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# Implementation of Decision Support Systems In Cement Supplier Evaluation With Fuzzy Analytical Hierarchy Process (FAHP)

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**A B S T R A C T**

The implementation of raw material selection is a multi criteria problem where each criterion used has a different importance and the information about it is not known with certainty. Selection of suppliers based on low price bids is no longer efficient in obtaining maximum performance, SCM must combine other criteria that are relevant to company objectives. PT. X faces obstacles related to unstable supplier performance, including delays, fluctuating prices and delivery that is not in accordance with the orders. The instability that occurs is not yet due to other factors that tend to be far from the company's plans and estimates. This research approach uses the AHP in the decision-making support process of a complex and measurable problem uses fuzzy to accommodate the uncertainty that occurs when making decisions. Based on the results of calculations that have been carried out using the FAHP combination method and the assessment using the rating scale, the calculation results of each criterion in this study are obtained with the quality criteria of 0.2829, delivery criteria 0.2096, price criteria 0.1457, service criteria 0,0984, the criteria for production capability 0.1466, and the criteria for supplier characteristics 0.1172. Based on these calculations, the quality criteria are the top priority in selecting suppliers, especially in the supply of cement raw materials.



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## 1. Introduction

The high level of business competition and the demand for building materials in the concrete block industry make business people need to improve their performance and optimize their resources, this of course must be supported by improvements in the treatment of suppliers, especially in the raw material supply chain. There are many strategies that companies have implemented in order to improve and maintain their performance, one of the areas of concern for companies in competing with other companies is the supply chain, therefore companies are required to choose reliable suppliers to meet their needs for the right supply of raw materials. so that they can compete in the industrial world proportionally.

PT. X is a companies in East Java with paving blocks produces, which in the production process requires a supplier of raw materials, by focusing on selecting suppliers for the main raw material for making paving blocks, namely cement, due to delays in the delivery of raw materials from cement suppliers so that the company experiencing down time and creating instability in the production process, and that needs improvement in the selection of cement suppliers (Hermansyah, M., 2018) Improvements are made because there are many suppliers of main raw materials and need to go through a selection process according to the criteria set by the company based on the results of calculations in supplier selection decisions. One of the strategic activities of a company is supplier segmentation, where a company creates supplier groups to be able to handle suppliers differently in the process of raw material excellence, by segmenting each supplier in analyzing the data collected. The method used to determine these priorities is FAHP (Azar, A., et al., 2015).

Making a selection decision is needed precisely to find out how much influence the criteria and sub criteria are in the selection of cement raw material suppliers with the correct problem solution structure in the application of a decision support system (Dalih, I., Hermansyah, M., 2020). The hierarchical structure of the problem in selecting suppliers of cement raw materials uses the application of a system with a priority order in selecting based on measurable assessments, so that it is expected to be able to help companies choose from a number of suppliers who have been the company's partners. The search for the solution structure of the problem of selecting suppliers of cement raw materials using the application of a decision support system. Knowing the priority order of the best suppliers in cement raw materials based on an assessment with the application of the system. Companies can find out the percentage of the influence criteria and sub criteria in selecting suppliers so that the selection is prioritized in the priority order criteria and sub criteria problems can be seen systematically arranged in a hierarchy. Companies can prioritize the allocation of raw material orders to suppliers that have the highest weight based on the criteria and sub-criteria used in supplier selection.

## 2. Literature Review

Kaganski, et al. (2018) Measuring company performance is a procedure for monitoring the life cycle of a company in competition to determine the information system framework to rely on in overcoming company weaknesses. A logic has a value of ambiguity or obscurity between two values is Fuzzy logic. The fuzzy approach, especially the Triangular Fuzzy Number approach to the AHP scale, is expected to be able to minimize uncertainty in the supply chain system so that it is expected that the results obtained are more accurate. (Micheline, J., Chiweshe., 2017) Modern businesses are required to compete in a dynamic global market due to intense competition related to quality, cost, and on-time delivery to increase flexibility, quality standards, and innovative capacity. To achieve this, businesses need experienced and trained staff, reliable machines, efficient processes, good relationships with suppliers and customers, supply of quality raw materials and services. (Hermansyah, M. et al., 2020). Improving the production tapioca system is one of the solutions to improve economy local of rural communities through developing an inventory of cassava as a raw material for cheap tapioca that can be obtained throughout the year, using the right management and strategy. The aims his study to determine the order criteria priority that influence in determining steps to improve performance of the production system. The method used FAHP using 4 criteria of management principles is planning, organizing, directing, and also controlling.

Decisions are the result of solving a problem that must be faced firmly. (Dagun, SM., 2000). Decision making is defined as the selection of a decision or policy based on certain criteria. "Decision making can be considered as a result or output of mental or processes cognitive that lead to the selection of a course of action among several available alternatives".

The fuzzy set is a development of the firm set theory, it will only have two membership possibilities. On the other hand, fuzzy set members have a fuzzy value between false and true (fuzziness). Each fuzzy set can be represented by a membership functions, which is a curve that shows the mapping of data input points into its membership value which has an interval between 0 to 1. To get the membership value is to go through the function approach. There are several functions that can be used, including Linear Representation, Trapezoid and Triangle (Kusumadewi, S., Purnomo, H., 2004) The rules of the triangular fuzzy number (TFN) function which are arranged based on the linguistic set are used to determine the degree of membership in the F-AHP. Triangle representation has three parameters, namely a, b, c with a < b < c, represented by a triangle (x;a,b,c).

$$\text{Membership function } \boldsymbol{\mu}[\boldsymbol{x}] = \begin{cases} \mathbf{0}; & \boldsymbol{x} \geq \boldsymbol{d} \text{ or } \boldsymbol{x} \leq \boldsymbol{a} \\ (\boldsymbol{x}-\boldsymbol{a})/(\boldsymbol{b}-\boldsymbol{a}); & \boldsymbol{a} < x < b \\ (\boldsymbol{d}-\boldsymbol{x})/(\boldsymbol{d}-\boldsymbol{c}); & \boldsymbol{c} < x < c \\ \mathbf{1}; & \boldsymbol{b} \leq \boldsymbol{x} \leq \boldsymbol{c} \end{cases}$$

Membership function

$\mu[x] = \{0; x[?][?][?]d \text{ or } x[?][?][?]a \ (xa)/(ba); a<x<b \ (dx)/(dc); c<x<c \ 1; b[?][?][?]x[?][?][?]c$

AHP is a models by Mr. Saaty to develop for decision support to look for order of priority or ranking or of the various alternatives solving problems. In complex situation decision making is not influenced by a factor alone but basically AHP multi factors. The interval scale of pairwise comparisons can use this measurement theory. To examine problems that begin by defining the problem and then arranging it into a hierarchy can use AHP. With a hierarchy a complex and unstructured problem is broken down into groups and organized into a hierarchy that Then, various considerations are used to sort the weights or priorities (Saaty, 1993).

According to (Saaty, 1993) the several basic principles of solving problems using the Analytic Hierarchy Process (AHP) method, including: Comparative judgment, Decomposition, Logical Consistency, and Synthesis of Priority. The AHP has basic axioms that must be met, namely: Reciprocal Comparison, Homogeneity, Dependence and Expectation. Saaty (1993) defines hierarchy as a representation of a complex problem in a multi-level structure where the first level is the goal, which is followed by the level of factors, criteria, sub-criteria, and so on down to the last level, namely the alternative. Complex problems with hierarchies can be broken down into groups that are arranged into a hierarchical form so that problems will appear more structured and systematic (Hermansyah, M., (2018). The AHP structure is shown in Figure below:

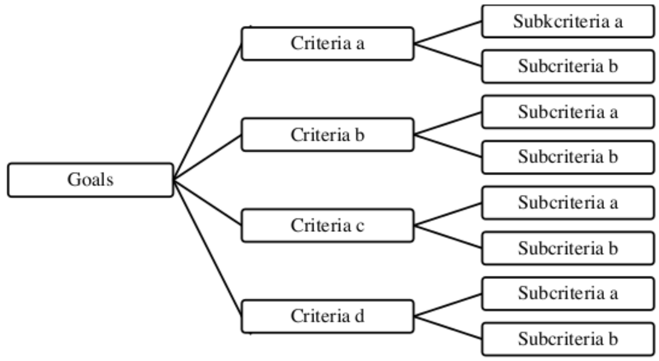


**Figure1.**Hierarchy of AHP Model P

Compiling pairwise comparisons by comparing all elements for each sub-hierarchy in pairs. Aims to determine the priority arrangement of elements. To assess the comparison of the level of importance of one element to another, a scale of 1 to 9. After giving an assessment of each comparison between elements, to determine the priority aprepared pairwise comparison matrix is.It then tests for consistency and analyzes the sensitivity of the overall priority to changes in the comparison.

Table 1: Pairwise Comparison Matrix

| Intensity of Interest | Explanation | Explanation |
|---|---|---|
| 1 | Both elements are equally important | Two elements have the same great influence on goals |
| 3 | Element is slightly more important than the other Elements | Experience and judgment slightly support over the other |
| 5 | An elements is more important than the others | Experience & judgment strongly supports one element over other elements |
| 7 | An element is clearly more absolutely important than the other elements | An element is strongly support and dominant is seen in practice |
| 9 | An element is absolutely important over the other elements | Evidence in favor of one element over the other has the highest possible level of affirmation strengthen |
| 2,4,6,8 | Values between two adjacent value considerations | This value is given when there are two compromises between two choices. |

*Source: Saaty (1993)*

Pairwise comparison matrix will produce eigenvectors that indicate the priority level of the elements being compared. What is meant by *eigenvalue* is a scalar number and *eigenvector* is a matrix that both can define matrix A. Where matrix A is a square matrix $n$ x $n$. However, not all square matrices have *eigenvalues* and *eigenvectors*.

$Ax = \lambda x$ Equivalently: $(\lambda I - A)x = 0$ (3)

In order to be an eigenvalue, then $det(\lambda I - A) = 0$ (4)

This equation is called the characteristic equation for A and has $n$ roots. The roots of the characteristic equation, which are expressed by ,$\lambda i$ = 1, 2, …, n, re called the eigen values of A. While the characteristic vector $x \neq 0$ that will satisfy equation (Dalih, I., Hermansyah, M., 2020) is called the eigenvector of A. As a result, the 1, then $trace\ [\boldsymbol{A}] = n = \sum_{i=1}^{n} \lambda_i$, can be concluded that the largest eigen value of A is equal to $n$, and the other eigen values are zero. In AHP the largest eigen value is expressed by $\lambda_{max}$. For a consistent matrix $\lambda_{max}$ = n, in practice it cannot be guaranteed that the matrix is consistent. One of the reasons is that the human element/decision maker cannot always be absolutely consistent in expressing preferences for the elements being compared. In other words, that the assessment given to each element of the problem at a hierarchical level may be inconsistent.

Perception as decision making may be an inconsistency. In matrix theory, it can be seen that a small error in the coefficients will cause a small deviation in the eigen values. By combining what has been described previously, if the main diagonal of the matrix A is worth one and if A is consistent then small deviations from *aij* will still show eigen value the largest λ max, the value will approach n and eigen value the remainder will be close to zero. But if A is not consistent, small variations on aij will create eigen value the largest λ max is always greater than or equal to n ie ≥ nλ maks. The deviation from the consistency of dengan max with n can be used to see how much inconsistency A is, expressed by the consistency index with the equation:

$$CI = \frac{\lambda_{max} - n}{n - 1}$$

According to (Saaty. (1993) the pairwise comparison matrix is declared consistent if the consistency ratio (CR) 10%. If the CI = 0, it means matrix is consistent inconsistency. The specified limit is measured using the Consistency Ratio (CR), which is a comparison of the consistency index with value of Random Index (RI). This value depends on the order of the matrix n.

$$CR = \frac{CI}{RI}$$

FAHP is a ranking method and is a combination of the AHP method with a concept approach. Fuzzy FAHP covers the weaknesses found in AHP , namely the problem of criteria that have more subjective properties. Set Fuzzy theory helps in measurements related to human subjective judgments using language or linguistics. Linguistic variables are definite and useful for processing information in thes phere fuzzy, a triangular number developed fuzzy (TFN) has been symbolized as M.The essence of the method fuzzy AHP is a pairwise comparison with a ratio scale associated with the value of the scale fuzzy. (Wang, H., 2013) defines the AHP intensity value into a scale fuzzy triangular, a membership function for the scale of linguistic variables. Then the rules of mathematical operations for numbers fuzzy triangular are:

$$\boldsymbol{M_1 + M_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2)}$$
$$\boldsymbol{M_1 \otimes M_2 = (l_1 l_2, m_1 m_2, u_1 u_2)}$$
$$\boldsymbol{\lambda \otimes M_1 = (\lambda l_1, \lambda m_1, \lambda u_1), \lambda >} 0, \lambda \epsilon R$$
$$\boldsymbol{M_1^{-1}} = \left(\boldsymbol{\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{u_1}}\right)$$

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$$M_1 : M_2 = \left(\frac{l_1}{u_2}, \frac{m_1}{m_2}, \frac{u_1}{l_2}\right)$$

In mathematics, the cross Kronecker product denoted by is an operation on two vectors by multiplying according to their position, thus forming a vector of the same size. Based on the extent of analysis method, each criterion was taken and analyzed for each criterion. Therefore, the value of m extent analysis for each criterion is obtained by following the following notation:

$$M_{gi}^1, M_{gi}^2, M_{gi}^3, M_{gi}^4, M_{gi}^5, \dots \dots \dots, M_{gi}^m$$

Where $g_i$ is the objective set (i = 1, 2, 3, 4, 5, .., n) and all, $M_{gi}^j (j = 1,2, \dots \dots, m)$, are Triangular Fuzzy Numbers (TFNs). (Dagun, SM., 2000) The stages of analysis Chang is known as follows: (Kusumadewi, S., Purnomo, H., 2004).

Step 1: Fuzzy Synthetic Extend

The value of the fuzzy synthetic extent (Si) of the ith object is defined as follows:

$$S_i = \sum_{j-1}^{m} M_{gi}^j \otimes \left[\sum_{i-1}^{n}\sum_{j-1}^{m} M_{gi}^j\right]^{-1}$$

Obtained equation 2

$$\sum_{j-i}^{m} M_{gi}^j a$$

The fuzzy addition operation of the m analysis extend value for the equation 3 matrix below,

$$\sum_{j-1}^{m} M_{gi}^j = \left(\sum_{j-1}^{m} l_j, \sum_{j-1}^{m} m_j, \sum_{j-1}^{m} u_j\right)$$

Where 1 is the lower limit value, m is the expected value, and u is the upper limit value.

Equation 4

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^j\right]^{-1}$$

Fuzzy addition operation of $M_{gi}^j (j = 1,2, \dots \dots \dots, m)$

$$\sum_{i-1}^{n}\sum_{j-1}^{m} M_{gi}^j = \left(\sum_{i-1}^{n} l_i, \sum_{i-1}^{n} m_i, \sum_{i-1}^{n} u_i\right)$$

Then calculate the inverse of the vector in equation 5

$$\left[\sum_{i-1}^{n}\sum_{j-1}^{m} M_{gi}^j\right]^{-1} = \left(\frac{1}{\sum_{i-1}^{n} u_i}, \frac{1}{\sum_{i-1}^{n} m_i}, \frac{1}{\sum_{i-1}^{n} l_i}\right)$$

Step 2: Degrees of Probability

Degree of probability of $M_1 = (l_2, m_2, u_2) \geq M_2 = (l_1, m_1, u_1)$ defined as:

$$V(M_1 \geq M_2) = \sup_{x \geq y}\left[min\left(iM_1(x), iM_2(y)\right)\right]$$

Where soup is supremum (the upper limit of the smallest set). If there is a pair (x, y), where x ≥ y and $\mu M_1(x) = \mu M_2(y)$, then $V(M_1 \geq M_2) = 1$. As long as $M_1$ and $M_2$ are convex fuzzy numbers, then:

$$V(M_2 \geq M_1) = \begin{cases} 1, \dots \dots \dots if\ m_1 \geq m_2 \\ 0, \dots \dots \dots if\ l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, for\ other\ conditions \end{cases}$$

Where d is the highest intersection value between $\mu M_1$ and $\mu M_2$, as shown in Figure 2.

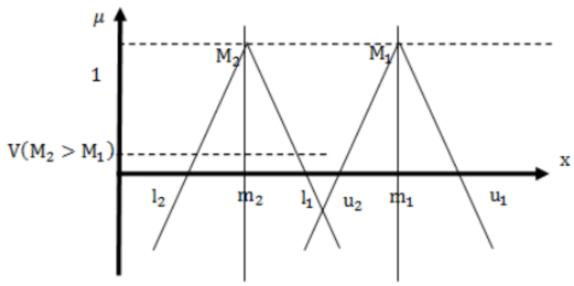


Figure 2. The intersection of $M_1$ and $M_2$

To compare $M_1$ and $M_2$, both $V(M_2>M_1)$ and $V(M_1>M_2)$ values are needed.

Step 3: The probability level for convex fuzzy numbers is better than for convex fuzzy numbers. (Dubois, D and Prade , H., 1980)
$M_1$ (i = 1, 2, 3, …, k) can be described by
$V(M \geq M_1, M_2, M_3, \dots, M_k) =$
$V[(M \geq M_1)\ and\ (M \geq M_2)\ and\ (M \geq M_3) \dots .. (M \geq M_k)] =$
$Min\ V\ (M \geq M_k), i = 1,2,3, \dots, k$
Assume the equation 9
$\boldsymbol{d^1(A_i) = min\ V\ (S_i \geq S_k)}$
For k = 1,2,3,….n ; k ≠ i.
The weight vector is defined:
$\boldsymbol{W^1 = \left(d^1(A_1), d^1(A_2), d^1(A_3), \dots d^1(A_n)\right)^T}$
Where $A_i$ (i = 1,2,3,….,n) is n elements.

Step 4. Normalization
Normalization of weight vectors is important not only for easy interpretation, but also for the unique solutions of several methods such as the logarithmic least square method. Normalization consists of 2 ways, namely division and geometric.

$\boldsymbol{W = \left(d\ (A_1), d\ (A_2), d\ (A_3), \dots d\ (A_n)\right)^T}$
Where W is not a fuzzy number.

## 3. Metodology

The data used are primary data obtained through research using survey methods, namely distributing questionnaires. Respondents are company staff who have worked for more than 1 year, so they already know and know about suppliers. With the following criteria: a) Quality. The Quality Criteria include 5 sub-criteria, namely the percentage of rejects, inspection methods, conformity with specifications, quality systems, and technical support. b) Delivery. Delivery criteria include 4 sub-criteria, namely timeliness of delivery, suitability of the number and specifications of parts sent, completeness of shipping documents, and delivery capacity. c) Price. Price criteria include 3 sub-criteria, namely competitive prices, price details, and payment terms. d) Production capability. The criteria for production capability include 5 sub-criteria, namely the required lead time, the ability to fulfill order changes, product diversity, minimum order quantity, and production capacity. e) Service. Service criteria include 3 sub-criteria, namely responsiveness to orders received, average part claim replacement time, and responsiveness in repairs. f) Characteristics of suppliers, Criteria Characteristics of suppliers include 5 sub-criteria, namely financial stability, geographical location, reputation, negotiability, and professionalism.

For an unknown population (infinite population), the sampling method used is a non-probability sampling technique, namely purposive sampling where the sample is selected randomly and subjectively. The sample taken in this study is 30 respondents. The computer program used is Microsoft Excel. 2010. The analytical methods used to achieve the objectives in this study are described as follows:

a. Define and describe the problem, namely the factors that are the company's priority in determining suppliers, for supplier evaluation decision criteria, 6 main criteria are taken, namely quality, delivery, price, production capability, service, and supplier characteristics.
b. To test the validity and reliability of the questionnaire, then it was used to collect data and a survey was conducted on 30 respondents using purposive sampling method.
c. Compile a pairwise comparison matrix for each respondent's data at each criterion level. Calculates the priority vector of the elements on each criterion in the hierarchy. The priority vector calculation is done by calculating the eigenvector and calculating the maximum eigenvalue.
d. Perform a consistency test on each pairwise comparison matrix. If CR $\leq$ 10%, then the matrix is consistent, and if it is not consistent then improvements are made.
e. Calculate the geometric mean for each criterion and sub-criteria, then make a pairwise comparison again obtained from the results of the rounded geometric mean.
f. Change the weight of pairwise comparison assessments into fuzzy triangular numbers. From the matrix, the value of fuzzy synthetic extent is determined for each criterion and sub-criteria.
g. Comparing fuzzy synthetic extent values. From the results of the comparison of fuzzy synthetic extent values, the minimum value is taken through the calculation of the normality of the weight vector and the minimum value.

## 4. Results and Discussion

This stage collects data on respondents assessment of the relative importance of each criterion and sub-criteria in pairs. Main Criteria Consistency Test with Fuzzy AHP Method. The respondent's assessment data is converted into a triangular fuzzy number in the form (l, m, u). Assessment of the level of importance between criteria using the FAHP method, then the average value of 30 respondents is taken, so that a pairwise comparison matrix is obtained for criteria related to objectives as shown in Table 3 below:

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**Table 2** Matrix pairwise comparison of the main criteria after the average value is taken

| Kriteria | C1 | | | C2 | | | C3 | | | C4 | | | C5 | | | C6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | l | m | u | l | m | u | L | m | u | l | m | U | L | m | u | l | m | U |
| C1 | 1 | 1 | 1 | 1,93 | 3,93 | 5,93 | 3,9 | 5,9 | 7,83 | 1,73 | 3,73 | 5,73 | 2,6 | 4,53 | 6,53 | 3,37 | 5,37 | 7,37 |
| C2 | 0,18 | 0,28 | 0,75 | 1 | 1 | 1 | 2,93 | 4,5 | 6,23 | 1,38 | 2,90 | 4,53 | 1,92 | 3,56 | 5,33 | 0,86 | 2,33 | 3,87 |
| C3 | 0,13 | 0,17 | 0,27 | 0,31 | 0,75 | 1,24 | 1 | 1 | 1 | 1,24 | 2,48 | 3,85 | 1,59 | 2,96 | 4,42 | 1,18 | 2,36 | 3,71 |
| C4 | 0,18 | 0,28 | 0,76 | 0,57 | 1,12 | 1,94 | 0,80 | 1,66 | 2,72 | 1 | 1 | 1 | 0,95 | 2,44 | 4,03 | 1,45 | 2,88 | 4,31 |
| C5 | 0,16 | 0,25 | 0,59 | 0,31 | 0,72 | 1,37 | 0,78 | 1,50 | 2,42 | 0,61 | 1,23 | 2,19 | 1 | 1 | 1 | 0,91 | 2,08 | 3,37 |
| C6 | 0,14 | 0,21 | 0,47 | 0,81 | 1,44 | 2,43 | 0,80 | 1,72 | 2,84 | 0,84 | 1,57 | 2,49 | 0,97 | 1,90 | 3,03 | 1 | 1 | 1 |

Source: Data processing

Furthermore, the consistency test was carried out on pairwise comparison data. Consistency test is carried out to obtain rational decisions so that data that has been declared consistent can be used to determine priority weights. The right priority weight is used to help decision making. The consistency test for the matrix is only tested for the highest and lowest triangular elements because the matrix is reciprocal. An interval comparison matrix is said to be consistent if it satisfies the following conditions:

$$\boldsymbol{Max_k(l_{ik}l_{kj}) \leq Min_k(U_{ik}U_{kj}), untuk\ semua\ i,j,k = 1,2,3\ \ldots,n}$$

Consistency test meets the requirements $\boldsymbol{Max_k(l_{ik}l_{kj}) \leq Min_k(U_{ik}U_{kj})}$, so that the assessment element $\boldsymbol{C_{12}}$ is declared consistent, so that the calculation can proceed to the stage of weighting.

The respondent's assessment data is converted to Triangular Fuzzy numbers, so the next step is to use synthetic extent analysis by determining the fuzzy synthesis value so that it gets a weight vector for each hierarchical element. The last step is to normalize so that the weights obtained are not fuzzy numbers. This weight will be the basis for ranking the vendor assessment criteria with the Criteria Weighting Stage:

a. The calculation of the Fuzzy Synthetic Extent (Si) value, the results can be seen in Table 4. below:

**Table 3.** Components of the Fuzzy Extent Equation for the Pairwise Comparison Matrix of Criteria

| $\sum_{j=1}^{n} \tilde{a}_{ij}$ | | | $\left[\sum_{i=1}^{n}\sum_{j=1}^{n} \tilde{a}_{ij}\right]$ | | | $\left[\sum_{i=1}^{n}\sum_{j=1}^{n} \tilde{a}_{ij}\right]^{-1}$ | | |
|---|---|---|---|---|---|---|---|---|
| l | m | u | L | m | u | L | M | u |
| 14,53 | 24,47 | 34,40 | 41,53 | 72,76 | 108,59 | 0,009209 | 0,013744 | 0,024077 |
| 8,27 | 14,56 | 21,72 | | | | | | |
| 5,44 | 9,72 | 14,50 | | | | | | |
| 4,96 | 9,39 | 14,77 | | | | | | |
| 3,76 | 6,78 | 10,94 | | | | | | |
| 4,57 | 7,84 | 12,27 | | | | | | |

Source: Data processing

The results of the calculation of values *Fuzzy Synthetic Extent* for criteria related to hierarchical objectives are shown in Fig. Table 5. follows:

**Table 4.** Calculation of Fuzzy Synthetic Extent Value CriteriaRelated to Hierarchical Goals

$$S_i = \sum_{i=1}^{n} \tilde{a}_{ij} \left[ \sum_{i=1}^{n} \sum_{i=1}^{n} \tilde{a}_{ij} \right]^{-1}$$

| L | m | u |
|---|---|---|
| 0,133833 | 0,336269 | 0,82824 |
| 0,076149 | 0,200145 | 0,52284 |
| 0,050136 | 0,133545 | 0,349086 |
| 0,045646 | 0,129083 | 0,35556 |
| 0,034625 | 0,093159 | 0,263467 |
| 0,042082 | 0,107799 | 0,295382 |

Source: Data processing

b. After obtaining the results of calculating the Fuzzy Synthetic Extent value, then determining the probability level between the 2 values Fuzzy Synthetic Extent (M1 > M2).

c. Furthermore, the comparison of the synthetic extent value and the minimum value is carried out. In Table 6. it can be seen the results of the comparison of the synthetic extent value and the minimum value.

**Table 5.** Comparison of *Synthetic Extent* Values and Minimum Values

| | S1 ≥ | S2 ≥ | S3 ≥ | S4 ≥ | S5 ≥ | S6 ≥ |
|---|---|---|---|---|---|---|
| **S1** | | 0,74078 | 0,51499 | 0,51695 | 0,34778 | 0,41421 |
| **S2** | 1 | | 0,80385 | 0,79724 | 0,63648 | 0,70362 |
| **S3** | 1 | 1 | | 0,9856 | 0,84082 | 0,90499 |
| **S4** | 1 | 1 | 1 | | 0,85842 | 0,92147 |
| **S5** | 1 | 1 | 1 | 1 | | 1 |
| **S6** | 1 | 1 | 1 | 1 | 0,93797 | |
| **Min** | **1** | **0,74078** | **0,51499** | **0,51695** | **0,34778** | **0,41421** |

Source: Data processing

d. Then the weight vector calculation is carried out and the weight vector normalization is carried out in order know the weight value of the criteria, as shown in Table 7. and Table 8.

**Table 6** VektorBobot

| | d'(A1) | d'(A2) | d'(A3) | d'(A4) | d'(A5) | d'(A6) |
|---|---|---|---|---|---|---|
| W' | **1** | **0,74078** | **0,51499** | **0,51695** | **0,34778** | **0,41421** |

Source: Data processing

**Table 7** Normalization Vector Weight

| | d'(A1) | d'(A2) | d'(A3) | d'(A4) | d'(A5) | d'(A6) |
|---|---|---|---|---|---|---|
| W | **0,28291** | **0,20957** | **0,14569** | **0,14625** | **0,09839** | **0,11718** |

Source: Data processing

Based on the results of data processing, the priority weights for the criteria are in the following order:

1. Quality Criteria (A1) has the highest priority weight with a value of **0.28291**
2. Delivery Criteria (A2) has a priority weight of **0.20957**
3. Service Criteria (A5) has a priority weight of **0.14569**

4. The production capability criterion (A4) has a priority weight of **0.14625**
5. Price Criteria (A3) has a priority weight of **0.09839**
6. Characteristics Criteria *Supplier* (A6) has a priority weight of **0.11718**

The results of this data processing are used as a weight graph, priority criteria and sub-criteria. Graph of weights and priorities for criteria using the Fuzzy AHP method in Figure 3. below:

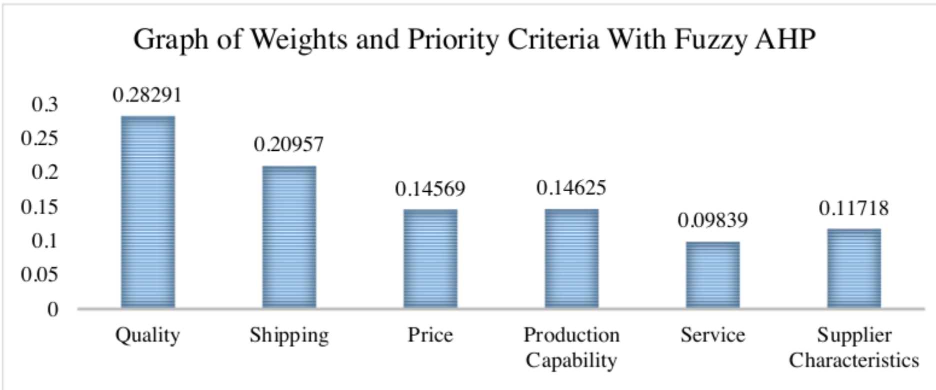


**Figure 3.** Graph of Weights and Priority Criteria With Fuzzy AHP

Weights and priorities for quality sub-criteria, delivery sub-criteria, price sub-criteria, production capability sub-criteria, service sub criteria, characteristics sub-criteria supplier by using the FAHP method, and the magnitude of the influence of the criteria and sub-criteria as a whole can be seen from the weighting of the resulting criteria and sub-criteria. This analysis is seen from the difference in weight between the highest and lowest weights of each method in a certain criterion or sub-criteria. The hierarchical structure of supplier selection problems consists of 6 criteria and 25 sub-criteria The order of priority for supplier selection based on an assessment with the FAHP method can be seen in Table 9:

**Tabel 8** Priority Sequence Results and Weighting Analysis

| Highest - Lowest criteria | Highest – Lowest subcriteria | Score |
|---|---|---|
| Quality | 1. Inspection Method | **0,28720** |
| | 2. Reject percentage | **0,27928** |
| | 3. Quality System | **0,17397** |
| | 4. Conformance Specification | **0,13817** |
| | 5. Technical Support | **0,12136** |
| Shipping | 1. Delivery Timeliness | **0,64795** |
| | 2. Completeness of Shipping Documents | **0,28134** |
| | 3. Shipping Capacity | **0,05418** |
| | 4. Conformity of the number and specifications of parts sent | **0,01653** |
| Production Capability | 1. Lead time required | **0,29279** |
| | 2. Ability to fulfill order changes | **0,22675** |
| | *3. Minimum order quantity* | **0,17662** |
| | 4. Product Diversity | **0,16531** |
| | 5. Production Capacity | **0,13853** |
| Price | 1. Breakdown Price | **0,63961** |
| | 2. Payment Terms | **0,26049** |
| | 3. Competitive price | **0** |

| | | |
|---|---|---|
| Supplier Characteristics | 1. Geographical Location | **0,30562** |
| | 2. Financial Stability | **0,29539** |
| | 3. Negotiability | **0,25599** |
| | 4. Reputation | **0,08264** |
| | 5. Professionalism | **0,06036** |
| Service | 1. Responsive to orders received | **0,72777** |
| | 2. The average time for part claim replacement is | **0,19003** |
| | **3. Responsive in Improvement** | **0,08226** |

Source: Data processing

## 5. Conclusion

The criteria used in supplier selection are Quality, Delivery, Price, Production Capability, Service and Supplier Characteristics. The most influential criterion in supplier selection is the quality criteria with a weight of 0.28291, the second priority is the delivery criteria with a weight of 0.20957, the third priority is the criteria for production capability with a weight of 0.14625, the fourth priority is price with a weight of 0.14569, priority fifth is supplier characteristics with a weight of 0.11718 and the sixth priority is service with a weight of 0.09839.Use the "Insert Citation" button to add citations to this document.

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