JURNAL MULTIDISIPLIN MADANI (MUDIMA)

Homepage: https://journal.formosapublisher.org/index.php/mudima

ISSN: 2808-5639 (Online)

Research Article

Volume 4, No 6, June (2024)	DOI: https://doi.org/10.55927/mudima.v4i6.9691	Page: 758-766

The Decision-Making Process for the Selection of Naval Base VI to Uphold its Functions Through the Multi-Criteria Decision Making (MCDM) Integration Approach

Rudi Hartono Siregar[1*], Udi Surbakti[2], Hadi Prasutiyon[3]

[1]Naval Technology College, Bumimoro-Morokrembangan

[2]Department of Mechanical Engineering, 10 November Institute of Technology

[3]Department of Marine Engineering, Hang Tuah University

Corresponding Author: Rudi Hartono Siregar rudihartono@gmail.com

ARTICLE INFO

Keywords: Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA), Indonesian Navy Bases

Received : 5 *April*
Revised : *18 May*
Accepted : 24 *June*

ABSTRACT

This research discusses the degradation condition of Naval Main Bases VI Makassar, which has experienced a decline in function as a naval operational support center. Factors such as the impact of the Makassar New Port (MNP) reclamation project and the morphological condition of the area have influenced the optimal implementation of base duties and the decrease in the base's confidentiality as an Integrated Fleet Weapon System (SSAT). Through the Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method, this research aims to determine the best alternative in choosing the location of Naval Main Bases VI. The alternatives involved are Naval Bases Mamuju, Kendari, Naval Base Baubau, and Naval Base Palu. Criteria and sub-criteria, attributes as the basis for determining the best alternative choices include geography, resources, socio-cultural aspects, and vulnerability. The research results show that the use of the MOORA method provides optimal risk mitigation decisions for selecting the best alternative location. This research serves as an objective recommendation when deciding on more effective and targeted decision-making, thus using this method can achieve optimal results and can further develop knowledge in Decision Support Systems (DSS). The calculation results with the highest ranking are: Naval Base Palu with a value of (0.2402); this method is suitable for selecting the Alternative Naval Main Bases VI that is acceptable

INTRODUCTION

Naval Main Base VI Makassar plays a crucial role in supporting the operations of the Indonesian Navy, particularly concerning the impact of the Makassar New Port (MNP) reclamation project. Despite Naval Main Base VI is important responsibility in providing administrative and logistical support, its condition is not optimal due to various factors such as budget constraints, inadequate dock facilities, and a shortage of human resources. The effects of economic growth and the MNP project also encompass changes in the surrounding area's morphology, resulting in issues such as limited ship maneuvering space and accelerated silting in Naval Main Bases VI, is dock basins, which undoubtedly affect the base's functionality.

The urgency of this research lies in maintaining the role and function of the base according to its primary function as a place for developing naval strength to operational areas or "deployment forces position," which will be crucial in supporting the Indonesian Navy's operational tasks as a maritime security unit (Suharjo & Suharyo, 2019). The urgency in this research is to maintain the role and function of the naval base according to its primary function as a place for developing naval strength for deployment forces position, which is crucial in supporting the maritime security operations of the Indonesian Navy as a maritime security operational unit. Furthermore, the base serves as a "home base" with criteria functions aligned with the 5 Rs, namely: Rest, Refresh, Refuel, Repair, and Replenishment (Ahmadi & Herdiawan, 2021). This plays a significant role in the success of operational support deployment.

Moreover, the role of the base as a waiting point and a place for developing naval strength at sea is essential. Additionally, the existence of naval Main Bases VI is located on the Indonesian Archipelagic Sea Lanes II, covering the maritime routes of the Sulawesi Sea, the Makassar Strait, the Lombok Strait, and the Flores Sea. These routes connect international shipping and trade traffic from Africa to Southeast Asia and Japan, as well as from Australia to Singapore, China, and Japan. Hence, the optimal existence and function of the base are highly anticipated.

This study is essential in assisting to identify criteria for each alternative to obtain a decision. The research employs the MOORA method. When decision-makers are faced with complex tasks involving evaluating alternatives based on often conflicting criteria, it becomes a complex challenge. The problem becomes even more complex because the number of attributes to be evaluated is related to critical success factors in the industry (Singh, 2017).

In this research, data collection is conducted with five experts who currently hold positions within the Naval main Bases VI Makassar environment. These experts possess over 15 years of work experience on average and have attained a Bachelor's degree (S1). They will provide input, suggestions, and assessments.

This research contributes to evaluating alternative locations for the headquarters of Main Naval Bases VI that are suitable to replace the current location. Additionally, the study aims to provide strategic input in formulating projections for the future strength of the Indonesian Navy by considering the environmental conditions' impact, including the MNP project and changes in the surrounding area's morphology (Syarif, 2016). The MOORA method is used to determine the best alternative location to maintain the base's function and strategic role.

METHODOLOGY

This research employs a qualitative descriptive statistical approach. The qualitative descriptive statistical design at different and sequential times begins with qualitative research first, supported by numerical statistical data (Hanson et al., 2005; Taguchi, 2018). Data collection in this article is divided into two categories: primary data and secondary data (Nurjanah et al., 125 C.E.). Data collection in this research, as the primary data source, includes experts currently serving, practitioners, academics, regulatory makers who have served for approximately 10 (ten) years, while secondary data is derived from real data in the field.

This research will be conducted at Naval Main Bases VI Makassar, the object of this study. The research will be conducted from October 2023 to June 2024 by providing questionnaires to experts based on several secondary data. However, the researcher's observations still see significant opportunities or chances to enter and contribute theoretically.

A. Methodology Steps for MOORA

The Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA) method is a decision-making system method by (Singh, 2017), aiming to solve many economic, managerial, and construction problems with mathematical formula calculations with precise results (Gadakh, 2011). The following are several steps to apply the MOORA method:

a. The initial step involves inputting data according to the criteria for alternatives, resulting in a decision from the DSS system using the MOORA method.

b. Displaying all available information for attributes to form a matrix within a decision. Data provided by equation 1 are presented as matrix X. Where Xij indicates the size of the 1[th] alternative for the J[th] attribute, m indicates the total number of alternatives, and n indicates the number of attributes. Then the ratio system is developed for each result of an alternative compared to a denominator representing all alternatives regarding that attribute, as shown in the following equation:

$$X = \begin{bmatrix} x_{11} & x_{1i} & x_{1n} \\ x_{j1} & x_{ji} & x_{jn} \\ x_{m1} & x_{mi} & x_{mn} \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

Xij = is the normalized value of alternative j on criterion i.

i = 1.2.3.4….,n *is* the original value of alternative j on criterion i.

j = 1.2.3.4…,n is the minimum value of criterion i.

x = is the maximum value of criterion i.

c. Normalize the MOORA matrix, this is done to standardize each element of the matrix to produce uniform elements. This effort can be done using the following equation:

$$X = * ij = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:

Xij = is the normalized value of alternative j on criterion i.

i = 1.2.3.4….,n *is* the original value of alternative j on criterion i.

j = 1.2.3.4…,n is the minimum value of criterion i.

x = is the maximum value of criterion i.

*X * ij** = Normalized matrix of alternative j on criterion i

d. Performing Multi-Objective MOORA optimization calculations.

1) If weights of importance are not assigned to each attribute or criterion for each alternative. The normalized measures are added in the case of maximization for favorable attributes and subtracted in the case of minimization for unfavorable attributes, or in other words, reducing the maximum and minimum values in each row to obtain rankings in each row. If formulated, it is expressed as follows:

$$Yi = \sum_{j=1}^{g} xij - \sum_{j=g=1}^{n} xij \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where:

i = 1, 2, …, g - criteria or attributes with maximum status

i = g+1, g+2, …, n - criteria or attributes with minimum status

yi = normalized assessment value from alternative 1 against all attributes.

2) If weights of importance are assigned to each attribute or criterion for each alternative. If weights are assigned to criteria for each alternative, the assignment

of weight values to the criteria is such that the maximum weight value for a criterion is greater than the minimum weight value for a criterion. To signify that an attribute is more important, it can be multiplied by the corresponding weight (significance coefficient) (Gadakh, 2011). The formula to calculate the value of Multi-Objective MOORA Optimization is as follows:

$$Yi = \sum_{j=1}^{g} wjxij - \sum_{j=g=1}^{n} wjxij \ldots\ldots\ldots\ldots(4)$$

where:

i = 1, 2, …, g - criteria or attributes with maximum status

i = g+1, g+2, …n - criteria or attributes with minimum status

wj = weight for j.

yi = normalized assessment value from alternative 1 against all attributes.

e. Determining the ranking value from the MOORA calculation results. The value yi can be positive or negative depending on the

maximum total (favorable attributes) in the decision matrix. A ranking order of yi indicates the final choice. Thus, the best alternative has the highest yi value, while the worst alternative has the lowest yi value.

The Scale Values are used to determine the values of respondents' answers through the provided questionnaire. Below is the scale of responses used:

Table 1. Likert Rating Scale

Response Scale Value	Value
Very Satisfied	5
Satisfied	4
Neuteral	3
Dissatisfied	2
Very Dissatisfied	1

B. Research Design

The research design is a guideline that directs all stages or activities of a research project, starting from the initial data collection to the final stage of interpreting the research findings.

By selecting experts, defining criteria and objectives, and then processing data, ultimately in the final stage, we aim to obtain results that will be used to make decisions based on the considered criteria.

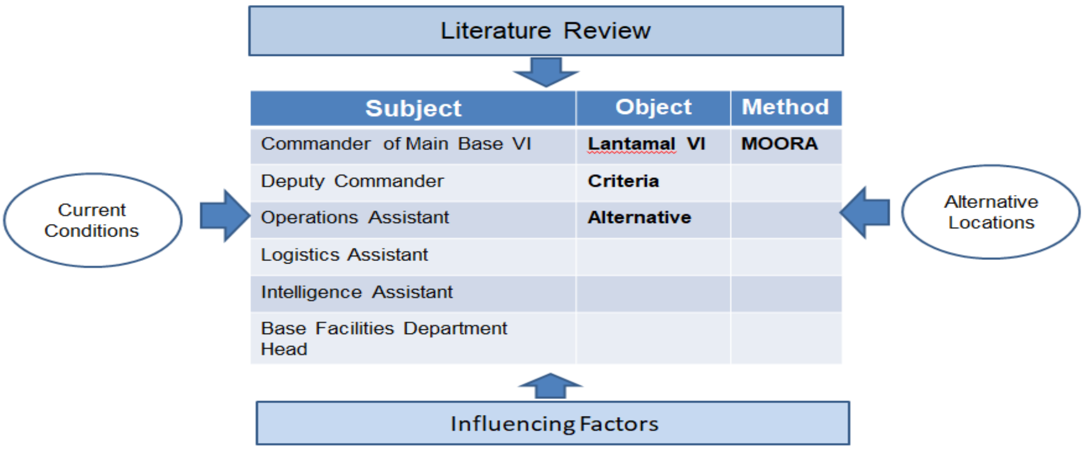

Figure 1. Research Design

C. Flowchart

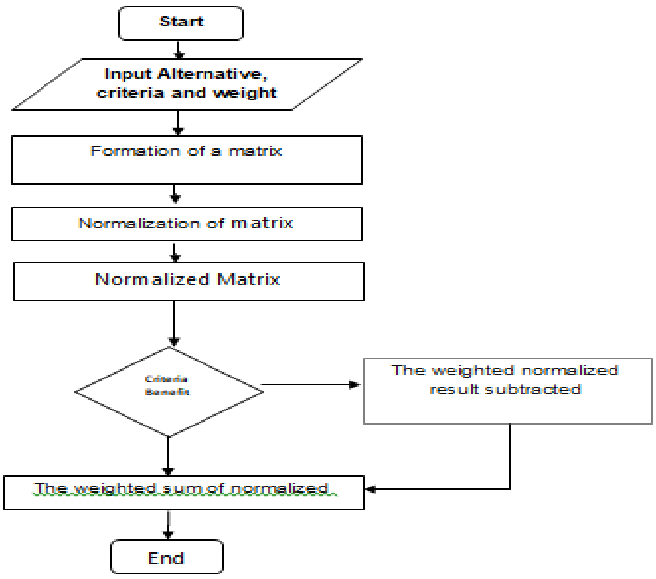

Figure 2. Flowchart

In this research, a flowchart is a graphical representation of the steps and sequence of procedures in a program. It typically influences problem-solving processes that require further study and evaluation (Crystallography, 2016). Flowcharts can be used to present manual activities, processing activities, or both. A flowchart consists of a series of symbols used to construct a research activity that begins with the Start, followed by inputting data related to Criteria, Weight, and Alternatives. Then, data processing is carried out using the MOORA method, and the final stage is a phase of the research results.

RESULT AND DISCUSSION

Based on the data collection results that have been conducted and explained previously, the criteria used in this research activity consist of 4 criteria as seen in Table 1.

Table 2. Criteria

NO	CRITERIA NAME	CRITERIA
1	GEOGRAPHY (C1)	BENEFIT
2	VULNERABILITY (C2)	COST
3	SOCIO-CULTURAL (C3)	BENEFIT
4	RESOURCES (C4)	BENEFIT

Then each criterion is assigned a weight for each criterion. For all criteria types are benefits, and the total weight of all criteria is 1 or 100%. As seen in Table 2.

Table 3. Criterion Weight Values

NO	CRITERIA	WEIGHT VALUES (W)	CRITERIA
1	GEOGRAPHY (C1)	0,45	BENEFIT
2	VULNERABILITY (C2)	0,25	COST
3	SOCIO-CULTURAL (C3)	0,15	BENEFIT
4	RESOURCES (C4)	0,1	BENEFIT

Based on Table 4, there are 4 alternative options with their respective symbols as seen in the Alternative table.

Table 4. Alternative

NO	ALTERNAATIVE	SYMBOLS
1	LANAL KENDARI	(Y1)
2	LANAL MAMUJU	(Y2)
3	LANAL PALU	(Y3)
4	POSAL BAUBAU	(Y4)

Each alternative in Table 5 contains various criteria with diverse values inputted into the table.

Table 5. Criterion Values for Each Alternative

ALTERNATIVE	CRITERIA			
	C1	C2	C3	C4
KENDARI	5	4	5	4
MAMUJU	5	5	4	2
PALU	5	4	3	4
BAO BAO	4	3	4	2
Optimum	Max	Min	Max	Max

The criterion values for each alternative are known, thus creating a decision matrix as shown in Table 6 below.

Table 6. Decision Matrix *Xij*

ALTERNATIVE	CRITERIA			
	C1	C2	C3	C4
KENDARI	5	4	5	4
MAMUJU	5	5	4	2
PALU	5	4	3	4
BAUBAU	4	3	4	2

A. Normalizing the Matrix

Normalization of the MOORA matrix is conducted to standardize each element of the matrix, resulting in uniform elements. This effort can be achieved using the following equation:

$$X = * ij = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad \text{................(2)}$$

Table 7. Normalization Matrix

Geography (C1)		Vulneralibility (C4)		Resources (C3)		Social Cultural(C2)	
KENDARI	0,5241	KENDARI	0,4924	KENDARI	0,6155	KENDARI	0,6325
MAMUJU	0,5241	MAMUJU	0,6155	MAMUJU	0,4924	MAMUJU	0,3162
PALU	0,5241	PALU	0,4924	PALU	0,3693	PALU	0,6325
BAU BAU	0,4193	BAU BAU	0,3693	BAUBAU	0,4924	BAU BAU	0,3162

From the normalization results of the criterion values, the Normalized Matrix Results of all criterion values for each alternative are obtained as shown in Table 8.

Table 8. Normalized Decision Matrix Xij

Normalized Decision Matrix			
0,5241	0,4924	0,6155	0,6325
0,5241	0,6155	0,4924	0,3162
0,5241	0,4924	0,3693	0,6325
0,4193	0,3693	0,4924	0,3162

After obtaining the normalized matrix results as shown in Table 8, the next step is to optimize the values of the normalized matrix. Then, multiply it by *wij* resulting in the values as shown in Table 8.

Table 9. Multiplication of Normalized Matrix xij.wj

C1	**C2**	**C3**	**C4**
0,2359	0,1231	0,0923	0,0632
0,2359	0,1539	0,0739	0,0316
0,2359	0,1231	0,0554	0,0632
0,1887	0,0923	0,0739	0,0316
Max	Min	Max	Max

B. Optimization Values

The optimization value is denoted by the symbol *yi*. The value of *yi* can be positive or negative depending on the maximum (beneficial attributes) and minimum (non-beneficial attributes) values in the decision matrix. In this case, the decision on the feasibility of the Main Naval Bases VI location is determined from the final result of the *yi* values. Where the eligible decision to receive incentives is the *yi* with the highest value. For Multi-Objective optimization, normalized performances are aggregated in the case of maximization (for beneficial attributes) and subtracted in the case of minimization (for non-beneficial attributes). When attribute weights are included, it can be formulated as follows:

$$Yi = \sum_{j=1}^{g} wjxij - \sum_{j=g=1}^{n} wjxij \quad \text{................(4)}$$

Table 10. Attribute Optimization Values (Normalized Matrix Multiplied by Weights)

C1	**C2**	**C3**	**C4**
0,2359	0,1231	0,0923	0,0632
0,2359	0,1539	0,0739	0,0316
0,2359	0,1231	0,0554	0,0632
0,1887	0,0923	0,0739	0,0316
Max	Min	Max	Max

After obtaining the attribute values as shown in Table 8, the next step is to rank them by identifying the maximum value in each row (alternatives), as the one with the highest value will be ranked first, followed by the others accordingly. So, let's create Table 11 to show the rankings based on the values obtained from the matrix multiplication.

Table 11. Rangkings

Alternative	Max C1+C3+C4	Min C2	Yi (Max-Min)	Rangking
KENDARI	0,3914	0,1231	0,2683	1
MAMUJU	0,3413	0,1539	0,1875	4
PALU	0,3545	0,1231	0,2314	2
BAU BAU	0,2942	0,0923	0,2019	3

From the ranking results, it can be concluded that the Multi-Objective Optimization by Ratio Analysis (MOORA) method can be used to determine weight values for ranking in order to obtain the best alternative choice.

The findings of this research can provide a strong basis for the development of policies related to the management of naval bases, including resource allocation and appropriate infrastructure improvement. The implications of this research can also lead to further in-depth studies, including the development of more sophisticated analytical methods or exploration of specific aspects that may not have been fully revealed in this study.

CONCLUSION

In this study, there is an implication of the degradation of the base function, hence the need to select a location alternative from several available alternatives using the MOORA method to ensure the functioning of Main Naval Bases VI base.

The research results obtained optimization values, so the calculation of these optimization values is stored in the database to be used as a reference for recommendations that are considered feasible in determining alternative locations for Main Naval Bases VI. Therefore, from the results of the optimization values, a ranking is obtained, where the highest value represents the best location alternative, namely Naval bases Kendari with a value of (0.2683).

In this research, among all the criteria considered, Geography is identified as the main variable, having the highest value and most significant influence in determining the best alternative choices in decision-making.

Limitations & Future Research

The limitations of this study lie in the accuracy of measurements depending on the selection of criteria and sub-criteria for the Location Selection of Main Naval Bases VI, how reliable and trustworthy the organization's data are, which can be interpreted as organizational bias; implying that it can affect the accuracy of measurements which is a limitation of this study. Therefore, in the future, strengthening data collection techniques by improving algorithms and data structures to reduce bias is necessary. This study also did not consider sustainable scenarios and provide modeling facing existing strategic environmental dynamics. Therefore, further research is needed to incorporate sustainable aspects, so that the results obtained will be more optimal.

REFERENCES

Ardielli, E. (2020). Evaluation of ehealth deployment at primary care in the eu member states by usage of selected mcdm methods. *Review of Economic Perspectives*, 20(3), 337–359. https://doi.org/10.2478/revecp-2020-0016

Gadakh, V. (2011). Application of MOORA method for parametric optimization of milling process. *International Journal of Applied Engineering Research*, April.

Hanson, W. E., Plano Clark, V. L., Petska, K. S., Creswell, J. W., & Creswell, J. D. (2005). Mixed methods research designs in counseling psychology. *Journal of Counseling Psychology*, 52(2), 224–235. https://doi.org/10.1037/0022-0167.52.2.224

Musbawati, A. N., Harisah, A., & Sir, M. M. (2022). Pengaruh Lantamal VI Terhadap Morfologi Permukiman Tabaringan Makassar. SEIKO : *Journal of Management & Business*, 5(1). https://doi.org/10.37531/sejaman.v5i1.1653

Nurjanah, S., Istiyono, E., Widihastuti, Iqbal, M., & Kamal, S. (125 C.E.). The Application of Aiken's V Method for Evaluating the Content Validity of Instruments that Measure the Implementation of Formative Assessments. *Journal of Research and Educational Research Evaluation*, 12(3), 133.

Singh, B. (2017). Applications of MOORA method for benchmarking decision in Indian industries. *International Journal of Advanced Operations Management*, 9(2), 88–105. https://doi.org/10.1504/IJAOM.2017.086674

Suharjo, B., & Suharyo, O. S. (2019). The naval harbours priority development using zero-one matrix decision variable (ZOMDV) and fuzzy MCDM methods; a case study. *International Journal of Civil Engineering and Technology,* 10(2), 623–634.

Taguchi, N. (2018). Description and explanation of pragmatic development: Quantitative, qualitative, and mixed methods research. *System*, 75, 23–32. https://doi.org/10.1016/j.system.2018.03.010