Decision Support System for SMEs Selection using MOORA Method for Corporate Vendor's Requirement

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Abstract: Decision **Support Systems (DSS) are part of computer-based information systems which include knowledge-based systems used to support decision making in a system. DSS provide a semi-structured decision, where no one knows exactly how decisions should be made. This study applies the Multi-Objective Optimization On The Basic Of Ratio Analysis (MOORA) Method as a method to be applied in a decision support system. A mathematical approach that is used as a solution to solve the selection of Small Medium Enterprises (SMEs) for the needs of the company's vendors. This study aims to determine how the MOORA system works through a mathematical approach to provide decisions on the selection of SMEs for the needs of vendors in the company. The research was conducted using a quantitative where each criterion has been determined in advance the value of its existence. Criteria data are determined based on the previous work process skills of the SMEs that will be made into vendors.**

Keywords: **DSS, MOORA, SMEs, Normalization**

I. INTRODUCTION

The existence of vendors in government or private organizations and agencies is needed. Apart from supplying a series of raw production goods, vendors also act as service and service providers. Various kinds of vendors offer many services and are competing as vendors who are competent in their fields. Besides that, sometimes vendors are not ready when from government or private agencies give a sudden work challenge and provide a very fast deadline for completion of work. Therefore, an assessment of a vendor is necessary as an evaluation of the performance of a vendor that has collaborated with government and private agencies. Assessment of vendors is carried out objectively and transparently without any friendship or kinship so as not to cause problems in the future (Dhillon, Syed, & de Sá-Soares, 2017; Liu & Yuliani, 2016).

In choosing a vendor, the company uses a work contract that follows the ongoing project work time. Besides that, choosing a vendor must be fast and precise, so that it affects the project's working time. Another problem is the subjectivity of the material procurement staff, such as kinship and friendship with vendors, which is very influential and there is even an indication of using collusive methods for vendor selection (Chand, Bhatia, & Singh, 2018).

So far, the selection of raw material vendors is only an opinion from employees and sales who come to the company to offer services for suppliers of quality raw materials to be used as raw materials for the manufacturing process. It will be reviewed on each sales supplier who will supply construction raw materials, and offer affordable and good quality prices, some even offer a long payment period, the importance of choosing to offer suppliers of construction raw materials that exist today to get results selection of suppliers of construction raw materials and the payment period made by the company (W. K. Brauers & Zavadskas, 2006; Karande & Chakraborty, 2012).

In the optimization process, when two or more characteristics conflict with the subject's objective for a certain boundary optimization simultaneously, this is known as multi-objective optimization or multi-attribute optimization. Multi-purpose problems can be found all over the world in different companies, industrial sectors, corporate offices, manufacturing units etc. or anywhere else the optimal choice needs to be made in the presence of two or more conflicting attributes (Allen, Cruz, & Warburton, 2017).

This study provides an overview of the use of the MOORA system in carrying out the calculation process, starting from determining criteria, determining the normalization matrix to obtaining a ranking in determining SMEs. The alternative ranking is influenced by the weighting of the criteria and the normalization of the procedures adopted to create the decision matrix elements dimensionless and comparable. Also found a separate normalization from one part to another. The expectation of this research is to provide continued knowledge about the mathematical calculation process and the operation of predetermined matrix elements (Arabsheybani, Paydar, & Safaei, 2018; W. K. M. Brauers, Ginevičius, & Podvezko, 2010)

II. LITERATURE REVIEW

Multi-objective optimization is a process carried out together which is useful for optimizing several criteria that contradict certain constraints. Such as maximizing profits and minimizing costs production; maximize employee performance and minimize overhead expenses of a factory; maximizing the selection of outstanding employees and minimizing the subjective in the selection (Karande & Chakraborty, 2012; Khan & Maity, 2016).

In the SMEs selection environment, decisions are made based on the determination of various predetermined criteria, and this problem is a little more difficult to determine. In the problem of decision making, the determination of criteria must be measurable and the results can be measured for each alternative candidate for the existing SMEs. Among the usually contradicting each other in the case of termination criteria, some things can be profitable (maximum values are desired) and some are not profitable (if the minimum criteria values are always preferred). Multi-objective optimization based on ratio analysis method (MOORA) considers favorable and unprofitable ranking objectives (criteria) or selects one or more alternatives from a set of available options (W. K. M. Brauers et al., 2010; Chakraborty, 2011)

This approach begins with a decision matrix which shows the output

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

Where x_{mn} is an alternative performance metric of criterion, and number of alternatives is m and number of parameters is n. Then the matrix of the decision is normalized for it to become dimensionless and comparable with all its elements. This standardization process is a set of ratios in which the output of an alternative on a criterion is compared to a denominator that is representative of all the alternatives relevant to that criterion (Sahu, Datta, & Mahapatra, 2014).

The following basic standardization protocol is followed.

$$X_{ij} = \frac{X_{ij}}{\sum_{i=1}^{m} X_{ij}} \dots\dots\dots\dots\dots\dots\dots\dots(2)$$

Where x_{ij} is a dimensionless number describing [0, 1] interval the standardized output of alternative ith on a jth criterion. This it is worth noting here that the decision elements. Matrix is structured without taking into account requirements sort (profitable or non-profit).

Written by Brauers et al occasionally, the following normalization process is found so when a matrix of decisions has a very large value for a particular one criterion, the normalized value for that criterion is greater than one (W. K. Brauers & Zavadskas, 2006; W. K. M. Brauers et al., 2010).

For the optimization of the attributes can be normalized to the size in the maximum case (for favorable attribute conditions) and can reduce for the minimal case (for the unfavorable attribute conditions) (W. K. M. Brauers et al., 2010; Khan & Maity, 2016).

$$y_{i} = \sum_{j=1}^{g} x_{ij} - \sum_{j=g+1}^{n} x_{ij} \dots\dots\dots\dots\dots\dots(3)$$

Where g is the maximum number of parameters (n - g) the number of conditions to be minimized and y_i is the importance of the evaluation for *i*th alternative for all the requirements. The best choice, when sorted in descending order, is that which has the highest importance for evaluation. An ordinal rating is recommended y*i* principles for deriving the candidate's final preferences. The value of Yi has a positive or negative value depending on the maximum and minimum totals in the decision matrix. The conclusion is that the best alternative has the highest value, and the worst one has the lowest value (Gürbüz & Erdinç, 2018; Hindardjo; et al., 2020).

The characteristics of a decision support system are as follows: (1) as a tool to provide recommendations for decision making in corporate agencies. (2) Humans are the holders of the highest authorization in making decisions, but for tools that can be in the form of application machines. (3) Unstructured and structured problem solving where each decision interacts with and supports the discussion of decision making. (4) DSS can obtain relevant information and can be used as needed. (5) Each existing subsystem is interconnected and interrelated and has a function as a system that can complete decision making. (6) Consists of two main supporting aspects of the model and data (Husain, 2019; Zaelani, Husain, & Budiyantara, 2020).

III. RESEARCH METHODS

In this paper, an attempt has been made to explore the application of a new multi-purpose decision making technique using the MOORA method described in the figure below.

The research was conducted in 9 steps. Starting from the initial study, which was then carried out a literature review to determine the concept of thinking from the MOORA method. After that, the criteria for the SMEs that have been selected are carried out and then given a determining value for the SME criteria.

The next step is to carry out the initial matrix process where the existing criteria are formed into a matrix based on the values that have been given. Finally, normalization is carried out using a mathematical approach in calculating the calculations. The final stage is ranking based on the order of the SMEs with the greatest yi value obtained and finally making the report (Chakraborty, 2011).

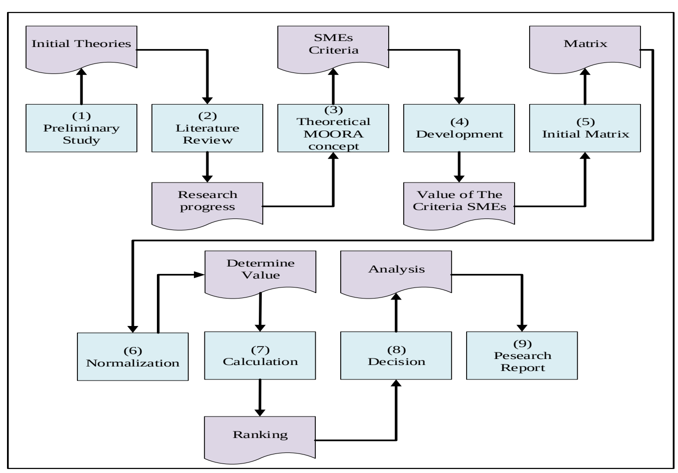

Fig 1. Research Method

IV. RESULTS AND DISCUSSION

In the MOORA method, some criteria are used as calculation material in the process appraisal. It is intended to determine which SMEs will be selected from several alternative SMEs selected. The first step taken to start calculations with the MOORA method is to determine the assessment criteria. Following are the SMEs selection criteria data for enterprise vendors (Patnaik, Swain, Mishra, Purohit, & Biswas, 2020).

Table I. Selection Criteria of SME

No	Criteria	Percentage
C1	Payment limit	25%
C2	Products offered	25%
C3	Credit limit offered	25%
C4	Customer service time	15%
C5	Taxation system	10%

Based on the five predetermined criteria, it's time to provide a detailed explanation of the above criteria.

a. Payment limit, namely each vendor provides a payment period that has been agreed upon with the company that is its partner

Table II: Payment Limit

Payment Limit	Value Criteria
Cash on delivery	1
Paid 14 working days after receipt of the complete invoices	2
Paid 30 working days after receipt of the complete invoices	3
Paid 45 working days after receipt of the complete invoices	4
Paid 60 working days after receipt of the complete invoices	5

b. Products Offered, namely the products offered by vendors in the form of goods or services

Table III. Products Offered

Products Offered	Value Criteria
Cash on delivery	1
Paid 14 working days after receipt of the complete invoices	3
Paid 30 working days after receipt of the complete invoices	5

c. Credit limit offered, namely the debt limit offered by the vendor to the company

Table IV. : Credit Limit Offered

Credit limit offered	Value Criteria
Cash	1
Up to IDR 20,000,000 (twenty million rupiah)	2
Above IDR 20,000,000 (twenty million rupiah) to IDR 50,000,000 (fifty million rupiah)	3
Above IDR 50,000,000 (fifty million rupiah) up to IDR 100,000,000 (one hundred million rupiah)	4
Above IDR 100,000,000 (One hundred million rupiah)	5

d. Customer service time, namely the time vendors can take in providing services to customers.

Table V. Customer Service Time

Credit limit offered	Value Criteria
Monday to Friday 08.00 a.m. -17.00 p.m.	1
Monday to Friday 24 hours	2
Monday to Sunday 08.00 a.m. -17.00 p.m.	3
Monday to Sunday 24 hours	4

e. Taxation system, namely taxation includes individuals and business entities that have a taxpayer identification number (NPWP) or do not.

Table VI. Taxation System

Payment Limit	Value Criteria
Individuals with NPWP / without NPWP	1
Business entities do not have NPWP	2
Business entity with NPWP	3
Business entities with NPWP and PKP (taxable companies)	4

After determining the criteria then the process of determining the vendor will process the decision support system.

Table VII. Value of the Criteria for Each Vendor

Alternative	C1	C2	C3	C4	C5
A1	1	5	4	1	3
A2	2	5	2	5	3
A3	3	5	2	3	4
A4	3	1	1	5	1
A5	3	5	3	5	3
A6	2	1	2	2	2
A7	1	1	2	1	2
A8	1	1	2	1	1
A9	2	5	4	4	4
A10	3	5	4	5	3
A11	5	5	4	5	3
A12	1	1	1	1	2

Initial data matrix

$$X = \begin{bmatrix} 1 & 5 & 4 & 1 & 3 \\ 2 & 5 & 2 & 5 & 3 \\ 3 & 5 & 2 & 5 & 3 \\ 3 & 1 & 1 & 5 & 1 \\ 3 & 5 & 3 & 5 & 3 \\ 2 & 1 & 2 & 2 & 2 \\ 1 & 1 & 2 & 1 & 2 \\ 1 & 1 & 2 & 1 & 1 \\ 2 & 5 & 4 & 4 & 4 \\ 3 & 5 & 4 & 5 & 3 \\ 5 & 5 & 4 & 5 & 3 \\ 1 & 1 & 1 & 1 & 2 \end{bmatrix}$$

The MOORA normalization process begins by adding up all the criteria that have gone through the initial matrix stages, then the total value that has been added is operated with the power root (Ghoushchi, Yousefi, & Khazaeili, 2019).

$$X_{ij} = \begin{bmatrix} 0.114 & 0.373 & 0.410 & 0.076 & 0.327 \\ 0.228 & 0.373 & 0.205 & 0.379 & 0.327 \\ 0.342 & 0.373 & 0.205 & 0.379 & 0.327 \\ 0.342 & 0.075 & 0.103 & 0.379 & 0.109 \\ 0.342 & 0.373 & 0.308 & 0.379 & 0.327 \\ 0.228 & 0.075 & 0.205 & 0.152 & 0.218 \\ 0.114 & 0.075 & 0.205 & 0.076 & 0.218 \\ 0.114 & 0.075 & 0.205 & 0.076 & 0.109 \\ 0.228 & 0.373 & 0.410 & 0.303 & 0.436 \\ 0.342 & 0.373 & 0.410 & 0.379 & 0.327 \\ 0.570 & 0.373 & 0.410 & 0.379 & 0.327 \\ 0.114 & 0.075 & 0.103 & 0.076 & 0.218 \end{bmatrix}$$

From the results of normalization (X*ij*) then determine the y*i* value by using equation (3)

$$.y_i = \begin{bmatrix} 0.028 & 0.093 & 0.103 & 0.011 & 0.033 \\ 0.057 & 0.093 & 0.051 & 0.357 & 0.033 \\ 0.085 & 0.093 & 0.051 & 0.357 & 0.033 \\ 0.085 & 0.019 & 0.026 & 0.357 & 0.011 \\ 0.085 & 0.093 & 0.077 & 0.357 & 0.033 \\ 0.057 & 0.019 & 0.051 & 0.023 & 0.022 \\ 0.028 & 0.019 & 0.051 & 0.011 & 0.022 \\ 0.028 & 0.019 & 0.051 & 0.011 & 0.011 \\ 0.057 & 0.093 & 0.103 & 0.045 & 0.044 \\ 0.085 & 0.093 & 0.103 & 0.057 & 0.033 \\ 0.142 & 0.093 & 0.103 & 0.057 & 0.033 \\ 0.028 & 0.019 & 0.026 & 0.011 & 0.022 \end{bmatrix}$$

The calculation of MOORA Multi Objective Optimization Value (max-min) in this case refers to equation (3) because each criterion has its own weight. This optimization value is calculated for each given alternative. This value is the number of multiplication of the criterion weight with the maximum attribute value (max), namely the value of the benefit type attribute minus the number of multiplication of the criterion weight with the minimum attribute value (min), namely the attribute value of the cost type.

From the calculation results in table VII, it can be seen that A11 shows the first ranking in the determination using the MOORA method.

Table VIII. Ranking of the Alternative

No	C1	C2	C3	C4	C5	Max	Min	y*i*	Rank
A1	1	5	4	1	3	0.22	0.04	0.18	3
A2	2	5	2	5	3	0.20	0.09	0.11	7
A3	3	5	2	3	4	0.23	0.09	0.14	6
A4	3	1	1	5	1	0.13	0.07	0.06	11
A5	3	5	3	5	3	0.26	0.09	0.17	4
A6	2	1	2	2	2	0.13	0.04	0.08	8
A7	1	1	2	1	2	0.10	0.03	0.07	10
A8	1	1	2	1	1	0.10	0.02	0.08	9
A9	2	5	4	4	4	0.25	0.09	0.16	5
A10	3	5	4	5	3	0.28	0.09	0.19	2
A11	5	5	4	5	3	0.34	0.09	0.25	1
A12	1	1	1	1	2	0.07	0.03	0.04	12

V. CONCLUSION

In this paper, a mathematical approach is applied to solve the problem of selecting SMEs is to use the MOORA method. This method is simple enough to understand and easy to apply while giving a total ranking of the alternatives previously considered. This is based on the observation that the rankings obtained from the selection of SMEs are almost accurate when compared to those obtained previously without using them. The main advantage of this method is the uncomplicated normalization procedure and also see the criteria weights. The appearance of this method is also comparable to that of other popular, widely used methods. So, this method can also be applied to other decision-making scenarios regardless of the number of alternatives and criteria. The results obtained from the selection of SMEs using a decision-making system using the MOORA method show that A11 is in the first rank.

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