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APPLICATION OF MULTI-OBJECTIVE OPTIMIZATION BY RATIO ANALYSIS (MOORA) IN DETERMINING THE LOCATION OF BERKAH TIRTA'S DRINKING WATER BUSINESS

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ABSTRACT

In the workplace environment, competition is a common phenomenon, especially when it comes to determining the location to start a business, namely the selection of the right location. The business of water refill stations is experiencing rapid development, and the success of this business is significantly influenced by the accurate determination of the location. To enhance efficiency in location determination, the MOORA method is employed an analytical tool for decision-making. The use of the MOORA method in this research aims to analyze and compare each potential location based on predetermined criteria such as accessibility, market potential, operational costs, space size, crowd center and other external factors. The implementation of MOORA is expected to serve as an initial step in making strategic decisions related to location determination in various fields of business and provide a foundation for further research to develop more advanced methods in location selection. The results of the MOORA implementation in determining the strategic location indicate that location D or alternative is the preferred choice with a value of 0.323517894.

Keyword: MOORA, Location, Efficient , Business, DSS

INTRODUCTION

The rapid growth in the drinking water refill sector characterizes significant business development, where competition is intensifying. Determining a business location is one of the crucial factors that plays an important role in the success of this business. A strategic location can have a positive impact on operational efficiency, competitiveness and business continuity. Therefore, this research specifically aims at using Multi-Objective Optimization by Ratio Analysis (MOORA) to determine the optimal location for the Berkah Tirta Drinking Water Refill Business in the context of increasingly tight industrial growth and competition. Accuracy in choosing a business location has direct implications for business performance, including aspects such as accessibility, market potential, operational costs, area, population density and environmental factors. The use of MOORA as a research method aims to increase

effectiveness in the decision-making process related to determining business locations. This method allows simultaneous assessment of various criteria that influence the success of a drinking water refill business.

Decision Support Systems (DSS) are useful tools in the decision-making process by using data and models to solve unstructured problems. In this research, the MOORA (Multi-Objective Optimization on the basis of Ratio Analysis) method is used, an approach that can handle complex problems mathematically through computerization, with a focus on simultaneous quality optimization. MOORA has the advantage of excellent selectivity because it is able to determine goals from opposing criteria (Limbong & Yanti, 2020; Majumder, 2015; Manurung, 2018). In this case, the effectiveness of the MOORA method in determining the best alternative becomes increasingly clear, because this method is defined as a process of optimizing conflicting criteria simultaneously. (Hendrayana & Mahendra, 2019).

There are several previous studies conducted which are used as a reference in this research using the same method, namely research conducted by Kusmanto et al in 2022 conducting research on the implementation of the MOORA method to make decisions regarding recommendations for customer eligibility to receive credit against 5 alternatives and comparison of 5 criteria with The results were obtained by alternative 2, named Mujiani, with a value of 245,987 (Kusmanto et al., 2022). Research conducted by Andreas Gerhard Simorangkir et al. in 2021 conducted MOORA implementation research to determine employees who were entitled to receive promotions using 6 alternatives and a comparison of 6 criteria and with the results obtained alternative 4 in the name of Samuel with a value of 0.511 (Simorangkir et al., 2021). Research conducted by Yogi Setian with Teguh Wiharko et al in 2023 implemented the MOORA method for recommendations for mountain climbing tourist destinations in Greater Bandung with 10 alternatives and a comparison of 4 criteria to get the final result, namely Mount Putri Lembang as a recommendation for mountain climbing tourist destinations in Greater Bandung with the results value 0.177 (Setiawan & Wiharko, 2023). The implementation of MOORA was also carried out in research conducted by Heri Susanto et al in 2022 to help assess employee performance through a decision support system using 11 alternatives and 4 criteria with different weights. The final result was that alternative 2 received first place with a score of 5.7805 (Susanto et al., 2022).

In the same year, namely 2022, M. Reza Lubis et al also succeeded in using MOORA to help make decisions in determining customer credit for purchasing electronic goods using 10 alternatives and 5 criteria and obtained the final results, some were eligible and some were not eligible to receive the facility. credit customers for electronic goods (Lubis et al., 2022). Based on several studies conducted, the author used it as a reference and basis for solving problems so that the author is interested in conducting similar research using the MOORA method to be

implemented in the process of determining the location of Berkah Tirta's business location. It is hoped that the research results will provide an optimal location that can increase operational efficiency, competitiveness and sustainability of the Berkah Tirta drinking water refill business.

RESEARCH METHOD

MOORA Method

The Multi-Objective Optimization on the basis of Ratio Analysis (MOORA) method was first introduced by Brauers and Zavadskas in 2006 as a multi-object system. This system aims to maximize two or more opposing attributes simultaneously. Initially, Brauers introduced this method in 2004 under the name "Multi-Objective Optimization," which is useful for solving various complex decision-making problems in the context of a corporate environment. MOORA was then implemented to handle various types of problems involving complex mathematical calculations (Brauers et al., 2008). Here are some steps of the MOORA method:

Define criteria

Identifying the purpose of recognizing the evaluation attributes and entering the criteria values into an alternative, where these values will be processed to produce a decision.

Create a Decision Matrix

The decision matrix contains the criteria values of all alternatives: $X_{ij} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$

With X as the decision matrix, Xij refers to the response of alternative j to criterion i, where i has a value from 1 to n as the order number of attributes or criteria, and j has a value from 1 to m as the order number of alternatives.

Matrix Normalization

Matrix normalization is used to harmonize each element in the matrix so that the values of the elements become uniform. Brauers concluded that in terms of the denominator, the best option is to take the square root of the sum of the squares of each alternative per attribute. Matrix normalization can be expressed as follows:

$$X_{ij}^{*} = \frac{X_{ij}}{\sqrt{\sum_{j=1}^{m} X_{ij}^{2}}}$$

Calculating Optimization Value

At this stage, the main step is done by multiplying each attribute on each alternative with the weight of the criteria using the following equation::

$$y_1^* = \sum_{j=1}^{g} w_j \; x_{ij}^* \sum_{j=g+1}^{n} w_j x_{ij}^*$$

Decision Support System (DSS)

Decision Support System is a system that can solve problems or communication in problems with structured and unstructured conditions (Prasetyo et al., 2023).

Strategic Location

Strategic location in the business world refers to the selection of locations where a company decides to set up or run its facilities, such as offices, factories, shops, or warehouses. Decisions related to business location have a major influence on overall business performance and success (Sulistiani et al., 2023).

Business

Business is an economic activity involved in the production, distribution, and exchange of goods or services with the aim of achieving financial gain. Businesses can operate in various sectors, such as industry, trade, or services. In the context of business, the main focus of the company is to create added value, fulfill customer needs or wants, and achieve financial sustainability. Various business activities involve strategic planning, operational management, marketing, sales, and financial management. Business owners can be individuals, groups, or legal entities, and businesses can range in scale from small businesses to large corporations.

RESULTS AND DISCUSSION

MOORA Implementation

In the process of determining the strategic business location for the Berkah Tirta drinking water business using the MOORA method by determining alternatives, criteria, criteria weights.

a. Define Alternatives, Weights, and Criteria Table

Alternative Table

The first step in MOORA is that we determine the alternatives first, the author sets 4 alternatives where the data is based on several strategic locations in the region.

ALTERNATIVE	LOCATION NAME
$A1$	Location A
$A2$	Location B
$A3$	Location C
$A4$	Location D

Table 1. Alternative Table

Criteria Table

In determining the strategic business location for the Berkah Tirta drinking water refill business, several criteria were determined as follows:

CODE	CRITERIA	WEIGHT	TYPE
$C1$	Road Access	15%	*Benefit*
$C2$	Number of Competitors	20%	*Benefit*
$C3$	Rental price	10%	*Cost*
$C4$	Place Size	10%	*Benefit*
$C5$	Crowd Center	20%	*Benefit*

Table 2. Criteria Table

Criteria	Weight
Good	>3
Enough	=3
Not Enough	<3

Table 3. Criteria weights c1, c4, c5

Table of Alternatives and Criteria

After obtaining data regarding alternatives, the next step is to determine the criteria values for each alternative. The process of determining a criterion value involves using the values of each sub-criterion which are then added up and divided by the weight of the corresponding criteria..

ALTERNATIF	CRITERIA				
	C1	C2	C3	C4	C5
LOCATION A	5	2	6000000	3	2
LOCATION B	5	3	5000000	2	2
LOCATION C	2	3	5500000	5	3
LOCATION D	3	5	8000000	2	5

Table 4. Alternatives and Criteria

b. Decision matrix X_{ij}

The next step is to determine the decision matrix using the following formula :

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

$$X_{ij} = \begin{bmatrix} 5 & 2 & 6000000 & 3 & 2 \\ 5 & 3 & 5000000 & 2 & 2 \\ 2 & 3 & 5500000 & 5 & 3 \\ 5 & 5 & 8000000 & 2 & 5 \end{bmatrix}$$

c. Normalization of decision matrices

The next step is to normalize the X matrix for each criterion as follows:

$$X_{ij}^{*} = \frac{X_{ij}}{\sqrt{\sum_{j=1}^{m} X_{ij}^{2}}}$$

$c_1 = \sqrt{5^2 + 5^2 + 2^2 + 3^2} = 7{,}93725$

$x_{11} = \frac{5}{7{,}93725} = 0{,}62994$

$x_{21} = \frac{5}{7{,}93725} = 0{,}62994$

$x_{31} = \frac{2}{7{,}93725} = 0{,}25197$

$x_{41} = \frac{3}{7{,}93725} = 0{,}37796$

$c_2 = \sqrt{2^2 + 3^2 + 3^2 + 5^2} = 6{,}85565$

$x_{12} = \frac{2}{6{,}85565} = 0{,}29172$

$x_{22} = \frac{3}{6{,}85565} = 0{,}43759$

$x_{32} = \frac{3}{6{,}85565} = 0{,}43759$

$x_{42} = \frac{5}{6{,}85565} = 0{,}72932$

$c_3 = \sqrt{6000000^2 + 5000000^2 + 5500000^2 + 8000000^2} = 12459935{,}79$

$x_{13} = \frac{6000000}{12459935{,}79} = 0{,}48154$

$x_{23} = \frac{5000000}{12459935{,}79} = 0{,}40128$

$x_{33} = \frac{5500000}{12459935{,}79} = 0{,}44141$

$x_{43} = \frac{8000000}{12459935{,}79} = 0{,}64205$

$c_4 = \sqrt{3^2 + 2^2 + 5^2 + 2^2} = 6{,}48074$

$x_{14} = \frac{3}{6{,}48074} = 0{,}46291$

$x_{24} = \frac{2}{6{,}48074} = 0{,}30860$

$$x_{34} = \frac{5}{6{,}48074} = 0{,}77151$$
$$x_{44} = \frac{2}{6{,}48074} = 0{,}30860$$

$$c_5 = \sqrt{2^2 + 2^2 + 3^2 + 5^2} = 6{,}48074$$

$$x_{15} = \frac{2}{6{,}48074} = 0{,}30860$$
$$x_{25} = \frac{2}{6{,}48074} = 0{,}30860$$
$$x_{35} = \frac{3}{6{,}48074} = 0{,}46291$$
$$x_{45} = \frac{5}{6{,}48074} = 0{,}77151$$

Based on the calculations that have been carried out, the form of the normalized matrix X_ij is as follows:

$$x_{ij} = \begin{bmatrix} 0{,}62994 & 0{,}29172 & 048154 & 046291 & 030860 \\ 0{,}62994 & 0{,}43759 & 040128 & 030860 & 030860 \\ 0{,}25197 & 0{,}43759 & 044141 & 077151 & 046291 \\ 0{,}37796 & 0{,}72932 & 064205 & 030860 & 077151 \end{bmatrix}$$ multiplied by the weight (0.15, 0.2, 0.1, 0.1, 0.2)

$$x_{ij} = \begin{bmatrix} 0{,}09449 & 0{,}05834 & 0{,}04815 & 0{,}04629 & 0{,}06172 \\ 0{,}09449 & 0{,}08751 & 0{,}04012 & 0{,}03086 & 0{,}06172 \\ 0{,}03779 & 0{,}08751 & 0{,}04414 & 0{,}07715 & 0{,}09258 \\ 0{,}05669 & 0{,}14586 & 0{,}06420 & 0{,}03086 & 0{,}15430 \end{bmatrix}$$

d. Calculating preference values

ALTERNATIVE	BENEFIT(C1+C2+C4+C5)	COST (C3)	Yi(benefit-cost)	RANK
LOCATION A	0.26084946	0.048154341	0.212695119	4
LOCATION B	0.274592123	0.040128618	0.234463505	3
LOCATION C	0.295049127	0.044141479	0.250907648	2
LOCATION D	0.387723682	0.064205788	0.323517894	1

From the results of calculations using the MOORA method from the 4 existing alternatives to decide the best location for the Berkah Tirta drinking water refill business, location D or the 4th alternative was obtained with a value of 0.323517894 as a very suitable place to open this business.

CONCLUSION

Based on the research that has been carried out, the author draws the conclusion that the MOORA method can be implemented in looking for the best alternative, namely in the form of a strategic location to open a refill drinking water business with the criteria of road access, competitiveness, rental price, area, and busy center. So the owner of the Berkah Tirta drinking water refill business can make the decision to open a business in location D which has a value of 0.323517894 in first place.

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