Decision Support System for Choosing a Culinary Place Using the ELECTRE Method

Dani Hamdani[1]

[1]Information System Dept., Faculty of Engineering, Widyatama University
[1]dani.hamdani@widyatama.ac.id
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Abstract: Culinary tourism has developed rapidly, various culinary tourism spots have sprung up. The fast growth of locations and types of culinary makes tourists and the public need the right information to visit culinary locations. There are several criteria for choosing a culinary location, these criteria include distance, budget, and type of culinary. With the decision support system for choosing a culinary place with the ELECTRE method, it can be used as a solution to determine the culinary location according to the desired criteria. With this method, it will provide culinary tourism recommendations based on the alternative value of each predetermined criterion.

Keywords: tourism, culinary, electre

1. Introduction

Culinary is a lifestyle that inextricably linked to daily life. Starting from simple food to high-class and luxurious food [1]. According to Kotler, lifestyle is a way of life embodied in activities, interests, and opinions for someone who lives in the world. The term "lifestyle" refers to "the whole person" as he or she communicates with the world. Lifestyle describes "the whole person" who interacts with the environment. In general, it can be said that a person's known lifestyle is the way he spends his time (activities), What matters is that someone thinks of his surroundings (interests), and what an individual considers himself to be in comparison to the rest of the world (opinion) [2]. Eating and drinking are human activities to meet the necessities of life, eating and drinking activities are often carried out by families at home, while several factors influence families to attend a cafe to enjoy eating and drinking with family members. The basic factors that influence it are external factors and internal factors. External factors consist of environmental factors. Environmental factors consist of cultural factors, references, and social class. Internal factors consist of factors of ideas and consumer characteristics [2]. Based on the observations of Faishal et al, culinary visits tend to be in the afternoon until dinner time (19.00 - 21.00). The menu they enjoy varies, ranging from local food to types of food originating from abroad. One example of local food enjoyed by families is fried rice and meatballs, chicken noodles/dumplings, surabi, Sumedang tofu with all its appearance modifications. Meanwhile, foods that come from abroad that are enjoyed by families include spaghetti and pizza from Italy, kebabs from Turkey, and fried chicken from the USA[3]. Ignatov and Smith define culinary tourism as a tour undertaken by tourists and during the trip [4]. Harvey further explained that culinary tourism is able to tell about cultural heritage, an overview of community life and the landscape of a geographic area [5]. The culinary image can also influence the desire of tourists to visit these destinations. For example, Italy is famous for its culinary variety. Corigliano & Baggio explain that the success of gastronomic tourism in Italy is largely due to the assimilation between the country's gastronomy and its national identity[6].

Unfortunately often both tourists and the surrounding community do not know what culinary tours are suitable for their desires. Culinary tourism has developed rapidly, various culinary tourism spots have sprung up. There are several criteria for choosing a culinary location, these criteria include distance, budget, and type of culinary. With the decision support system for choosing a culinary place with the ELECTRE method, it can be used as a solution to determine the culinary location according to the desired criteria. With this method, it will provide culinary tourism recommendations based on the alternative value of each predetermined criterion.

Elimination Et Choix Traduisant La Realite (ELECTRE), according to Janko and Bernoider, is a multi-criteria decision-making approach focused on the principle of outranking by comparing pairs of alternatives based on each appropriate criterion[7]. The ELECTRE method is more appropriate to use in cases with many choice alternatives and few defined criteria [8]. The ELECTRE method uses a selection system to select the appropriate criteria. The selection system is more appropriate than ranking because by selecting culinary locations that do not meet the criteria, it will be eliminated, while only the top results can be used as a reference by ranking.

As a result, the Decision Support System is required to assist the group in selecting a culinary destination. This information system can be used as a medium that can help tourists and the public in finding and selecting the best culinary places according to their wishes.

In addition to providing information about culinary places, as an additional solution, this media also helps owners of culinary places to buy and sell their food and/or drinks, so that information can spread faster than conventional buying and selling. The system can also provide recommendations for culinary places based on the large number of visitors to which culinary places are often chosen.

2. Literature Review

Culinary tourism comes from two words, namely tourism and culinary. Tourism is traveling together to broaden knowledge, insights, etc. [9], while culinary is cuisine or food, so culinary tourism is traveling together to broaden horizons about food.

Managerial decision-makers may use decision support systems to enhance their decision-making skills in specific situations.

A decision support system is an immersive computer-based framework that uses data and models to solve unstructured problems in order to make decisions.

According to Peter and Michael, the basic principles of the Decision Support System concept are problem structure, decision support, and decision effectiveness. The three concepts formulated the objectives of the Decision Support System, namely:

- Decision support systems can assist in making decisions to solve semi-structural problems.
- Decision Support Systems can support a person's judgment.
- Decision Support Systems can increase the effectiveness and efficiency of a person in making a decision [10, 11].

Electre (Electre Et Choix Traduisant la Realite) is a multi-criteria decision-making approach that employs pairwise comparisons of alternatives based on each relevant criterion[9]. The electre approach can be used to solve problems with a large number of options but just a few parameters. In situations where alternatives that do not meet the requirements are discarded and suitable alternatives can be created, the Electre method is used. The steps taken in solving the problem using the Electre method are as follows:

1. The decision matrix is normalized

Taking each attribute and converting it to a comparable value. Any normalization of the x_{ij} value can be done with a formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x^2 ij}}$$, to *i = 1, 2, 3, ... , m* and *j = 1, 2, 3, ..., n.*

So that the normalized R matrix is obtained,

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & & & \\ r_{m1} & r_{m2} & \ldots & r_{mn} \end{bmatrix}$$

R is a normalized matrix in which m stands for alternatives and n for parameters and r_{ij} is the normalization of the preferred measurement of the i alternative in relation to the j criterion.

2. The weighting of the matrix that has been normalized

Each column of the matrix R is multiplied by the weights after it has been normalized (w_j) determined by the decision maker. So that V = RW which is written as:

$$V = R \,.\, W$$

$$\begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & \cdots & v_{2n} \\ \vdots & & & \\ v_{m1} & v_{m2} & \ldots & v_{mn} \end{bmatrix} = \begin{bmatrix} w_1 r_{11} & w_1 r_{12} & \cdots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \cdots & w_n r_{2n} \\ \vdots & & & \\ w_1 r_{m1} & w_2 r_{m2} & \ldots & w_n r_{mn} \end{bmatrix}$$

Where W is:

$$W = \begin{bmatrix} w_1 & 0 & \ldots & 0 \\ v_{21} & w_2 & \cdots & 0 \\ \vdots & & & \\ 0 & 0 & \ldots & w_n \end{bmatrix}$$

3. Determine if there is any concordance or discordance.

Every set of parameters J is divided into two subsets, concordance and discordance, for each pair of alternatives k and l (*k*,*l* = 1,2,3,...,*m* and *k ≠ l* . The criteria in an alternative that includes concordance are:

$C_{kl} = \{j, v_{kj} \geq v_{ij}\}$, to j = 1,2,3,...,n.

Conversely, the complementary of the set of concordances is the set of discordances, that is, if:

$D_{kl} = \{j, v_{kj} < v_{ij}\}$, to j = 1,2,3,...,n.

4. Calculate the matrices of concordance and discordance

a) The concordance matrix is calculated

The weights used in the concordance set are systematically used to evaluate the importance of the elements in the concordance matrix:

$$C_{kl} = \sum_{j \in C_{kl}} w_j$$

b) The discordance matrix is calculated

To calculate the value of the elements in the discordance matrix, divide the maximum number of parameters in the discordance subset by the maximum value of all values, in a systematic manner:

$$d_{kl} = \frac{max\{|v_{kj} - v_{ij}|\} \, j \in D_{kl}}{max\{|v_{kj} - v_{ij}|\} \, \forall \, j}$$

5. Determine the matrices of dominant concordance and discordance

a) Determine the matrix of dominant concordance

The threslod value, which compares the value of the concordance matrix variable to the threshold value, can be used to create the F matrix as the dominant concordance matrix.

$$C_{kl} \geq c$$

With threshold value (c) is :

$$c = \frac{\sum_{k=1}^{m} \sum_{l=1}^{m} C_{kl}}{m(m-1)}$$

So that the elements of the matrix F are determined as follows:

$$f_{kl} = \begin{Bmatrix} 1, jika \; c_{kl} \geq c \\ 0, jika \; c_{kl} < c \end{Bmatrix}$$

b) Determine the matrix of dominant discordance

To build a dominant discordance matrix, the threshold value is also used, namely:

$$D_{kl} \geq d$$

So that the elements of the matrix G are determined as follows:

$$g_{kl} = \begin{Bmatrix} 1, jika \; d_{kl} < d \\ 0, jika \; d_{kl} \geq d \end{Bmatrix}$$

c) Determine the dominant aggregate of the matrix

The aggregate dominance matrix is then calculated as an E matrix, with each element being a multiplication of the elements of the matrix F and the elements of the matrix G, as shown below:

$$E_{kl} = f_{kl} \times g_{kl}$$

d) Alternatives that aren't as good are eliminated

e) Matrix E provides the order of choice for each alternative, that is, if e_kl = 1 then alternative A_k is a better choice than A_l. So that rows in matrix E that have the least number of e_kl = 1 can be eliminated. Thus, the best alternative is the one that dominates the other alternatives[1].

3. Method

Qualitative descriptive techniques are used to manage data from the research results. The parameters or criteria used are the criteria for distance, budget, and type of culinary. The following are the levels of the Electre method:

1) Determine the suitability rating of each alternative on each criterion, graded from one to five, namely:

1 = Very bad

2 = Bad

3 = Enough

4 = Good

5 = Very good.

2) Determine the criterion importance level (preference weight), which is also assessed by one to five, namely:

1 = Very low

2 = Low

3 = Enough

4 = Height

5 = Very High.

3) Determine preference weights

In this study, there are preference weights as follows:
a. Budget criteria = 5
b. Distance criteria = 4
c. Culinary type criteria = 4
So that W = (5,4,4)

4. Findings

The calculation using the Electre method is as follows:

Alter native	Criteria		
	Budg et	Distance	Type of culinary
A1	5	2	3
A2	5	2	2
A3	3	5	4

Decision making gives preference weight as: W = (5,4,4)
The decision matrix formed from the table above is as follows:

$$R = \begin{matrix} 5 & 2 & 3 \\ 5 & 2 & 2 \\ 3 & 5 & 4 \end{matrix}$$

Weight: $W_1 = 0{,}5$
$W_2 = 0{,}4$
$W_3 = 0{,}4$
To solve the above problem using the Electre method the steps described previously will be carried out:
Step 1
In this first step, the decision matrix will be normalized using the following formula:
$r_{ij=}\frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x^2 ij}}$, to *i = 1, 2, 3, ... , m* and *j = 1, 2, 3, ..., n*
Calculate the normalized decision matrix:
$|X_1| = \sqrt{5^2 + 5^2 + 3^2} = 7{,}68115$
$R_{11} = \frac{X11}{|X1|} = \frac{5}{7{,}68115} = 0{,}65094$
$R_{21} = \frac{X21}{|X1|} = \frac{5}{7{,}68115} = 0{,}65094$
$R_{31} = \frac{X31}{|X1|} = \frac{3}{7{,}68115} = 0{,}39057$

$|X_2| = \sqrt{2^2 + 2^2 + 5^2} = 5{,}74456$
$R_{12} = \frac{X12}{|X2|} = \frac{2}{5{,}74456} = 0{,}34816$
$R_{22} = \frac{X22}{|X2|} = \frac{2}{5{,}74456} = 0{,}34816$
$R_{32} = \frac{X32}{|X2|} = \frac{5}{5{,}74456} = 0{,}87039$

$|X_3| = \sqrt{3^2 + 2^2 + 4^2} = 5{,}38516$
$R_{13} = \frac{X13}{|X3|} = \frac{3}{5{,}38516} = 0{,}55709$
$R_{23} = \frac{X23}{|X3|} = \frac{2}{5{,}38516} = 0{,}37139$
$R_{33} = \frac{X33}{|X3|} = \frac{4}{5{,}38516} = 0{,}74278$
So that the normalized R matrix is obtained as follows:

$$R = \begin{bmatrix} 0{,}65094 & 0{,}34816 & 0{,}55709 \\ 0{,}65094 & 0{,}34816 & 0{,}37139 \\ 0{,}39057 & 0{,}87039 & 0{,}74278 \end{bmatrix}$$

Step 2
Each column of the R matrix is multiplied by the predetermined weight after obtaining a normalized R matrix. Then it will produce a matrix V as follows:
$V = W_j \cdot X_{ii}$
Then the V matrix is obtained as follows:

$$V = \begin{bmatrix} 0,32547 & 0,13926 & 0,22284 \\ 0,32547 & 0,13926 & 0,14856 \\ 0,19529 & 0,34816 & 0,29711 \end{bmatrix}$$

Step 3

In the third step, we'll use the formula to decide the set of Concordance and Discordance after we've obtained the V matrix:

a. Concordance

$C_{kl} = \{j, v_{kj} \geq v_{ij}\}$, to j = 1,2,3,...,n.

Compound Concordance Index	
C_{12}	{1,2,3}
C_{13}	{1}
C_{21}	{1,2}
C_{23}	{1}

b. Discordance

$D_{kl} = \{j, v_{kj} < v_{ij}\}$, to j = 1,2,3,...,n.

Compound *Discordance Index*	
D_{12}	{ }
D_{13}	{2,3}
D_{21}	{3}
D_{23}	{2,3}
D_{31}	{1}
D_{32}	{1}

Step 4

Then the concordance and discordance matrices will be formed. The C_{kl} element is formed using the formula:

a. Concordance

$$C_{kl} = \sum_{j \in C_{kl}} w_j$$

$C_{12} = W_1 + W_2 + W_3 = 0,5 + 0,4 + 0,4 = 1,3$
$C_{13} = W_1 = 0,5$
$C_{21} = W_1 + W_2 = 0,5 + 0,4 = 0,9$
$C_{23} = W_1 = 0,5$
$C_{31} = W_2 + W_3 = 0,4 + 0,4 = 0,8$
$C_{32} = W_2 + W_3 = 0,4 + 0,4 = 0,8$

Then the results of the Concordance matrix are as follows:

$$C = \begin{bmatrix} - & 1,3 & 0,5 \\ 0,9 & - & 0,5 \\ 0,8 & 0,8 & - \end{bmatrix}$$

b. Discordance

$$d_{kl} = \frac{max\{|v_{kj} - v_{ij}|\}\, j \in D_{kl}}{max\{|v_{kj} - v_{ij}|\} \forall j}$$

$$D_{12} = \frac{\max\{0\}}{\max\{|0,32547-0,32547|;|0,13926-0,13926|;|0,22284-0,14856|\}}$$
$$= \frac{\max\{0\}}{\max\{0;0;0,07248\}} = \frac{0}{0,07248} = 0$$

$$D_{13} = \frac{\max\{|0,13926-0,34816|;|0,22284-0,29711|\}}{\max\{|0,32547-0,19529|;|0,13926-0,34816|;|0,22284-0,29711|\}}$$
$$= \frac{\max\{0,2089;0,07427\}}{\max\{,13018;0,2089;0,07527\}} = \frac{0,2089}{0,2089} = 1$$

$$D_{21} = \frac{\max\{|0,14856-0,22284|\}}{\max\{|0,32547-0,32547|;|0,13926-0,13926|;|0,14856-0,22284|\}}$$
$$= \frac{\max\{0,07428\}}{\max\{0;0;0,07248\}} = \frac{0,7428}{0,07248} = 1$$

$D_{23} = \frac{\max\{|0{,}13926-0{,}34816|;|0{,}1486-0{,}29711|\}}{\max\{|0{,}32547-0{,}19529|;|0{,}13926-0{,}34816|;|0{,}14856-0{,}29711|\}}$
$= \frac{\max\{0{,}2089;0{,}14855\}}{\max\{0{,}13018;0{,}2089;0{,}14855\}} = \frac{0{,}2089}{0{,}02089} = 1$

$D_{31} = \frac{\max\{|0{,}19529-0{,}32547|\}}{\max\{|0{,}19529-0{,}32547|;|0{,}34816-0{,}13926|;|0{,}29711-0{,}22284|\}}$
$= \frac{\max\{0{,}13018\}}{\max\{0{,}13018;0{,}2089;0{,}07427\}} = \frac{0{,}13018}{0{,}2089} = 0{,}62317$

$D_{32} = \frac{\max\{|0{,}19529-0{,}32547|\}}{\max\{|0{,}19529-0{,}32547|;|0{,}34816-0{,}13926|;|0{,}29711-0{,}14856|\}}$
$= \frac{\max\{0{,}13018\}}{\max\{0{,}13018;0{,}2089;0{,}014855\}} = \frac{0{,}13018}{0{,}2089} = 0{,}62317$

Then the Discordance matrix is obtained as follows:

$$\begin{bmatrix} - & 0 & 1 \\ 1 & - & 1 \\ 0{,}62317 & 0{,}62317 & - \end{bmatrix}$$

Step 5

The dominant concordance and discordance matrices will be determined in this stage:

a. Determines the matrix of dominant concordance

$$c = \frac{\sum_{k=1}^{m}\sum_{i=1}^{m} C_{kl}}{m(m-1)}$$

$= \frac{1{,}3+0{,}5+0{,}9+0{,}5+0{,}8+0{,}8}{3(3-1)}$

$= \frac{4{,}8}{6} = 0{,}8$

Then the element of the matrix F is determined by

$$f_{kl} = \begin{Bmatrix} 1, jika\ c_{kl} \geq c \\ 0, jika\ c_{kl} < c \end{Bmatrix}$$

So that get:

$$F = \begin{bmatrix} - & 1 & 0 \\ 1 & - & 0 \\ 1 & 1 & - \end{bmatrix}$$

b. Determine the dominant discordance matrix

$$d = \frac{\sum_{k=1}^{m}\sum_{i=1}^{m} D_{kl}}{m(m-1)}$$

$= \frac{0+1+1+1+0{,}62317+0{,}62317}{3(3-1)}$

$= \frac{4{,}24634}{6} = 0{,}70772$

The elements of the matrix G will be determined by

$$g_{kl} = \begin{Bmatrix} 1, jika\ d_{kl} < d \\ 0, jika\ d_{kl} \geq d \end{Bmatrix}$$

So that get:

$$G = \begin{bmatrix} - & 0 & 1 \\ 1 & - & 1 \\ 0 & 0 & - \end{bmatrix}$$

c. Determine the dominant aggregate of the matrix

The dominant aggregate matrix is determined by a formula:

$$E_{kl} = f_{kl} \times g_{kl}$$

So that the matrix obtained by the aggregate dominant matrix is as follows:

$$E = \begin{bmatrix} - & 0 & 0 \\ 1 & - & 0 \\ 0 & 0 & - \end{bmatrix}$$

d. Elimination of less favorable alternatives

If $E_{kl} = 1$ it indicates that alternative A_k s preferred. It recommends A_2 based on the results obtained from the dominant aggregate matrix using the ELECTRE process.

5. Conclusion

After reviewing the results using the ELECTRE method, it was determined that the calculation results can be used by visitors and the general public to decide the location or culinary place that is used as a destination, and that using this method can provide the best alternative solution in decisions involving several parameters.

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