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DSS for Evaluating Weighting Methodology Using Fuzzy AHP

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Abstract:

Giving weight to the evaluation methodology that is very risky in the selection of consultancy services tender. Because the value or the weight given by the procurement committee could be subjective. This is possible with the application of fuzzy AHP method. This research were tested with a procurement "ABC" with parameters used are understanding of service, methodology of quality, the results of work, supporting facilities and new ideas from companies participating in the bidding process "ABC". Results of the tender committee calculation shows that companies A and F have the same weight values are 30, companies B and D is 21.75, 18.75 for company C, and company E is 15. While the results of this research show that companies A and F value of the weight is 4.919, company B and D to obtain the value of 3.819, the company C is 3.340 and the company E is 2.459.

Keywords: Evaluation of Methodology, e-procurement, Procurement of consulting services, Fuzzy AHP.

I. INTRODUCTION

Electronic procurement (e-procurement) more effectively and efficiently than conventional tendering process, this method is considered more fair and transparent because it can avoid the cooperation between procurement committee with the companies participating in the bidding process (Yan-Wang, Chengyu, Shuai, Dejian, Wenyu, & Yong, 2014). Since Indonesia implementing e-procurement in 2012, Indonesia has been saving 12% of the state budget.

The case of the procurement of consulting services on a public selection method has many obstacles such as determination of weights. The cause is difficult to provide quantitative values in the value of the methodology of work presented by each of the companies that participated in a tender. While the stages of evaluation and methods is a major determinant in the process of winning a tender (Hongliang, 2011). For that it needs a decision support system that is able to provide weighting methodology objectively method using Fuzzy Analytic Hierarchy Process (Fuzzy AHP). Fuzzy AHP is very useful and has been tested in a complete case-based decision (Chou, Yen, Sun, & Hon, 2013).

Decision support systems have many advantages, which can be applied to model databases, algorithms, interfaces and control systems that require decision making system in various fields such as the academic world, planning, procurement, decision study of decisions and many other fields (Ahmad, Saman, Noor, & Othman, 2007). The data was obtained from the research sample data consulting services tenders "Planners of development (early stage) buildings at the ABC Offices", where the process of tender has been completed in 2014.

Previous research, methods of Fuzzy AHP can be applied in the case of evaluation experts for the same case, the result of this method is highly efficient and dynamic when applied (Herlina, Indrabayu, & Suyuti, 2015). Other related research conducted by Ahmad (2007), who analyze the tender the contractor for association Jabatan Kerja Raya Malaysia (JKRM) using Analytical Hierarchy Process Guided mentode (GAHP), the system is able to evaluate the criteria, and alternatives.

AHP is difficult to quantify the value of the data on project risk assessment, this is only possible by using Fuzzy method. The solution is to combine between fuzzy and AHP into Fuzzy AHP for evaluating the risk to the project (Yumei, 2010). FAHP suitable for building a dynamic decision (Dengneng, Chih, & Chia, 2011).

II. MATERIAL AND METHODS

2.1 AHP

AHP is a method that is simple but powerful and strongly support applied to complex problems (Yumei, 2010). AHP method discovered by Prof T.L. Saaty in 1970. AHP method helps solve complex issues, can develop weights or priorities. This method also combines the power of feeling and logic are concerned on a range of issues, then synthesize the diverse considerations into a variety of results that match the estimates we intuitively as presented on the consideration that has been created (Ya- yueh, & Duen, 2005).

Stages in the process of the method of AHP are: (1) defining the problem and determine the desired goals; (2) create a hierarchical structure that begins with a general purpose followed by the criteria and other alternatives; (3) form a matrix comparison matrix or paired decision which describes the effect of each element of each criterion; (4) test the consistency of the hierarchy. If the value of the consistency of the resulting ratio did not meet the standard set that is CR≤0.1 then assessment should be repeated again.

2.2 Fuzzy AHP

Fuzzy AHP is a method of approximation is used to minimize the imbalance in the scale of AHP in the shape of value ' crisp '. Fuzzy logic that is used is a function of Triangular Fuzzy Number due to the triangular function is used to assess information on decision-making problems are purely subjective, intuitive and can be easily applied in computing (Ying-MING, Ying, & Zhongsheng, 2008). With the following stages (CHENG, 2004) :

a) The function that is used is a function of triangle called the Triangular Fuzzy Number (TFN), a way to transform the logic against a scale of 1-9 in the AHP. The scale used is shown in table 1.

Table 1. Paired comparison of Assessment scales based on T. L. Saaty model (Hongliang, 2011).

The Scale of AHP	The Scale of Fuzzy	Inverse Scale Fuzzy
1	$\check{1} = (1,1,1)$	$(1/1, 1/1, 1/1)$
3	$\check{3} = (1,3,5)$	$(1/5, 1/3, 1/1)$
5	$\check{5} = (3,5,7)$	$(1/7, 1/5, 1/3)$
7	$\check{7} = (5,7,9)$	$(1/9, 1/7, 1/5)$
9	$\check{9} = (7,9,9)$	$(1/9, 1/9, 1/7)$
2	$\check{2} = (1,2,4)$	$(1/4, 1/21/1,)$
4	$\check{4} = (2,4,6)$	$(1/6, 1/4, 1/2)$
6	$\check{6} = (4,6,8)$	$(1/8, 1/6, 1/4)$
8	$\check{8} = (6,8,9)$	$(1/9, 1/8, 1/6)$

b) Analysis of synthetic extents used to obtain an object's expansion in fulfilling the purpose of the so-called satisfied extents. If $C = \{C_1, C_2, \dots, C_n\}$ is a set of criteria for n and $A = \{A_1, A, \dots, A_m\}$ is a set of criteria as m, then for fuzzy M. M_{Ci}^{1}, M_{Ci}^{2}, …,M_{Ci}^{m} is the value of the extents i-criteria and m-alternatives decision =1, 2, ……, n for all M_{Ci}^{j}(j=1, 2, … , m) is a triangular fuzzy numbers. Steps fuzzy synthetic extent that :

a. Add up the rows of fuzzy matrix Ã using triangular fuzzy number arithmetic operations:
$RS_i = \sum_{j=1}^{n} \tilde{a}_{ij} = \left(\sum_{j=1}^{n} l_{ij}, \sum_{j=1}^{n} m_{ij}, \sum_{j=1}^{n} u_{ij}\right), = 1, \dots, n$ (1)

b. Normalize the sum of each line above with the equationa The normalization of the summation of each line above with the equation:
$\tilde{S}_i = \frac{RS_i}{\sum_{j=1}^{n} RS_j} = \left(\frac{\sum_j^n l_{ij}}{\sum_{k=1}^{n}\sum_{j=1}^{n} u_{kj}}, \frac{\sum_j^n m_{ij}}{\sum_{k=1}^{n}\sum_{j=1}^{n} m_{kj}}, \frac{\sum_j^n u_{ij}}{\sum_{k=1}^{n}\sum_{j=1}^{n} l_{kj}}\right), i = 1, \dots, n$ (2)

c. Defuzzification value can be obtained from the following equation:
$DM_i = \frac{(u_i - l_i) + (m_i - l_i)}{3} + l_i$ (3)

With $M_i = (l_i, m_i, u_i$. Defuzzifikasi value will be normalized by dividing the value of the defuzzifikasi value of the sum total of defuzzifikasi. The result of the normalization value for the weighting criteria being defuzzifikasi of the problem will be solve.

2.3 The Proposed Method

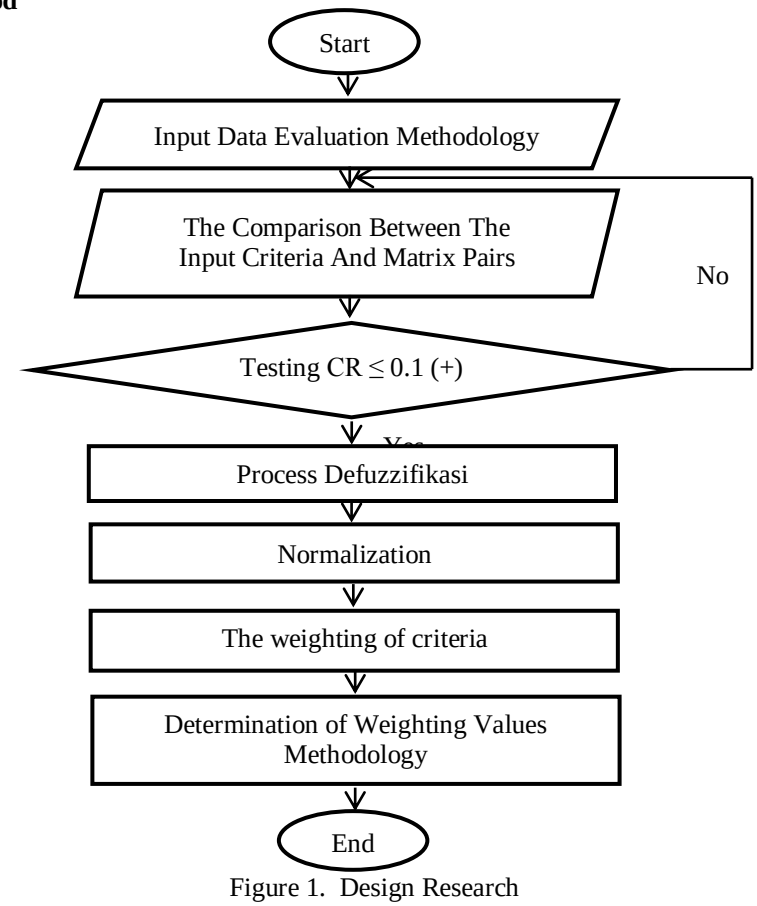

Figure 1. Design Research

The process for determining the weights of the evaluation process starts from the evaluation of the input data methodology company following a tender process, further solves the problem or share in the form of a hierarchy, it aims to find out the importance of the criteria in the structure of the hierarchy problem. Proceed to the stage of the process of numerical analysis by means of comparative interests in the form of input matrices, numerical values obtained using the comparative scale set by the Saaty as shown in table 1.

Consistency test is conducted to compare the inconsistent state that occurred caused by human limitations, when CR<0.1 then acceptable, decision making process can proceed. Fuzzifikasi performed using Triangular Fuzzy Number to assess the information problems that are subjective, intuitive and easily applied to computing, after that defuzzifikasi.

Next up is stage of normalization that is dividing defuzzifikasi value, then the value of the normalization results weighting criteria. And the final stage is to seek value Weighting methodology. In general the groove system can be seen as shown in the figure 1 below :

III. RESULT AND DISCUSSION

3.1 Structure of The Hierarchy

Preparation of a hierarchy based on the objectives, criteria and alternatives are selected. The results of the hierarchy looks like figure 2 here :

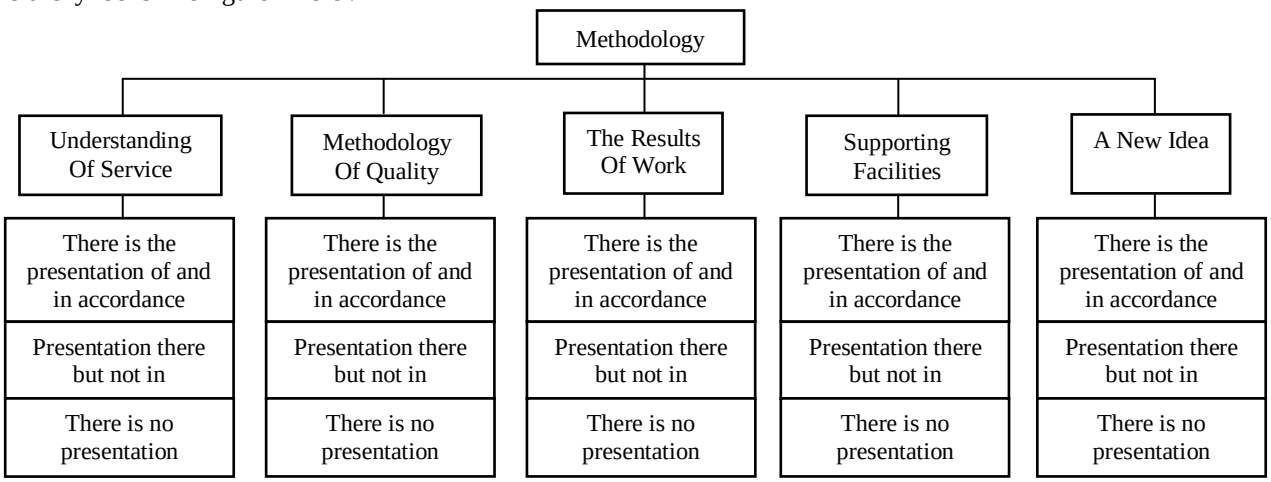

Figure 2. Hierarchy evaluation methodology consultancy services

3.2. Pairwise Comparison Matrix

Table 2. Pairwise comparison matrix

	M1	M2	M3	M4	M5
M1	1	2	2	2	3
M2	0,5	1	1	1	2
M3	0,5	1	1	1	2
M4	0,5	1	1	1	2
M5	0,333	0,5	0,5	0,5	1

The comparison criteria are presented in the form of a matrix, where variables M1 is understanding of service, M2 for the methodology of quality, the M3 is the results of work, the M4 is supporting facilities, and the last is the M5 for a new idea.

3.3 Consistency Matrices Pairwise Testing

$$CI = \frac{t-n}{n-1} \quad (4)$$

Testing the consistency of the matrix pair is done by first searching for the value of CI, where CI is the Consistency Index, t is the average value of vector consistency and n is the order of the matrix. The value of CI is = 0.0005, then find the value using the formula CR.

$$CR = \frac{CI}{RI} \quad (5)$$

CR is a comparison of the value of consistency with Random Index (RI) whose value from table 3.

Table 3. random index values for matrix

The Size of The Matrix	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

The results calculation of the equations (5), the value of CR = 0.001. Because CR≤0.1 then this process can proceed with finding a value of RS using equations (1).

Table 4. The value of R_s

	R_1	R_2	R_3	R_4	R_5
R_S	3.5, 7, 12	4.25, 5.5, 8	4.25, 5.5, 8	4.25, 5.5, 8	1.95, 2.83, 5
R_{total}	18.2, 26.333, 41				

Looking for The value using equation (2), as follows:

Table 5. The value of S_i

	S_i
S_1	0.192, 0.266, 0.293
S_2	0.234, 0.209, 0.195
S_3	0.234, 0.209, 0.195
S_4	0.234, 0.209, 0.195
S_5	0.107, 0.108, 0.122

3.4. Defuzzifikasi Process

Defuzzifikasi process is done using the equation (3), so that the values of DM_i on the following table 6.

Table 6. The value of DM_i

	DM_1	DM_2	DM_3	DM_4	DM_5
DM_i	0.250	0.213	0.213	0.213	0.112
DM_{total}	0.888				

3.5 Normalisazation

$$W_i = \frac{DM_i}{(DM_1 + DM_2 + \cdots + DM_5)} \quad (6)$$

From defuzzifikasi, then normalized using equation (6). Where W_i is the result of normalization and defuzzifikasi is the value of DM_i. The result can be seen in table 7

Table 7. the value of W_i

	W_1	W_2	W_3	W_4	W_5
W_i	0.282	0.239	0.239	0.239	0.126

3.6 weighting criteria

Table 8. The value of weighting criteria (W_{ai})

	W_i (A)	The Percentage (B)	Weighting Criteria (A.B)
W_{a1}	0.282	25%	0.071
W_{a2}	0.239	20%	0.048
W_{a3}	0.239	20%	0.048
W_{a4}	0.239	20%	0.048
W_{a5}	0.126	15%	0.019

Criteria weighting values shown in table 8, W_{ai} is the multiplication between the value of the normalization with the percentage of each weighting variable.

3.7 Weight Determination Methodology

The value of the overall weighting methodology, is as shown in Table 9 below:

Table 9. The value of weight determination methodology (B_i)

Bobot Metodologi		**PT. A**	**PT. B**	**PT. C**	**PT. D**	**PT. E**	**PT. F**
M1	Nilai Input (A)	25	25	25	25	12.5	25
	W_{a1} (B)	0.071	0.071	0.071	0.071	0.071	0.071
	B_1 (A.B)	1.762	1.762	1.762	1.762	0.881	1.762
M2	Nilai Input (A)	20	20	10	20	10	20
	W_{a2} (B)	0.048	0.048	0.048	0.048	0.048	0.048
	B_2 (A.B)	0.958	0.958	0.480	0.958	0.480	0.958
M3	Nilai Input (A)	20	10	10	10	10	10

	W_{a3} (B)	0.048	0.048	0.048	0.048	0.048	0.048
	B_3 (A.B)	0.958	0.479	0.479	0.479	0.479	0.479
M4	Nilai Input (A)	20	10	10	10	10	10
	W_{a4} (B)	0.048	0.048	0.048	0.048	0.048	0.048
	B_4 (A.B)	0.958	0.480	0.480	0.480	0.480	0.480
M5	Nilai Input (A)	15	7.5	7.5	7.5	7.5	7.5
	W_{a5} (B)	0.019	0.019	0.019	0.019	0.019	0.019
	B_5 (A.B)	0.284	0.142	0.142	0.142	0.142	0.142
Total Nilai Bobot		**4.919**	**3.819**	**3.340**	**3.819**	**2.459**	**4.919**

The weighting generated by multiplying the methodology value weighting criteria (W_{ai}) evaluation value (input value) methodology previously inputted at the earliest before process.

IV. CONCLUSION

Results of the tender committee calculation shows that companies A and F have the same weight values are 30, companies B and D is 21.75, 18.75 for company C, and company E is 15. While the results of this research sindicate that campanies A and F value of the weight is 4.919, company B and D scored 3.819, company C is 3.340 and company E is 2.459. It can be concluded that the value of the weights obtained from the tender Committee and research this is the same, companies A and F have the same weight value, B and D also has the same value and company E is the company with the lowest weight value. This indicates that the fuzzy AHP decision-making can be applied in the evaluation of the weighting methodology on the procurement of consultancy services.

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