COMBINATION OF MACBETH METHOD AND RANK ORDER CENTROID TECHNIQUES IN DETERMINING THE BEST TOURISM LOCATION IN EAST BALI

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ABSTRACT

Travel activities must be done in self-development, self-relaxation, and adding to the tourism experience. One of the popular tourist activities is visiting tourist sites; for example, in the Karangasem district, there are many tourist sites that local and foreign tourists often visit. When traveling, tourists usually decide to visit interesting tourist destinations. The number of tourist destinations available often makes tourists confused about choosing a destination according to their preferences. The purpose of this study is for tourists to determine tourist location destinations based on qualitative and quantitative assessments. The Macbeth method accommodates eight qualitative assessment attributes and two quantitative attributes from decision-makers. The rank order centroid technique is used in calculating the attribute weight value of the assessment criteria based on the order of attribute priority. The results of the study are the best tourist locations with Besakih Temple (A3) with a value of V = 45.25, then Tirta Gangga (A2) with a value of V = 43, Tenganan Village (A4) with a value of V = 39, 45 and Taman Edge (A1) with a value of V = 35.37.

Keywords: *Macbeth Method, Rank Order Centroid, Qualitative Attribute, Semantic Scale, Decision Making On Determination Tourist Location*

1. INTRODUCTION

Tourism is a travelling activity with various purposes such as calming down, adding experience, self-development and self-empowerment(Parhusip & Arida, 2018). Tourism is one of the potential sectors the source of regional income (Prasetyaningrum & Sari, 2019), attracting local and foreign tourists to visit leading tourism objects in each region. One area that excels in the tourism sector in Indonesia is the Province of Bali(Yuendini et al., 2019). Bali has become a world tourist destination because of its unique culture, and there are hundreds of tourist objects in Bali scattered in every district that is often visited by tourists (Sugiartawan & Hartati, 2018). It was recorded that 58335 tourists visited Bali from January - April 2022 (BPS Provinsi Bali, 2022). This data shows that Bali is still a popular tourist destination for tourists. One of the tourist destinations in East Bali is the Karangasem Regency, precisely at the eastern tip of the island of Bali. Geographical conditions are still beautiful, and a large area makes many interesting tourist objects in Karangasem (Trimurti & Utama, 2020), Still, the tourism potential is not widely known, both local and foreign tourists(Yoga et al., 2019). Some examples of popular tourist sites in Karangasem include Taman Ujung, Tirta Gangga, White Sand Beach, Besakih Temple, and Tenganan Village. The list of tourist locations in Karangasem has been recorded at the Karangasem

Tourism and Culture Office. The data becomes a reference in disseminating information about tourist destinations in Karangasem (Dinas Pariwisata Kabupaten Karangasem, 2019). When travelling, tourists usually decide to visit interesting tourist destinations. The number of available tourist destinations often makes tourists confused about choosing a destination according to their preferences(Satria et al., 2018). Therefore, this research is intended for tourists to determine tourist destinations in Karangasem with qualitative and quantitative assessment attributes from decision-makers to produce the best tourist sites based on several categories, namely religious tourism, nature tourism, educational tourism, and cultural tourism. for tourists to be able to determine tourist destinations in Karangasem based on several categories, namely religious tourism, nature tourism, educational tourism, cultural and historical tourism (Sudipa et al., 2021)(Permana & Wirayani, 2021).

2. RESEARCH METODOLOGY
2.1 Macbeth Method

The Measuring Attractiveness by a Categorical Based Evaluation TecHnique (MACBETH) introduced by Bana e Costa and Vansmick(Costa & Chagas, 2004). Macbeth's method can solve alternative problems with multi-attribute by ranking alternatives with various quantitative and qualitative attributes as well as conflicting criteria or attributes. An approach that can assist decision-making in generating numerical preferences from qualitative and quantitative attributes using measurement scale(Bana e Costa et al., 2016)(Lamas Leite et al., 2017).

The robustness of Macbeth's method is that it is a compensatory method that considers the positive and negative attributes of the alternatives considered(Banihabib et al., 2017), can resolve conditions where the attributes are mutually independent, or has a tradeoff between attributes. Decision-makers do not need to evaluate qualitative attributes into quantitative attributes(Alinezhad & Khalili, 2019a). The step of Macbeth method include (Kundakcı, 2019):

A. Decision Matrix

Evaluation criteria in the form of a decision matrix that is used for alternative data input information on each attribute(Alinezhad & Khalili, 2019b).

$$X = \begin{bmatrix} r11 & ... & r1j & ... & r1n \\ ... & ... & ... & ... & ... \\ ri1 & ... & rij & ... & rin \\ ... & ... & ... & ... & ... \\ rm1 & ... & rmj & ... & rmn \end{bmatrix}_{m \times n} \quad ; i = j, \dots , m, j = 1, \dots, n \qquad (1)$$

Where

r_{ij} = the element of the decision matrix for ith alternative in jth attribute. In addition, the decision maker provides the weight of attribute [$w1; w2; ...; wn$]

B. Converting of Semantic Scale Into Numerical Scale

Changes in attribute values based on the negative or positive attributes. In converting the semantic scale into a numerical scale then, the negative attributes are converted into positive attributes, converting the semantic scale into a numerical scale using a seven-point semantic scale(Karande & Chakraborty, 2013).

Table 1 Seven-Point Semantic Scale

Semantic Scale	Equivalent numerical scale (negative attribute)	Equivalent numerical scale (positive attribute)	Significance
Null	6	0	Indeference between alternatif
Very Weak	5	1	An alternatives is very weakly attractive over another
Weak	4	2	An alternatives is weakly attractive over another

moderate	3	3	An alternatives is moderatively attractive over another
Strong	2	4	An alternatives is strongly attractive over another
Very Strong	1	5	An alternatives is very strongly attractive over another
Extreme	0	6	An alternatives is extremely attractive over another

C.   Prefence Level

The alternative decision-maker determines the alternative preference value for each attribute. The alternative reference value ith alternative on the largest jth attribute is given a score of 100. In contrast, the reference value ith alternative on the lowest jth attribute is given a score of 0. Preference level calcaulation using Equation (2) and Equation (3).

$$r_j^- = min\ r_{ij};\ i= 1,\ …,\ m,\ j=1,\ …,\ n \tag{2}$$

$$r_j^+ = max\ r_{ij};\ i = 1,\ …,\ m,\ j=1,\ …,\ n \tag{3}$$

where

r_j^- =the smallest reference values

r_j^+ = the largest reference values

D.   MACBETH Score (V)

Calculate the Macbeth score of each alternative on each attribute by taking into the r_j^- values and r_j+ values using the following equation (4).

$$v(r_{ij}) = v(r_j) + \frac{(r_{ij} - r_j^-)}{(r_j^+ - r_j^-)} \left[v\left(r_j^+\right) - v\left(r_j^-\right) \right] := \quad i=1,\ …,m,$$
$$j=1,\ …,n \tag{4}$$

where

$v(r_{ij})$ = macbeth score pada ith alternative in jth attribute

$v(r_j^-)$ value equals to zero

$v(r_j^+)$ value equals to 100

E.   Calculation of Final Ranking Score

The final score calculation is obtained through the process of multiplying the Macbeth score with the attribute weight value using the following equation (4).

$$V_i = \sum_{j=1}^{n} v\left(r_{ij}\right) . w_j \quad i=1,\ …,m \tag{5}$$

where

V_i = nilai akhir ith alternative

$v(r_{ij})$ = macbeth score pada ith alternative in jth attribute

w_j = nilai bobot jth attribute

Furthermore, each alternative's final value of the V ranking is sorted by the largest and smallest values. The largest V value indicates the best alternative value.

$$V_i > …… > V_m\ ; \quad i=1,\ …,m \tag{6}$$

2.2 Rank Order Centroid Techniques

Rank Order Centroid (ROC) is a method that prioritizes the priority level of an attribute or criterion and weights each attribute based on the priority ranking that the decision-maker has determined(Roberts & Goodwin, 2002).

$$W_j = \frac{1}{K} \sum_{i=j}^{K} \left(\frac{1}{i}\right)$$

(7)

Where:

Wj = attribute weighting value of *k*th

K = numer of attributes

i = attribute priority order value

3.   RELATED RESEARCH

Research on tourist sites has been carried out by (Prasetyaningrum & Sari, 2019) in the Yogyakarta area using the Analytical Hierarchy Process (AHP) method in this study using three criteria, namely culinary criteria, transportation criteria, and facilities criteria. Next, go to tourist sites in Bali using a combination of the AHP and Copeland Score methods with 40 assessment criteria (Sugiartawan & Hartati, 2018). Specifically, tourist sites in the Karangasem district have been carried out by (Sudipa et al., 2021) with four criteria and implemented the AHP method and linear interpolation techniques for attribute assessment. The Macbeth method has been implemented in various problems, namely supplier evaluation (Karande & Chakraborty, 2013)(Akyüz et al., 2018), manufacturing system selection (Tosun, 2017), and online book selection (Ertuğrul & Öztaş, 2016).

4.   RESULTS AND DISCUSSION
4.1 Data Analysis

The data analysis explains alternative data and assessment attribute data in determining the best tourist location. Alternative data and assessment attribute data using data from previous research(Sudipa et al., 2021). Adding attributes based on literature review from research (Sugiartawan & Hartati, 2018)(Sugiartawan et al., 2020). There are four best alternative locations based on the opinions of 75 respondents by random sampling, namely:Taman Ujung(A1), Tirta Gangga(A2), Besakih Temple(A3) and Tenganan Village(A4). As well as ten assessment attribute data, namely Completeness of rides provided at tourist sites (C1), Completeness of existing facilities at tourist sites(C2), Entrance ticket prices to tourist sites(C3), Distance to tourist sites(C4), Safety factors for visitors(C5), Management services to visitors(C6), Easy access to location(C7), Infrastructure development and renewal of tourist sites(C8), Promotion on social media(C9), Instructions for visitors in several different languages(C10).

4.2 Macbeth Method Calculation
A.   Decision Matrix

Convert qualitative attributes to numeric values based on Table 1. Quantitative attributes are not converted. Determining the nature of positive attributes is seen from the more significant the influence of the attribute, the better the determination of the nature of negative attributes is seen from the smaller the attribute value, the better the effect.

	+ C1	+ C2	- C3	- C4	+ C5	+ C6	+ C7	+ C8	+ C9	+ C10
A₁	Very Weak	Strong	10000	4,5	Very Strong	Moderate	Strong	Weak	Moderate	Very Strong
A₂	Moderate	Moderate	10000	7,6	Strong	Strong	Moderate	Very Weak	Very Strong	Moderate
A₃	Moderate	Very Weak	15000	33,6	Moderate	Weak	Very Weak	Strong	Moderate	Moderate
A₄	Very strong	Weak	10000	8,6	Weak	Very Strong	Very Strong	Very Strong	Strong	Very Strong

B.   Weigh Attributes

Calculate the weights of the assessment attributes using the ROC technique with equation (7) so that the results of the weight values for each attribute can be seen in the table.

Table 2 Weight Attributes

Attribute	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
W_j	0,292	0,192	0,143	0,11	0,084	0,065	0,05	0,034	0,02	0,01

C. Converting Semantic Scale into Numerical Scale

Convert qualitative attributes to numeric values based on Table 1. Quantitative attributes are not converted.

Table 3 Attributes Convertion Value

Attribute	C1	C2	C5	C6	C7	C8	C9	C10
A1	1	4	5	3	4	2	3	5
A2	3	3	4	4	3	1	5	3
A3	3	1	3	2	1	4	3	3
A4	5	2	2	5	5	5	4	5

D. Value of reference level

The reference level value is determined by looking at the largest alternative value for each attribute, called the r value, and the smallest alternative value for each attribute, called the r^+ value so that the results in table 4 below are obtained.

Table 4 Value of Reference Level

Attribute	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
r^-	1	1	10000	4,5	2	2	1	1	3	3
r^+	5	4	15000	33,6	5	4	5	5	5	5

E. The Macbeth Score (V)

Macbeth score calculation of each alternative value using equation (4).

$$V_1 = 0 + \frac{(1-1)}{(5-1)} \times (100 - 0) = 0$$

$$V_2 = 0 + \frac{(3-1)}{(5-1)} \times (100 - 0) = 50$$

$$V_3 = 0 + \frac{(3-1)}{(5-1)} \times (100 - 0) = 50$$

$$V_4 = 0 + \frac{(5-1)}{(5-1)} \times (100 - 0) = 100$$

From the calculation of the Macbeth score, the value of each alternative on each criterion is obtained. The calculation of the Macbeth score is intended for qualitative attribute values because it goes through a conversion process to numeric values. Meanwhile, quantitative attribute values are used to calculate the final ranking value. Macbeth score V calculation results can be seen in the following Table (5).

Table 5 Macbeth Score

	C1	C2	C5	C6	C7	C8	C9	C10
A1	0	100	100	33,33	75	25	0	100
A2	50	66,67	66,67	66,67	50	0	100	0
A3	50	0	33,33	0	0	75	0	0
A4	50	33,33	0	100	100	100	50	100

F. Calculation of Final Ranking Score

The final alternative value is obtained by multiplying the alternative values for each attribute with the attribute weights, then adding each alternative value for each criterion, resulting in a V value.

Table 6 Overall Score

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	V
A1	0	19,2	0	0	8,4	2,17	3,75	0,85	0	1	**35,37**
A2	14,6	12,8	0	1,18	5.6	4,34	2,5	0	2	0	**43**

| A3 | 14,6 | 0 | 14,3 | 11 | 2.8 | 0 | 0 | 2,55 | 0 | 0 | **45,25** |
| A4 | 14,6 | 6,4 | 0 | 1,55 | 0 | 6,5 | 5 | 3,4 | 1 | 1 | **39,45** |

Final Ranking of alternative are obtained by sorting the *V* values as follows

A3 > A2 > A4 > A1

From the calculation of the alternative final value in table 6, it is found that the best alternative tourist sites are Pura Besakih (A3), then Tirta Gangga (A2), Tenganan Village (A4) and Taman Ujung (A1).

5. CONCLUSION

The use of the Macbeth method in converting or scoring qualitative attributes from decision-makers is very appropriate because the assessments of decision-makers are often qualitative and quantitative. Using a seven-point semantic scale is expected to facilitate decision-makers in determining the best alternative in multi-criteria decision-making problems. From the case studies used, the final alternative results for the best tourist sites are Besakih Temple (A3) with a value of *V* = 45.25, then Tirta Gangga (A2) with a value of *V* = 43, Tenganan Village (A4) with a value of *V* = 39, 45 and Taman Ujung (A1) with a value of *V* = 35.37. Future research can use the Macbeth method in calculating attribute weights, and make comparisons with the results of attribute weights from other methods, as well as compare positive and negative attributes with methods that use the concept of attribute benefits and costs using the Simple Additive Weighting (SAW) method and compare the results of alternative ranking.

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