouse Luyang and Riverside Residensi Kepayan are 0.069799, 0.098905, 0.086762, 0.045032 and 0.067439 respectively. The distance of all alternatives from negative ideal solution (d_{iw}) for Elemen Utara Kota Kinabalu, KK Alam Puteri House, Country Shangri La, Townhouse Luyang and Riverside Residensi Kepayan are 0.072006, 0.05821, 0.059704, 0.081795 and 0.092209 respectively.

By using equation (3.7)**Error! Reference source not found.**, the relative closeness to the ideal solution is determined. After their proximity to the ideal solution is determined, all the alternatives are arranged in descending order depending on s_{iw} so that the rank of preference can be determined. The relative closeness distance of each decision alternative to the ideal solution, s_{iw} for overall performance is shown in Table 4.7. If the relative closeness to the ideal solution, s_{iw} is higher, the particular alternative is closest to the positive ideal solution and farthest from the negative ideal solution.

The overall performance of the property house is determined by combining all the score of each criterion. After that, an optimal overall ranking of companies is generated by using TOPSIS method. As shown in Table 4.8, Townhouse Luyang achieved the first ranking among the other property house with 0.644934 relative closeness to the ideal solution, which is the highest among the others. This is because Townhouse Luyang considered as an affordable house after considering all the criteria involve between other houses. Therefore, Townhouse Luyang achieved the first ranking as compared to other houses. The relative closeness to the ideal solution, for Riverside Residensi Kepayan and Elemen Utara Kota Kinabalu and Country Shangri La are 0.577577, 0.50778 and 0.407631 respectively. Therefore, Riverside Residensi Kepayan and Elemen Utara Kota Kinabalu obtained the second, third and fourth ranking respectively. On the other hand, the relative closeness to the ideal solution, for KK Alam Puteri House is 0.370494. Thus, KK Alam Puteri House achieve the lowest ranking based on the multiple criteria.

5   Conclusion

Based in the discussion and evaluation from the previous chapter, the following conclusions can be drawn is:

1. TOPSIS method which is a method of decision support system that can solve various problems of multicriteria decision can also be used to solve the problem of best property (house) alternative choice.
2. The calculation of TOPSIS method obtained manually with the calculation results using Microsoft Excel Software.
3. The weight for each criterion involve is find by using AHP method to get more accuracy.
4. The first ranks of analyzes are Townhouse Luyang (0.644934), the second is Riverside Residence Kepayan (0.577577), the third is Element Utara Kota

Kinabalu (0.50778), the fourth Country Shangri La (0.407631) and the last is KK Alam Puteri House (0.370494). Based on sorting, the best wooden alternative choice is Townhouse Luyang with a value of. 0.64493.

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