Implementation of Multi-Objective Optimazation on the Base of Ratio Analysis (MOORA) in Improving Support for Decision on Sales Location Determination

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Abstract. The location of sales is one of the most important factors, in the success of selling goods. At present, there are many business locations, in the form of new buildings being made which can later be used as sales locations. But in the selection of the sales location, sometimes the business actors do not consider whether the location will be strategic or not. So that the price is relatively cheap, the location of the business will be purchased without considering the position of the strategic sales location or not. To avoid losses for business actors, the application of a decision support system is absolutely necessary. It aims to provide assistance for business actors to produce effective, appropriate and efficient decisions. Decision support systems can use certain methods. In this study, the application of the Multi-Objective Optimization On The Base Of Ratio Analysis (MOORA) method is a simple method in ranking alternative business locations, so it is expected that the use of decision support systems in the selection of sales locations will provide large benefits for business actors.

1. Introduction

The success in carrying out sales activities is inseparable from the selection of sales locations. The rapid economic growth at this time encourages business people to compete in the selection of places, as a sales location. Many locations are now used as places aiming at, that place can be used as a business location by investors. So that even in new areas many vendors erect buildings to be resold. Cheap building prices make businesses to buy the building, with the aim of becoming a business location, without thinking about whether the place is crowded, close to the market, close to residential housing. Of course, this will make a loss for businesses because the merchandise will not sell, so that it will cause losses because the merchandise is only as a display.

In the selection of sales locations, there are many factors that are used as criteria. The goal is that the selection of the sales location can provide benefits for the business carried out. This is a complex problem for business actors in considering the selection of the sale location. So that the investment spent is worth more return, then we need an appropriate solution, so that the decisions made can be effective and efficient. For that, we need a computer-based decision-support information system. This information system is known as a decision support system (DSS) \cite{1}–\cite{4}.

DSS is a tool in the form of computer software that is intended for users or management in producing effective decisions. In the process carried out, the decision support system (DSS) uses methods in its
resolution [5], [6]. Among them are decision support system methods, namely Simple Additive Weighting (SAW), ELECTRE, VIKOR, Preference Selection Index, ARAS [7]–[10]. Besides these methods, there are also Multi-Objective Optimization On The Base Of Ratio Analysis (MOORA) methods, which are easier to use in producing the best ranking for the selection of sales locations.

From this explanation, the problem that will be discussed in this research is about the selection of sales locations to be more effective, and appropriate by using the Multi-Objective Optimization On The Base Of Ratio Analysis (MOORA) method, so that the benefits for business actors will not suffer losses in doing investment in sales location.

2. Methodology

Some research that has been done related to site selection, was conducted by Syafrida Hafni Sahir. The application of the Preference Selection Index method in DSS is able to provide good results in determining the location of used laptop sales [11], determining the location of facilities by applying Promethee II [12], determining the location of bank branches by applying MOORA [13].

The Multi-Objective Optimization method on the Basis of Ratio Analysis (MOORA), is a method of multi-objective optimization. The MOORA method is also known as the multi-criteria or multi-optimization method for attributes. The work process of the MOORA method is to carry out processes simultaneously to optimize two or more conflicting criteria, attributes (goals) are subject to certain restrictions[14].

The MOORA method was first introduced by Brauers (2004). The application is made in solving various types of complex decision-making problems in the manufacturing environment. The completion of implementing MOORA uses several steps[15], [16], namely:

Step 1: Create a Decision Matrix.

\[
x = \begin{bmatrix}
x_{11} & x_{12} & \cdots & x_{1n} \\
x_{21} & x_{22} & \cdots & x_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
x_{m1} & x_{m2} & \cdots & x_{mn}
\end{bmatrix}
\] (1)

Step 2: Normalize the Decision Matrix

\[
x_{ij}^{*} = x_{ij} / \sqrt{\sum_{i=1}^{m} x_{ij}^2} \quad (j = 1,2,\ldots,n)
\] (2)

Step 3: Optimize attributes.

\[
y_i = \sum_{j=1}^{g} x_{ij}^{*} - \sum_{j=g+1}^{n} x_{ij}^{*}
\] (3)

If the results are more optimal, weight can be used to get the value of Yi, so equation 3 can be shaped as follows.

\[
y_i = \sum_{j=1}^{g} w_j x_{ij}^{*} - \sum_{j=g+1}^{n} w_j x_{ij}^{*} \quad (j = 1,2,\ldots,n)
\] (4)

Wj is the attribute weight jth. The value of Yi can be either a positive or negative value, according to which type of attribute affects the decision matrix. The value obtained at Yi is the final preference. The best alternative has the highest Yi value.

3. Result and Discussion

In the decision making process using computers as data processing aids, using the MOORA method in its completion. It is intended that the results achieved are more effective and objective for decision-makers. The implementation of a Decision Support System requires data, namely criteria, weights, and alternative business locations. From these data, it can be obtained the decisions needed for business owners. The following criteria are used.
Table 1. Criteria and Weighted

| Criteria | Description | Weighted | Type |
|----------|-------------|----------|------|
| C₁       | Land area   | 0.30     | Benefit |
| C₂       | Many visitors | 0.15     | Benefit |
| C₃       | Number of Competitors | 0.15     | Benefit |
| C₄       | Distance from Nearest City | 0.10     | Cost |
| C₅       | Rental price | 0.30     | Cost |

The following are alternative data and the value of the compatibility rating for alternatives and criteria.

Table 2. Alternative match ratings and criteria

| Alternative                  | C₁ | C₂         | C₃ | C₄ | C₅    |
|------------------------------|----|------------|----|----|-------|
| Suzuya Katamso (A₁)          | 20 m² | 4000 People/Week | 2  | 3 Km | 15 Million |
| Maju Bersama Simp SM Raja (A₂) | 25 m² | 3500 People/Week | 2  | 5 Km | 15 Million |
| Medan Fair Plaza (A₃)        | 15 m² | 7000 People/Week | 4  | 0.5 Km | 21 Million |
| Suzuya Marelan (A₄)          | 19 m² | 4000 People/Week | 2  | 0.6 Km | 10 Million |
| Suzuya Tj Morawa (A₅)        | 22 m² | 2000 People/Week | 1  | 3 Km | 10 Million |
| Ramayana SM Raja (A₆)        | 24 m² | 6000 People/Week | 2  | 4 Km | 18 Million |

Table 2 above, the rating data is simplified, as shown in table 3.

Table 3. Simplified Match Rating

| Alternative | C₁ | C₂ | C₃ | C₄ | C₅ |
|-------------|----|----|----|----|----|
| A₁          | 20 | 4000 | 2 | 3 | 15 |
| A₂          | 25 | 3500 | 2 | 5 | 15 |
| A₃          | 15 | 7000 | 4 | 0.5 | 21 |
| A₄          | 19 | 4000 | 2 | 0.6 | 10 |
| A₅          | 22 | 2000 | 1 | 3 | 10 |
| A₆          | 24 | 6000 | 2 | 4 | 18 |

Next, the calculation process is carried out by applying the MOORA method. The initial step provides the decision matrix (Xij) obtained from table 3, as follows:

\[
X_{ij} = \begin{bmatrix}
20 & 4000 & 2 & 3 & 15 \\
25 & 3500 & 2 & 5 & 15 \\
15 & 7000 & 4 & 0.5 & 21 \\
19 & 4000 & 2 & 0.6 & 10 \\
22 & 2000 & 1 & 3 & 10 \\
24 & 6000 & 2 & 4 & 18
\end{bmatrix}
\]

After getting the Xij matrix, then calculate the \(X_{ij}^*\) normalized matrix using equation 2. The calculation results for the normalized matrix (\(X_{ij}^*\)) are obtained namely:

\[
X_{ij}^* = \begin{bmatrix}
0.3870 & 0.3465 & 0.3482 & 0.3886 & 0.3988 \\
0.4837 & 0.3032 & 0.3482 & 0.6476 & 0.3988 \\
0.2902 & 0.6064 & 0.6963 & 0.0648 & 0.5583 \\
0.4257 & 0.1733 & 0.1741 & 0.3886 & 0.2658 \\
0.4644 & 0.5198 & 0.3482 & 0.5181 & 0.4785
\end{bmatrix}
\]
The final step is to optimize the $X^*_ij$ matrix by using equation 4. This aims to make the final result better by including the processing of the weights of each criterion. The results of the optimization of the attributes can be seen by the value of $Y_i$ in table 4.

| $Y_i$ | Rank | Alternative |
|-------|-------|-------------|
| A3    | 0.291 | 1           |
| A4    | 0.216 | 2           |
| A6    | 0.101 | 3           |
| A1    | 0.088 | 4           |
| A5    | 0.036 | 5           |
| A2    | 0.027 | 6           |

From the results of the calculation of the value of $Y_i$, ranking the value obtained. Table 5 ranks the alternatives with the best to the worst scores.

The results are shown in table 5, it can be seen that the value of $A_3 > A_4 > A_6 > A_1 > A_5 > A_2$, so that in processing the results that Medan Fair Plaza ($A_3$) is the best selling location compared to other sales alternatives.

4. Conclusion
From the discussion above, the application of the MOORA method in the selection of sales locations is quite easy, the decision-maker only includes the criteria and weights used as priorities for the criteria made. The application of computers, in this case, can provide more effective and objective decisions. The application of the MOORA method is quite simple and effective in producing the decisions desired by business owners.

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