Comparison Of MOORA and COPRAS Methods Based on Geographic Information System For Determining Potential Zone of Pasir Batu Mining

Adiba Sabilla Ajrina[1]
Department of Information Technology Management, Faculty of Magister of Technology Management
Institut Teknologi Sepuluh Nopember
Surabaya, Indonesia
adiba.asabilla@gmail.com

Riyanarto Sarno[2]
Department of Informatics, Faculty of Information Technology and Communication
Institut Teknologi Sepuluh Nopember
Surabaya, Indonesia
riyanarto@if.its.ac.id

R.V. Hari Ginardi[3]
Department of Information Technology Management, Faculty of Magister of Technology Management
Institut Teknologi Sepuluh Nopember
Surabaya, Indonesia
hari@its.ac.id

***Abstract*- Population growth has an impact on increasing living needs, including the need for building materials. The high demand for building materials will spur the increase in mining activities, especially in Kediri Regency as the largest Pasir Batu producing district in East Java Province. On the other hand this industry also creates environmental changes that threaten the sustainability of environmental functions and the socio-cultural life. This was compounded by the lack of careful consideration in assessing the potential area for mining exploration by Pasir Batu. This paper proposes to determine the potential zone of Batu Pasir mining based on the specified criteria. Criteria are based on the definition of Mining and Exploration in UU Republik Indonesia 4/2009. The criteria used are grouped into 3 categories. First, natural factors consist of morphology, lithology, hydrology, vegetation and wild nature. Second, man-made factors include safe distance from the main road, settlement distance and population density.Third, aesthetic factors consist of natural elements and tourist locations. The research method used is the integration of Geographic Information System (GIS) with the calculation of Multi Criteria Decision Making (MCDM) using the AHP (Analytical Hierarchy Process) method, Multi-Objective Optimization by Ratio Analysis (MOORA) and Complex Proportional Assessment (COPRAS). GIS is used for data integration so that the determination of zoning is visual and easier to understand. The AHP method is used to determine the weighting of each criterion. The results of weighting the criteria serve as the basis for ranking alternative locations between the MOORA and COPRAS methods. The final outcome shows that two methods have a slightly different weight rank, but the COPRAS method is more stable and complex.The judgement is very influential in the selection of criteria and deliberate hierarchy to determine the significance of each criterion on the weighting of criteria.**

***Keywords*—*AHP, COPRAS, MCDM, , MOORA,* potential zone of mining, SIG**

I. INTRODUCTION

Indonesia is a vast country and has enormous natural resources. Some regions in Indonesia are famous for natural resources produced from mining activities. Natural resources are things that can be used for the needs and interests of human life so that they can improve human welfare and survival. Natural Resources have rare and limited properties so that their use requires several considerations. By its nature, resources are differentiated into natural resources that are renewable and unrenewable.

One example of renewable natural resources is Pasir Batu. Pasir Batu 's natural resources are product from activity of active volcanic in Gunung Kelud. [1] Some people in Kediri Regency are aware of this and then use these resources to become profitable mining businesses. Therefore, the current type of resource in this location is a renewable natural resource. Even so, renewable natural resources are also limited and spread over several points with different qualities. In practice, after mining activities, there are some mine sites that have less potential so that mining can not be held out as planned. In order to avoid this, Kediri Regency’s potential of Pasir Batu mining must be zoned.

Based on our knowledge, the proposed MCDM method using AHP, MOORA and COPRAS has not yet determined any research. Based on predetermined criteria, this study aims to determine the potential rank of the mining zone in Kediri Regency. The contribution of this paper is to determine the potential area of mining in Pasir Batu, which can be used as a basis for the government's assessment of mining space policy. This can also be used as one of the investors ' decision- makers to determine the location of the mining site with the potential required.

This research is intended to compare the potential mining zone in Kediri Regency by using two methodologies, namely MOORA and COPRAS. This study is carried out using the following methods of study: Criteria for determining spatial data, collection, analysis, calculation, comparison and reporting.

II. PREVIOUS WORK

There had been a lot of research about site selection on GIS over the last few years. Recent academic literature on site selection was commonly on solar farms, wind farms, and PV sites. [2] [3] [4] This research was about the potential determination of Pasir Batu mining zone. Reference [1] conducted the same topic. The paper was proposed by MCDM, which are AHP and BWM, and GIS-based, but calculations were only carried out until the criteria are weighted. The research was not followed by alternative ranking. The criteria used were also more limited compared to this study.

Reference [5] conducted a study on the evaluation of bike-share station in Turkey. The researcher used AHP and MOORA based on GIS. It must be noted that the software was used for the MOORA calculations on the paper. They used 12 considered explicitly spatial and real data criteria. Reference [3] Reference 3 carried out a study to optimize the selection of solar farms using the methods of Fuzzy AHP and PROMETHEE. Two weighting and ranking methods were used in the study. This was consistent with the study objectives, but the aim of the study was to directly integrate MCDM methods into the ArcGIS toolbox. This integration was not clearly written on the experimental method.

III. LITERATURE REVIEW

A. Geographic Information System

GIS is a system that is interrelated. GIS is also designed to capture, store, analyze and display data on Earth's surface positions. [4] GIS allows multiple layers of information to be displayed on a single map. As a result, GIS 's analytical basis is spatial records in virtual form acquired by satellite data or by digitizing different data. Data already in digital form, such as satellite images or other data software created, are feasibly uploaded to GIS. [6]

As described above, Geographic Information Systems (GIS) can actually answer in both spatial and non-spatial specific questions and their combinations to solve spatial difficulties. [7] This implies that the system is intended to support different geographical information analyzes, such as engineering techniques that used to investigate and discover information from a spatial angle, to expand and examine models and to provide data to improve understanding.. [8] This function or analytical technique is referred to as spatial analysis in geographic information systems (GIS). [4]

B. Analytical Hierarchy Process (AHP)

Saaty 's AHP technique in the 1970s is a practical MCDM technique that analyzes and solves complex decision-making problems. [9] It could be used to determine weights or priorities of criteria and to sort alternatives according to quantitative and qualitative evaluations. [10] The Analytical Hierarchy Process (AHP) is a method for resolving an unorganized complex scenario in a hierarchical scheme into different materials, offering contextual values both about the relative importance of each variable and specifying which variable has the highest priority to convince the final results of the case. [3]

The selection technique largely selects the first-rate alternative. A purposeful hierarchy with the primary entrance of human belief is the main system of the Analitycal Hierarchy Process (AHP). In its clusters, a complex and unorganized problem is solved and fully prepared with structure in a hierarchical form. [11]

In this study, AHP technique were used to wieighting predetermined criteria. Details of the AHP method are not really explained in this paper, as we do not extend the technique and various papers easily contain comprehensive descriptions.

C. Multi-objective optimization by ratio analysis (MOORA)

Brauers and Zavadskas (2006) developed the MORA method. [12] Multi-Objective Optimization on the basis of Ratio Analysis (MOORA) is a multi-objective system that optimizes two or more conflicting attributes simultaneously. MOORA has appeared frequently in recent literature, although it is a new method compared to other MCDM methods such as PROMETHEE, TOPSIS, ELECTRE and VIKOR.

The MOORA method has a degree of flexibility and ease to be understood in separating the subjective part of an evaluation process into decision weighting criteria with several attributes of decision making. [12] This method has a good level of selectivity because it can determine the objectives of conflicting criteria. Where criteria can be of beneficial value or benefit.

D. Complex Proportional Assessment (COPRAS)

COPRAS is one of the Multi Attribute Decision Making (MADM) methods for decision making in various fields of natural sciences and technology. The COPRAS method uses stepwise sorting and evaluates the procedures of alternatives in terms of significance and utility degrees. The success of this methodology is basically due to its simplicity and ease of use. [13]

The COPRAS method uses stepwise sorting and evaluates procedures from alternatives using fuzzy scales for qualitative attributes and calculates the relative weight weights of attributes using the AHP method for more consistent assessment. Sorting is determined by checking utility degrees. Complete sequencing can be obtained by arranging alternatives in descending order of utility degrees where the value of higher utility degrees is more desirable than low. Decision making using the COPRAS method provides complete alternative ordering from the best to the worst. [13]

IV. METHOD

The methodology of this research is arranged systematically as a research framework. It can be seen in Fig. 1.

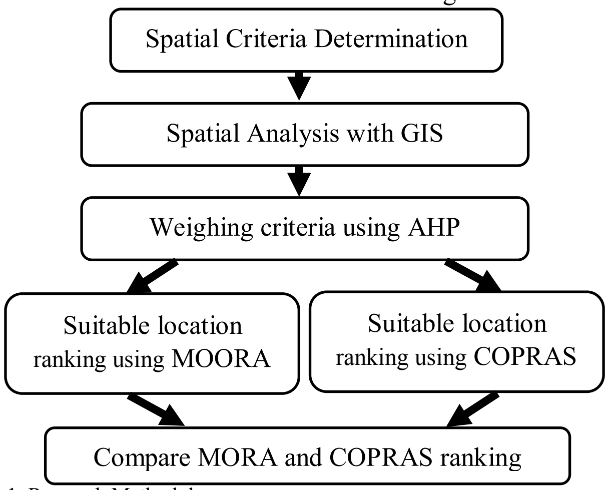

Fig. 1. Research Methodology

A. Spatial Data Analysis

Criteria are based on the definition of Mining and Exploration in Undang Undang Republik Indonesia No. 4 year 2009. The criteria used are grouped into 3 categories which are natural factors, man-made factors and aesthetic factors. Natural factors consist of morphology, lithology, hydrology, vegetation and wild nature. While man-made factors consist of distance from the main road, distance from settlement and population density. Then aesthetic factors consist of natural elements and tourist locations.

1) Natural Factors

a) Morphology

That the more sloping the morphological circumstances at the mine site, the practical mining and safety and security factors will also be better. This is not a major criterion, but the mining techniques performed will be easier and safer. In this study, the steep slopes of the hills scored 1, the slopes of moderate hills scored 2 and the slopes of the hills scored 3.

b) Lithology

The most appropriate lithology in Pasir Batu mining is alluvial lithology, since the material obtained is a loose material that is easier to use in mining. In addition, after lithology of aluvial, lithology of sediment is also an appropriate lithology. Alluvial lytology scored 3 in this study, sediment lithology scored 2 and other lithologies scored 1.

c) Hidrology

The production of Pasir Batu Mining will be greatly affected by the rainfall capacity on site, especially in excavation activities. The smaller the capacity of rainfall, the smaller the adverse impact. In this study, the rainfall capacity of more than 15 mm/day got a score of 1, while rainfall capacity between 15-20 mm/day got a score of 2. The highest score is an area with rainfall capacity less than 15 mm/day.

d) Vegetation

Mining activities must be carried out with 2 considerations, namely maximizing production but also minimizing damage to the surrounding environment. This also includes vegetation. The smaller the area of affected vegetation, the better for the environment. In this study, location with more than 60% vegetation area got a score of 1, while location with 30-60% vegetation area got a score of 2. The highest score is an area with vegetation area less than 30%.

e) Wildlife

The survival of wild animals also depends on human treatment of them. One of them provides a habitat for their habitat. Mining activities are expected not to disturb the native habitat of wild animals. So that the smaller the impact on the native habitat of wild animals in the forest, the better. In this study, location with more than 50% wildlife area got a score of 1, while location with 25-50% wildlife area got a score of 2. The highest score is an area with wildlife area less than 25%.

2) Man-made factors

a) Distance from the main road

Mining practices closer to the main highway will further reduce transport costs, facilitate access to roads and remove the cost of access to mining sites. However, this will also have a negative impact on social and environmental factors. In this research, the radius region of more than 5 km from the main road reached a score of 1, while the area reached a radius of 2.5 km-5 km. The highest score is an area less than 2.5 km in radius.

b) Distance from the settlement

The closer the settlement's mining site, the smaller the negative impact on the population. In this study, the 1 km radius area from the settlement had a score of 1, while the 1-2 km radius area had a score of 2. The best score is an area over 2 km in circumference.

c) Population density

The local environment will be greatly affected by mining activities, in particular transport activities. The smaller the population density of the mining area, the smaller the negative effect. The subdistrict with more than 1.5 million people per km2 had a score of 1 in this research, while the district had a score of 2 with 1-1.5 million people per km2. The district with less than one million people per km2 is the highest score.

3) Aesthetic Factors

a) Natural Features

Mining activities indeed support the continuity of development, but it is expected not to interfere with and damage the natural features in the location. The natural features in question are forests, mountains, waterfalls, landscapes, caves and springs. To minimize damage, location with 3 or more natural features got a score of 1, while location with 2-3 natural features got score 2. The highest score is the location with one or no natural features.

b) Touristic Places

The need for refreshing and traveling has been increasing lately. Mining activities are expected to avoid locations with touristic places such as sites / cultural heritage, natural tourism and artificial tourism. To minimize damage, location with more than 10 touristic places got a score of 1, while location with 5-10 touristic places got score 2. The highest score is the location with less than 5 or no touristic places.

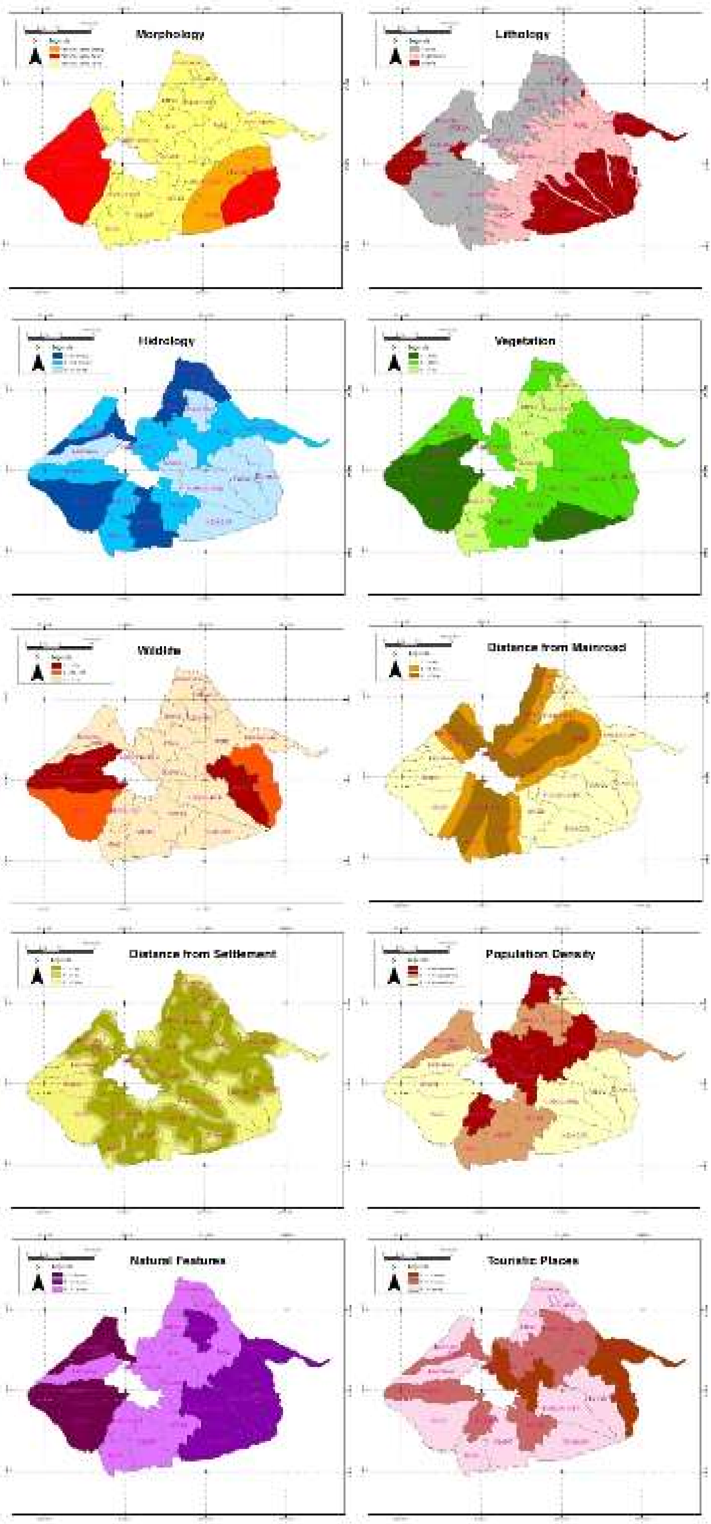

Fig. 2. Map layer of each criterion

B. Weighting Criteria Using AHP Method

The first step to be taken in the analysis of decision support systems using the AHP method is to create a hierarchical chart of each criterion. In Fig. 3, the hierarchy chart on the criteria for determining the Pasir Batu mining potential zone can be seen.

In order to identify the priority, we need to compare all the criteria for each hierarchy in pairs. In this study, the comparative evaluation used 9 scaled values [14]. There are 10 criteria in this study in order to produce a 10x10 matrix in the results of the comparison of each criterion.

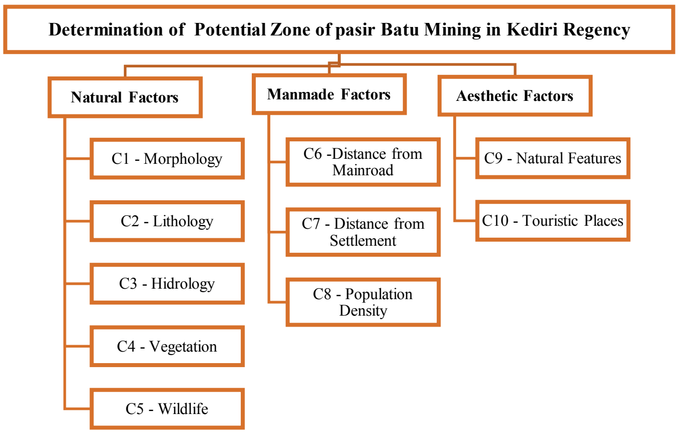

Fig. 3. Hierarchy Research Chart

The following steps are normalized on the basis of the comparison matrix: Sums the weight of each column, therefore the value of each column divided by total value of the column, and then estimating the comparative priority vector of each criterion by averaging an already standardized weight. The average weight (eigenvector) is determined by a number of criteria. The final outcome of the top priority weight calculation (eigenvector value) is a decimal number in one group with total priority criteria in one group. The results of a normalized matrix can be seen in Table I.

TABLE I. PAIRWISE COMPARISON MATRIX OF AHP

Criteria		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	BOBOT
C1	Morphology	1.00	0.12	0.33	0.40	0.67	0.14	0.20	0.20	0.25	0.29	1.89%
C2	Lithology	8.50	1.00	9.00	8.50	8.00	6.00	6.50	7.50	7.50	6.50	37.38%
C3	Hidrology	3.00	0.11	1.00	3.50	3.00	0.20	0.20	0.25	0.29	0.33	4.15%
C4	Vegetation	2.50	0.12	0.29	1.00	0.50	0.15	0.14	0.25	0.29	0.29	2.34%
C5	Wildlife	1.50	0.13	0.33	2.00	1.00	0.18	0.20	0.20	0.40	0.33	2.68%
C6	Distance from Mainroad	7.00	0.17	5.00	6.50	5.50	1.00	1.50	4.00	4.50	5.50	16.71%
C7	Distance from Settlement	5.00	0.15	5.00	7.00	5.00	0.67	1.00	4.00	3.00	3.50	13.60%
C8	Population Density	5.00	0.13	4.00	4.00	5.00	0.25	0.25	1.00	0.50	3.00	8.25%
C9	Natural Features	4.00	0.13	3.50	3.50	2.50	0.22	0.33	2.00	1.00	0.50	6.62%
C10	Touristic Places	3.50	0.15	3.00	3.50	3.00	0.18	0.29	0.33	2.00	1.00	6.38%
Amount		41.00	2.21	31.45	39.90	34.17	9.00	10.61	19.73	19.72	21.24	100%

Once the weights can be determined, the matrix consistency must be calculated. The measurement is actually carried out by summing up all the values of each column in the matrix, in order to normalize the matrix, divide so each column value by the total of the corresponding columns, summarize the values of each row and divide the average by a wide range of factors.By looking for the consistency index, the consistency ratio should be tested. Consistency is expected to be nearly perfect for a nearly legitimate selection. Although it is difficult to achieve the best, the consistency ratio is expected to be much less than 10 percent or the same. With those calculations obtained CI 0.1441 and CR 9.31% then the weighting desire is consistent.

C. *Fuzzy Logic*

Fuzzy logic is an appropriate way to map input space into an output space. This concept was introduced and first published by Lotfi A. Zadeh, a professor from the University of California at Berkeley in 1965. Fuzzy logic uses language expressions to describe variable values. [15]

In Fuzzy Decision Making (FDM) Method, there are 3 important steps that must be done, namely: problem representation, evaluation of fuzzy sets in each alternative decision and selection of optimal alternatives. Representation of the problem is done by identifying criteria that have been done before.

TABLE II. CRITERIA DEFINITION

Criteria		max/min	Fuzzy 1	Fuzzy 2	Fuzzy 3
C1	Morphology	max	Steep slope hills	Medium slope hills	Low slope hills
C2	Lithology	max	Others	Sedimentary	Alluvial
C3	Hidrology	min	< 15 mm/day	15-20 mm/day	> 20 mm/day
C4	Vegetation	min	< 30%	30-60%	> 60%
C5	Wildlife	min	< 25%	25-50%	> 50%
C6	Distance from Mainroad	min	< 2,5 km	2,5-5 km	> 10 km
C7	Distance from Settlement	max	< 1 km	1-2 km	> 2 km
C8	Population Density	min	< 1000 people/km2	1000-1500 people/km2	> 1500 people/km2
C9	Natural Features	min	0-1 feature	1-2 features	≥ 3 features
C10	Touristic Places	min	0-5 places	6-10 places	≥ 11 places

At the alternative selection stage is done by prioritizing decision alternatives based on the aggregation results. The results of the matrix decisions produced can be seen in Table III.

TABLE III. DECISION MATRIX

Number	Subdistrict	C1 Morphology	C2 Lithology	C3 Hidrology	C4 Vegetation	C5 Wildlife	C6 Distance from Mainroad	C7 Distance from Settlement	C8 Population Density	C9 Natural Features	C10 Touristic Places
1	Banyakan	1	2	1	3	3	2	2	1	1	1
2	Gampengrejo	3	3	2	2	1	1	2	3	1	3
3	Grogol	2	3	3	2	1	2	2	2	3	2
4	Kandangan	3	1	2	2	1	3	2	2	2	3
5	Kandat	3	2	3	2	1	1	1	2	1	1
6	Kepung	2	1	1	2	2	3	2	1	2	3
7	Kras	3	3	2	1	1	1	1	2	1	1
8	Kunjang	3	3	3	1	1	3	1	1	1	1
9	Mojo	1	3	3	3	2	3	2	1	3	1
10	Ngadiluwih	3	3	2	1	1	1	1	3	1	2
11	Ngancar	2	1	1	3	1	3	2	1	2	1
12	Pagu	3	3	2	1	1	2	1	3	1	2
13	Papar	3	3	3	1	1	1	1	2	1	1
14	Pare	3	3	2	2	1	1	2	3	1	2
15	Plosoklaten	2	1	1	2	1	3	2	1	2	1
16	Puncu	2	1	1	2	3	3	2	1	2	1
17	Purwoasri	3	3	3	2	1	2	2	3	1	1
18	Semen	1	2	2	3	3	3	2	1	3	2
19	Tarokan	2	3	2	2	1	2	2	2	3	1
20	Wates	3	2	2	2	1	3	2	2	1	2

D. *Suitable location ranking using MOORA*

MOORA is a multi-objective system that optimizes two or more conflicting attributes simultaneously. MOORA method is used to rank all the locations in Kediri Regency. The method of multi-objective ratio analysis optimization (MOORA) consists of two parts: The ratio system approach and the reference point approach. These two parts are based on the same standardization type.

Before optimizing criteria, we need to transform the Decision Matrix to Normalized Matrix. For normalization, the MOORA method uses a vector normalization procedure without changing the total cost to the criteria of the benefit type. Standardized performance ratings in Table IV MOORA are measured using the formula, as in:

$$r_{ij} = \frac{x_{ij}}{(\sum_{i=1}^{n} x_{ij})^{1/2}} \qquad (1)$$

where,

r_{ij} : normalized performance of i-th alternative with respect to j-th criterion

x_{ij}: performance ratings

TABLE IV. NORMALIZED MATRIX OF MOORA

Number	Subdistrict	C1 Morphology	C2 Lithology	C3 Hidrology	C4 Vegetation	C5 Wildlife	C6 Distance from Mainroad	C7 Distance from Settlement	C8 Population Density	C9 Natural Features	C10 Touristic Places
1	Banyakan	0.127	0.220	0.103	0.325	0.424	0.216	0.292	0.111	0.122	0.127
2	Gampengrejo	0.267	0.258	0.205	0.217	0.141	0.118	0.208	0.333	0.122	0.381
3	Grogol	0.187	0.261	0.308	0.217	0.141	0.198	0.201	0.222	0.367	0.254
4	Kandangan	0.267	0.130	0.205	0.217	0.141	0.287	0.221	0.222	0.244	0.381
5	Kandat	0.267	0.206	0.308	0.217	0.141	0.143	0.188	0.222	0.122	0.127
6	Kepung	0.154	0.136	0.103	0.217	0.283	0.294	0.237	0.111	0.244	0.381
7	Kras	0.267	0.267	0.205	0.108	0.141	0.141	0.176	0.222	0.122	0.127
8	Kunjang	0.267	0.265	0.308	0.108	0.141	0.290	0.162	0.111	0.122	0.127
9	Mojo	0.117	0.255	0.308	0.325	0.283	0.260	0.326	0.111	0.367	0.127
10	Ngadiluwih	0.267	0.257	0.205	0.108	0.141	0.105	0.146	0.333	0.122	0.254
11	Ngancar	0.142	0.096	0.103	0.325	0.141	0.299	0.263	0.111	0.244	0.127
12	Pagu	0.267	0.245	0.205	0.108	0.141	0.161	0.177	0.333	0.122	0.254
13	Papar	0.267	0.276	0.308	0.108	0.141	0.142	0.157	0.222	0.122	0.127
14	Pare	0.267	0.261	0.205	0.217	0.141	0.137	0.208	0.333	0.122	0.254
15	Plosoklaten	0.192	0.137	0.103	0.217	0.141	0.291	0.227	0.111	0.244	0.127
16	Puncu	0.157	0.111	0.103	0.217	0.424	0.290	0.229	0.111	0.244	0.127
17	Purwoasri	0.267	0.276	0.308	0.217	0.141	0.190	0.203	0.333	0.122	0.127
18	Semen	0.107	0.221	0.205	0.325	0.424	0.269	0.324	0.111	0.367	0.254
19	Tarokan	0.180	0.276	0.205	0.217	0.141	0.154	0.197	0.222	0.367	0.127
20	Wates	0.267	0.141	0.205	0.217	0.141	0.272	0.222	0.222	0.122	0.254

The basic idea of the MOORA method's ratio system approach is to identify the final performance index of the alternative as the difference among the amounts of weighted standardized benefit performance and cost criteria, as in:

$$Q_i = \sum_{j\in\Omega max} w_j r_{ij} - \sum_{j\in\Omega min} w_j r_{ij} \quad (2)$$

where,

Q_i : i-th alternative all ranking index

Ωmax dan Ωmin : benefit and cost criteria sets

w_j : j-th criterion weight

TABLE V. RANKING OF CRITERIA USING MOORA

Number	Subdistrict	C1 Morphology	C2 Lithology	C3 Hidrology	C4 Vegetation	C5 Wildlife	C6 Distance from Mainroad	C7 Distance from Settlement	C8 Population Density	C9 Natural Features	C10 Touristic Places	Qi	MOORA Rank
1	Banyakan	0.002	0.082	0.004	0.008	0.011	0.036	0.040	0.009	0.008	0.008	0.040	3
2	Gampengrejo	0.005	0.096	0.009	0.005	0.004	0.020	0.028	0.027	0.008	0.024	0.033	9
3	Grogol	0.004	0.098	0.013	0.005	0.004	0.033	0.027	0.018	0.024	0.016	0.015	13
4	Kandangan	0.005	0.049	0.009	0.005	0.004	0.048	0.030	0.018	0.016	0.024	-0.040	20
5	Kandat	0.005	0.077	0.013	0.005	0.004	0.024	0.026	0.018	0.008	0.008	0.028	11
6	Kepung	0.003	0.051	0.004	0.005	0.008	0.049	0.032	0.009	0.016	0.024	-0.030	19
7	Kras	0.005	0.100	0.009	0.003	0.004	0.024	0.024	0.018	0.008	0.008	0.056	1
8	Kunjang	0.005	0.099	0.013	0.003	0.004	0.048	0.022	0.009	0.008	0.008	0.033	8
9	Mojo	0.002	0.095	0.013	0.008	0.008	0.043	0.044	0.009	0.024	0.008	0.029	10
10	Ngadiluwih	0.005	0.096	0.009	0.003	0.004	0.017	0.020	0.027	0.008	0.016	0.037	7
11	Ngancar	0.003	0.036	0.004	0.008	0.004	0.050	0.036	0.009	0.016	0.008	-0.025	17
12	Pagu	0.005	0.091	0.009	0.003	0.004	0.027	0.024	0.027	0.008	0.016	0.027	12
13	Papar	0.005	0.103	0.013	0.003	0.004	0.024	0.021	0.018	0.008	0.008	0.052	2
14	Pare	0.005	0.097	0.009	0.005	0.004	0.023	0.028	0.027	0.008	0.016	0.039	6
15	Plosoklaten	0.004	0.051	0.004	0.005	0.004	0.049	0.031	0.009	0.016	0.008	-0.010	15
16	Puncu	0.003	0.042	0.004	0.005	0.011	0.048	0.031	0.009	0.016	0.008	-0.027	18
17	Purwoasri	0.005	0.103	0.013	0.005	0.004	0.032	0.028	0.027	0.008	0.008	0.039	5
18	Semen	0.002	0.083	0.009	0.008	0.011	0.045	0.044	0.009	0.024	0.016	0.007	14
19	Tarokan	0.003	0.103	0.009	0.005	0.004	0.026	0.027	0.018	0.024	0.008	0.040	4
20	Wates	0.005	0.053	0.009	0.005	0.004	0.045	0.030	0.018	0.008	0.016	-0.017	16

E. Suitable location ranking using COPRAS

Compared to previous methods, the complex proportional assessment method (COPRAS) has a slightly more complicated aggregation procedure, but it does not require a cost-benefit transformation. In Table VI, the normalized overall performance ratings in the COPRAS method are measured using the formula, as in:

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \quad (3)$$

TABLE VI. NORMALIZED MATRIX OF COPRAS

Number	Subdistrict	C1 Morphology	C2 Lithology	C3 Hidrology	C4 Vegetation	C5 Wildlife	C6 Distance from Mainroad	C7 Distance from Settlement	C8 Population Density	C9 Natural Features	C10 Touristic Places
1	Banyakan	0.029	0.051	0.024	0.077	0.107	0.051	0.067	0.027	0.030	0.031
2	Gampengrejo	0.062	0.060	0.049	0.051	0.036	0.028	0.048	0.081	0.030	0.094
3	Grogol	0.044	0.061	0.073	0.051	0.036	0.046	0.046	0.054	0.091	0.063
4	Kandangan	0.062	0.030	0.049	0.051	0.036	0.067	0.051	0.054	0.061	0.094
5	Kandat	0.062	0.048	0.073	0.051	0.036	0.034	0.043	0.054	0.030	0.031
6	Kepung	0.036	0.032	0.024	0.051	0.071	0.069	0.054	0.027	0.061	0.094
7	Kras	0.062	0.062	0.049	0.026	0.036	0.033	0.040	0.054	0.030	0.031
8	Kunjang	0.062	0.062	0.073	0.026	0.036	0.068	0.037	0.027	0.030	0.031
9	Mojo	0.027	0.059	0.073	0.077	0.071	0.061	0.075	0.027	0.091	0.031
10	Ngadiluwih	0.062	0.060	0.049	0.026	0.036	0.025	0.033	0.081	0.030	0.063
11	Ngancar	0.033	0.022	0.024	0.077	0.036	0.070	0.060	0.027	0.061	0.031
12	Pagu	0.062	0.057	0.049	0.026	0.036	0.038	0.041	0.081	0.030	0.063
13	Papar	0.062	0.064	0.073	0.026	0.036	0.033	0.036	0.054	0.030	0.031
14	Pare	0.062	0.061	0.049	0.051	0.036	0.032	0.048	0.081	0.030	0.063
15	Plosoklaten	0.045	0.032	0.024	0.051	0.036	0.068	0.052	0.027	0.061	0.031
16	Puncu	0.036	0.026	0.024	0.051	0.107	0.068	0.053	0.027	0.061	0.031
17	Purwoasri	0.062	0.064	0.073	0.051	0.036	0.045	0.047	0.081	0.030	0.031
18	Semen	0.025	0.051	0.049	0.077	0.107	0.063	0.074	0.027	0.091	0.063
19	Tarokan	0.042	0.064	0.049	0.051	0.036	0.036	0.045	0.054	0.091	0.031
20	Wates	0.062	0.033	0.049	0.051	0.036	0.064	0.051	0.054	0.030	0.063

The overall ranking index can be calculated using the following formula for each alternative in Table VII, as in:

$$Q_i = S_{+i} + \frac{\sum_{i=1}^{m} S_{-i}}{S_{-i}\sum_{i=1}^{m}\frac{1}{S_{-i}}} \quad (4)$$

Where,

$$S_{+i} = \sum_{j\in\Omega max} w_j r_{ij} \quad (5)$$

$$S_{-i} = \sum_{j\in\Omega min} w_j r_{ij} \quad (6)$$

TABLE VII. RANKING OF CRITERIA USING COPRAS

Number	Subdistrict	C1 Morphology	C2 Lithology	C3 Hidrology	C4 Vegetation	C5 Wildlife	C6 Distance from Mainroad	C7 Distance from Settlement	C8 Population Density	C9 Natural Features	C10 Touristic Places	S +i	S -i	(1/S-i)	S-i*sum(1/S-i)	Qi	Rank
1	Banyakan	0.001	0.019	0.001	0.002	0.003	0.008	0.009	0.002	0.002	0.002	0.029	0.020	49.028	17.677	0.055	3
2	Gampengrejo	0.001	0.022	0.002	0.001	0.001	0.005	0.006	0.007	0.002	0.006	0.030	0.023	42.575	20.357	0.053	10
3	Grogol	0.001	0.023	0.003	0.001	0.001	0.008	0.006	0.004	0.006	0.004	0.030	0.027	36.481	23.758	0.050	13
4	Kandangan	0.001	0.011	0.002	0.001	0.001	0.011	0.007	0.004	0.004	0.006	0.019	0.030	33.457	25.904	0.038	20
5	Kandat	0.001	0.018	0.003	0.001	0.001	0.006	0.006	0.004	0.002	0.002	0.025	0.019	51.914	16.695	0.053	9
6	Kepung	0.001	0.012	0.001	0.001	0.002	0.012	0.007	0.002	0.004	0.006	0.020	0.028	35.855	24.172	0.039	19
7	Kras	0.001	0.023	0.002	0.001	0.001	0.006	0.005	0.004	0.002	0.002	0.030	0.018	56.910	15.229	0.061	1
8	Kunjang	0.001	0.023	0.003	0.001	0.001	0.011	0.005	0.002	0.002	0.002	0.029	0.022	45.022	19.250	0.054	8
9	Mojo	0.001	0.022	0.003	0.002	0.002	0.010	0.010	0.002	0.006	0.002	0.033	0.027	36.770	23.571	0.053	11
10	Ngadiluwih	0.001	0.022	0.002	0.001	0.001	0.004	0.005	0.007	0.002	0.004	0.028	0.020	49.096	17.653	0.055	6
11	Ngancar	0.001	0.008	0.001	0.002	0.001	0.012	0.008	0.002	0.004	0.002	0.017	0.024	42.142	20.566	0.040	17
12	Pagu	0.001	0.021	0.002	0.001	0.001	0.006	0.006	0.007	0.002	0.004	0.028	0.023	44.272	19.577	0.052	12
13	Papar	0.001	0.024	0.003	0.001	0.001	0.006	0.005	0.004	0.002	0.002	0.030	0.019	53.694	16.141	0.059	2
14	Pare	0.001	0.023	0.002	0.001	0.001	0.005	0.006	0.007	0.002	0.004	0.030	0.022	44.929	19.290	0.055	7
15	Plosoklaten	0.001	0.012	0.001	0.001	0.001	0.011	0.007	0.002	0.004	0.002	0.020	0.023	43.778	19.798	0.044	15
16	Puncu	0.001	0.010	0.001	0.001	0.003	0.011	0.007	0.002	0.004	0.002	0.018	0.025	40.470	21.416	0.040	18
17	Purwoasri	0.001	0.024	0.003	0.001	0.001	0.007	0.006	0.007	0.002	0.002	0.032	0.023	42.837	20.233	0.055	5
18	Semen	0.000	0.019	0.002	0.002	0.003	0.011	0.010	0.002	0.006	0.004	0.030	0.029	33.904	25.563	0.048	14
19	Tarokan	0.001	0.024	0.002	0.001	0.001	0.006	0.006	0.004	0.006	0.002	0.031	0.023	44.028	19.685	0.055	4
20	Wates	0.001	0.012	0.002	0.001	0.001	0.011	0.007	0.004	0.002	0.004	0.020	0.025	39.532	21.924	0.042	16

Based on the calculation of MOORA and COPRAS methods, Table VIII shows us about the comparison of both methods.

TABLE VIII. MOORA AND COPRAS RANK COMPARISON

Number	Subdistrict	MOORA Rank	COPRAS Rank
1	Banyakan	3	3
2	Gampengrejo	9	10
3	Grogol	13	13
4	Kandangan	20	20
5	Kandat	11	9
6	Kepung	19	19
7	Kras	1	1
8	Kunjang	8	8
9	Mojo	10	11
10	Ngadiluwih	7	6
11	Ngancar	17	17
12	Pagu	12	12
13	Papar	2	2
14	Pare	6	7
15	Plosoklaten	15	15
16	Puncu	18	18
17	Purwoasri	5	5
18	Semen	14	14
19	Tarokan	4	4
20	Wates	16	16

V. CONCLUSION

In order to support the developement of increased infrastructure, appropriate resources should also be provided. Pasir Batu has the most important raw materials for infrastructure development. Kediri Regency, one of the sand grenades in East Java Province, must consider the potential points of the mining area. This paper helps to determine the potential mining area in Pasir Batu, which can be used as a basis for the government's assessment of mining space policy. This can also be used as one of the investor's decision makers to determine the location of the mining site with the necessary potential.

The basis for determining the potential zone of Pasir Batu mining is 10 criteria used in this study. In the MOORA method calculation and in the COPRAS method calculation. In the calculation by the MOORA method and the calculation by the COPRAS method, there are only 4 alternatives that have different rank. The 16 alternatives left are all the same. The final result shows that the weight rank of two methods are slightly different but COPRAS method has more stable and complex aggregation procedure. It is to be able to show utility degree. When compared alternatives, it can illustrate which one is better or worse. Based on the comparison of the two methods, the highest and the lowest rank location are the same, which are Subdistrict Kras as the highest rank and the lowest rank is Subdistrict Kandangan.

The criteria selection and preplanned hierarchy, including judgement from the expert to identify the importance of each criterion, is very important to the decision. Giving the priority builder weight influences the outcome very much. If there is a greater range of differences between each criterion, the result of the calculation will also vary. The level of dominance on each criterion will also vary depending on the priority value.

REFERENCES

[1] R. S. R. H. G. Adiba Sabilla Ajrina, "Comparison Of AHP and BWM Methods Based on Geographic Information System For," *2018 International Seminar on Application for Technology of Information and Communication,* 2018.

[2] Y. Charabi dan G. A, "PV site suitability analysis using GIS-based spatial fuzzy multi-criteria evaluation," *Renewable Energy,* pp. 2554-2561, 2010.

[3] K. Wiguna, R. Sarno dan N. Ariyani, "Optimization Solar Farm Site Selection Using Multi Criteria Decision Making Fuzzy AHP and Promethee: Case Study in Bali," *International Conference on Information & Communication Technology and Systems (ICTS),* pp. 237-243, 2016.

[4] J. Sánchez-Lozano, M. García-Cascales dan M. Lamata, "GIS based onshore wind farm site selection using Fuzzy Multi-Criteria Decision Making methods. Evaluating the case of Southeastern Spain," *Applied Energy,* pp. 86-102, 2016.

[5] M. Kabak, M. Erbaş, C. Çetinkaya dan E. Özceylan, "A GIS-based MCDM Approach for the Evaluation of Bike-share Stations," *Journal of Cleaner Production (2018),* 2018.

[6] M. Uyan, "GIS-based solar farms site selection using analytic hierarchy process," *Renewable and Sustainable Energy Reviews,* pp. 11-17, 2013.

[7] P. Ghusti, R. Sarno dan R. H. Ginardi, "Substation Placement Optimization Method Using Delaunay Triangulation Algorithm and Voronoi Diagram In East Java Case Study," *International Conference on Information & Communication Technology and Systems (ICTS),* p. 208 – 213, 2016.

[8] T. M., H. M. dan a. M. M., "The evaluation of solar farm locations applying Geographic Information System and Multi-Criteria Decision-Making methods: Case study in southern Morocco," *Renewable and Sustainable Energy Reviews,* pp. 1353-1362, 2015.

[9] Saaty, "How to make decision: The Analytical Hierarchy Process," *European Journal of Operational Research 48,* pp. 9-26, 1990.

[10] A. Apriliana, R. Sarno dan Y. Effendi, "Risk Analysis of IT Applications Using FMEA and AHP SAW Method With COBIT 5," *2018 International Conference on Information and Communications Technology (ICOIACT),* pp. 373 - 378, 2018.

[11] C. A. dan R. Sarno, "Application of Analytic Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods in singer selection process," *2018 International Conference on Information and Communications Technology (ICOIACT),* pp. 234-239, 2018.

[12] W. K. M. Brauers dan E. K. ZAVADKAS, "Multi-Objective Optimization with Discrete Alternatives on The Basis of Ratio Analysis," *INTELECTUAL ECONOMICS,* pp. 30-41, 2009.

[13] B. Đ. a. M. Đ. Dragisa Stanujkic*, "COMPARATIVE ANALYSIS OF SOME PROMINENT MCDM," *Serbian Journal of Management 8 (2),* vol. 8, pp. 213-241, 2013.

[14] G. Kabir dan R. Sumi, "Power substation location selection using fuzzy analytic hierarchy process and PROMETHEE: A case study from Bangladesh," *Energy,* pp. 717-730, 2014.

[15] 2. 1. I. C. o. I. &. C. T. a. S. (ICTS), "2017 11th International Conference on Information & Communication Technology and System (ICTS)," dalam *2017 11th International Conference on Information & Communication Technology and System (ICTS)*, 2017.