ANALYTIC HIERARCHY PROCESS FOR DETERMINATION OF DECISION MAKING IN THE SELECTION OF CONTRACTORS

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ABSTRACT

Decision-making at top management is a strategic issue, this affects and becomes one of the determining factors for the success of the company. The selection of contractors is one way to make decisions, the method that is widely used in decision-making is the Analytic Hierarchy Process (AHP) method, although this method is very old, this method is still widely use, because AHP is one of the popular decision-making methods for decision making. multi-criteria (MCDM), by taking a case study in a well-known palm oil company headquartered in Jakarta (Indonesia). The results of the criteria score are consistent with 0.002 and in the final selection of the first ranked alternative, there are 3 (three) contractors with the best score of 25% who excel in Pre-Qualification and Commercial Criteria testing, with this method the company is expected to be able to choose the right contractor for business partners and smooth operations.

Keywords: AHP; Hierarchy Process; Decision-Making; MCDM; Selection of Contractors.

ABSTRAK

Pengambilan keputusan pada manajemen puncak merupakan salah satu isu strategis, hal ini mempengaruhi dan menjadi salah satu faktor penentu keberhasilan bagi perusahaan. Pemilihan kontraktor merupakan salah satu cara untuk mengambil keputusan, metode yang banyak digunakan dalam pengambilan keputusan adalah metode Analytic Hierarchy Process (AHP)*, walaupun metode ini sudah sangat tua, metode ini masih banyak digunakan, karena AHP merupakan salah satu metode pengambilan keputusan populer untuk pengambilan keputusan untuk multy-criteria (MCDM), dengan mengambil studi kasus di sebuah perusahaan kelapa sawit ternama yang berkantor di Jakarta (Indonesia). Hasil dari skor penilaian konsisten dengan 0,002 dan pada pemilihan akhir alternatif peringkat pertama terdapat 3 (tiga) kontraktor dengan skor terbaik 25% yang unggul dalam pengujian Pra Kualifikasi dan Kriteria Komersial, dengan metode ini perusahaan diharapkan dapat memilih kontraktor yang tepat untuk mitra bisnis dan kelancaran operasional*

***Kata Kunci**: AHP; Hirarki Proses; Pengambilan Keputusan; MCDM; Pemilihan kontraktor.*

INTRODUCTION

Science and technology increased, more rapid turn industry development in the world, is characterized by the existence of a contest increasingly visible among companies. In a competitive environment, this company should consider indicators of the success of these companies, so that the continuity of not experience large obstacles. One indicator of how successful a company is in decision making. The making decisions must have the advantage for the company.

One of the results that we will discuss in this journal was in decision the results of the selection of the contractor. In the world of industry, to do the process of decision-making for selection

of a contractor should be the existence of criteria before deciding on a choice of several alternatives. Analysis of the evaluation is carried out to get a set of measurement standards, and then serve as a tool for comparing various alternative.

In this Palm oil Company, contractor selection will be done which will cultivate the seeds and palm oil presses, using a stylizer. The process of selecting appropriate contractors based on the results of pre-qualification, project management, technical and commercial. One of the methods used for decision-making is to use the method of AHP. The method of AHP is a technique that helps the holder's decision to resolve the problem. Basically, it is a general theory of AHP in determining a scale ratio of discrete or continuous (T. L. Saaty & Vargas, 2001), and this ratio can be taken from the actual size or scale of a basis that reflects the strength of feeling and relative preference. The work of AHP is to do pairwise comparisons to measure the relative importance of elements at each level of the hierarchy and evaluate alternatives at the lowest level of the hierarchy to make the best decision among many alternatives. AHP is a decision-maker that provides a means to modify subjective judgments and articles into objective measures. Due to its simplicity and flexibility, AHP has become a favorite decision tool for research in various fields, be it food, engineering, business, ecology, health, as well as in government (Sipahi & Timor, 2010). Analytical Hierarchy Process (AHP) is one of the supporting decision support tools, which was developed by Thomas L. Saaty in 1980, is a useful tool for managing multiple decision criteria (T. L. Saaty & Vargas, 2001).

AHP will produce a weighting for each evaluation criteria to compare the criterion by generating a new criterion. This technique is a method of valuation which is very flexible and powerful, with the final value being a relatively good rating from some of the criteria and options provided by the user (Pangestika & Siregar, 2018).

A. Definition of The Decision-Making

Decision-making is the process a person, group or organization draws conclusions about future actions with a set of goals and constraints on available resources. This process will be repeated frequently. involves framing problems, gathering intelligence, coming to conclusions, and learning from experience (Schoemaker & Russo, 2014). Harold and Cyril O'Donnell also argued that in decision-making is the selection between alternative on how to cast the core plan, the plan cannot be said to be nothing if no results, resources Trust command, or a reputation that has been created (Koontz & O'Donnell, 2004).

According to Gustavo et al, Decision-making in organizations has a greater impact at the management level which contains three important elements: a) The need for decision makers, to act procedurally, using company rules and standards, b) Is a decision support tool in decision making and c) Learning from current relationships – or from past relationships – with suppliers (Marchisotti *et al*., 2018). Alex and David Bennett suggest that every decision maker has a set of self-organizing and hierarchical theories that guide their decision-making process (Bennet & Bennet, 2013).

Based on the above understanding, decision-making is a systematic approach to the nature of a problem, the accumulation of facts and data, the rigorous determination of the alternatives, and acting which, according to calculations, is the most appropriate action. For that, there are some things in the decision-making:

a. Nothing happens coincidentally in making decisions.
b. Decision-making is not done in a hurry, because the approach to decision-making should be based on the ability of the organization, provided labor and environmental situation.
c. Before the problem is resolved properly, the essence of the problem must be clearly stated.
d. Or by arranging based on data obtained.
e. Good decisions are decisions that have been selected from the various alternatives that existed after careful analysis.

B. Contractor Definition

A contractor is defined as a person or body who receives a job and performs work at the cost stipulated according to the plan drawings and the rules and conditions set out (Juwana, 2016).

a. Contractor with the project owner, is bound by a contract in which the contractor provides its professional services in the form of a building as a realization of the willingness of the project

owner to be poured into the form of a drawing plan and accompanied by the rules set by the consultant, while the project owner as a professional contractor for the contractor.

b. Consultant with the contractor, the bond that is established based on the implementation of the Consultant as a poster of the plan and the rules and conditions, then the contractor as the executing officer to realize the existing working image into a building.

Based on the above, the contractor is the person or contracted entity to do the job.

RESEARCH METHODS

Were developed by Thomas L. Saaty around 1970, he was a mathematician who worked at the university of Pittsburgh, United States. One of the topics covered in a sufficiently long time is the fundamental scale of the Analytic Hierarchy Process. Saaty and Vargas describe their ratio scale, proportionality, and normalization ratio scale as the seven pillars of the Analytic Hierarchy Process (AHP) (T. Saaty & Vargas, 2012). To Saaty et al. this approach is used to show a fair or appropriate solution (from those directly involved in the process) and can be developed in other directions that are still related to decision making (T. Saaty et al., 2017).

The decision-making step in the AHP method is to make decisions in an orderly way to produce priorities, we need to describe the decision with the following steps: (T. Saaty & Vargas, 2012)

1. The decomposition of the problem

That is where a goal has been set, then described in a systematic form into the structure that forms the series in the system, so that goals can be achieved rationally.

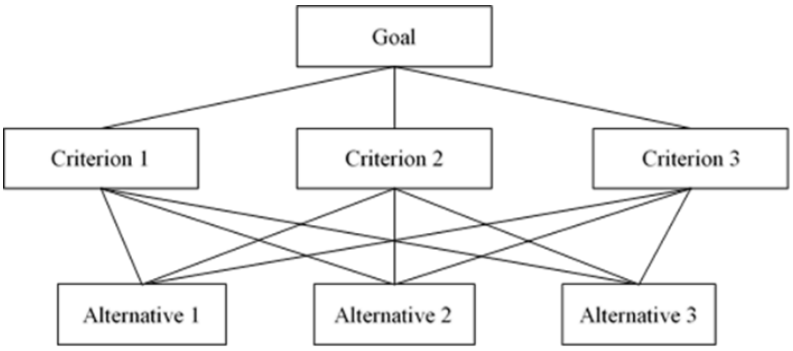

Figure 1. Process Hierarchy Structure

2. Evaluation / weighting to compare elements

In comparison the weighted level assessment paired reciprocal legal axiom, that is when the element is rated A more important (5) compared to element B, then B is more important (1/5) compared with a. When important elements such as B then each value = 1, example using procedures questionnaire, some comparisons can be done through a detailed questionnaire with matrix or semantic deferential.

Table 1. Scale of Assessment of Comparative Pairs

Intensity of Interest	Description
1	Equal Importance
3	Moderate importance of one factor over another
5	Strong or essential importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Value for inverse comparation

3. Preparation of the test matrix and Consistence

Step One**:** compiles the comparison matrix

Table 2. Comparison Matrix

Alternative / Criteria	1	2	3	n
1	1	C12	C13	C1n
2	C21	1	C23	C2n
3	C31	C32	1	C3n
n	Cn1	Cn2	Cn3	1

$$C_{ij} = \sum_{i=1}^{n} Cij \qquad (1)$$

Step Two:
Create a normalization matrix
Divides each element in the matrix by its total column, to produce a matched matrix in normalization.

$$X_{ij} = \frac{C_{ij}}{\sum_{i=1}^{n} C_{ij}} \; ; \begin{bmatrix} X11 & X12 & X13 & X1n \\ X21 & X22 & X23 & X2n \\ X31 & X32 & X33 & X3n \\ X41 & X42 & X43 & X4n \end{bmatrix} \qquad (2)$$

To get the Eigen Factor is to divide the number of matrix columns that are normalized by the number of criteria used (n) to produce the weight matrix.

$$W_{ij} = \frac{\sum_{j=1}^{n} X_{ij}}{n} \qquad (3)$$

a. Measuring consistency by calculating

$$\begin{bmatrix} C11 & C12 & C13 & C1n \\ C21 & C22 & C23 & C2n \\ C31 & C32 & C33 & C3n \\ C41 & C42 & C43 & C4n \end{bmatrix} * \begin{bmatrix} W11 \\ W21 \\ W31 \\ W41 \end{bmatrix} = \begin{bmatrix} Cv1 \\ Cv1 \\ Cv1 \\ Cv1 \end{bmatrix}$$

λ = (Cv1/W11; Cv2/W12; …,Cvn/Wn) (4)
$\boldsymbol{\lambda}$max = Average (λ) (5)
CI = (λmax -n) / (n-1) (6)
IR = 1.98 (n-2) / (n) (7)
CR = CI / RI (8)

Where:
CI = Consistency Index
IR = Index Random Consistency
CR = Consistency Ratio
n = The number of criteria or sub criteria

If this ratio is very large (Saaty suggests > 0.10), then we are not consistent enough and the best thing to do is go back and revise the comparisons.

4. Calculate the value of the Criteria comparison matrix on Alternatives, steps according to no.3, which is to make comparisons of matrix, make normalized matrices to obtain Eigen Factor, and calculate values or weight of alternatives by multiplying Eigen Factor with Matrix normalization.
5. Decision Determination by choosing the best alternative according to the assessment.

This AHP is still very relevant to use today, because it is a very good decision making, if the criteria of one and the other are not interconnected or just in the form of a hierarchy (Maulidina & Putra, 2018). The selection of the contractor to take is the case study of Palm Oil Private Company in Jakarta. This Palm Oil Company is a company engaged in agribusiness; the company will make improvements to the stylizer. Stylizer is a tool used to boil oil palm before pre-cast and pressing.

The repair process will be carried out during low fruit crops that is in June-July. The work will be done using a service contractor. In Company will select several contractors based on prequalification, project management, technical and commercial decisions. The selection process of the contractor will use Analytics Process Hierarchical (AHP).

Data sources obtained from this journal are derived from secondary data, which is obtained through the available documents at this Palm Oil Company. The selected contractors are 4 (four) contractors. The criteria to be tested from contractors are: PQ for Pre-Qualification, PM for Project managers, Tech for Technical, and Com for Commercial, where each criterion is assessed by various departments, such as for PQ, one of the assessors are Engineering (ER), from the PM assessment one of which is the Standard Operation (SOP), health and safety (HSE), the speed of the purchase order process (PO), from commercial assessments such as Quality (QC), etc.

RESULT AND DISCUSSION

1. Structure hierarchy
   Based on the data obtained from the company.

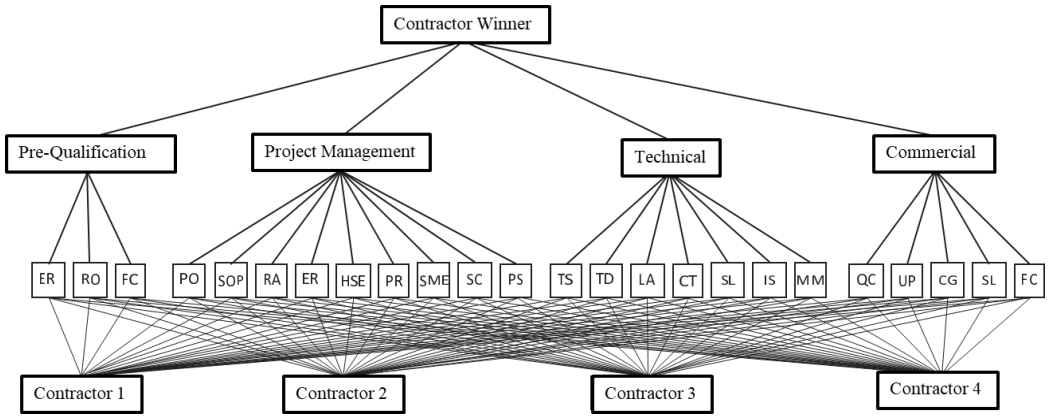

Figure 2. Structure of Hierarchy

Word shortening for easy calculation:

1. PQ for Pre-Qualification
2. PM for Project manager
3. Tech for Technical
4. Com for Commercial

Those four factors become criteria in AHP decision-making process to evaluate the best alternative solution of contract model.

2. Make pairwise matrix

Table 3. Weighted Matrix Matched between Criteria

Criteria	PQ	PM	T	C
PQ	1.00	2.00	5.00	3.00
PM	0.50	1.00	2.50	1.50
T	0.20	0.40	1.00	0.75
C	0.33	0.67	1.33	1.00
Total	2.03	4.07	9.83	6.25

Table 4. Normalization of Paired Matrix between Criteria

Criteria	PQ	PM	T	C	Total Row	Eigen Factor
PQ	0.49	0.49	0.51	0.48	1.97	**0.49**
PM	0.25	0.25	0.25	0.24	0.99	0.25
T	0.10	0.10	0.10	0.12	0.42	0.10
C	0.16	0.16	0.14	0.16	0.62	0.16
Total Column	1.00	1.00	1.00	1.00	4.00	

3. Calculating Eigen Values and Consistency

After getting the value from Eigen Factor. Next calculate the comparison matrix (table 3) multiplied by the eigenvector (Table 4).

$$\begin{bmatrix} 1 & 2 & 5 & 3 \\ 0.5 & 1 & 2.5 & 1.5 \\ 0.2 & 0.4 & 1 & 0.75 \\ 0.33 & 0.67 & 1.33 & 1 \end{bmatrix} * \begin{bmatrix} 0.49 \\ 0.25 \\ 0.10 \\ 0.16 \end{bmatrix} = \begin{bmatrix} 1.98 \\ 0.99 \\ 0.42 \\ 0.62 \end{bmatrix}$$

After that calculate the Hierarchy Consistency

a. Calculate λmax

λ = 1.98/0.49 ; 0.99/0.25 ; 0.42/0.10 ; 0.62/0.16

= 4.01; 4.01; 4.00; 4.00

λmax = Largest (λ)

= 4.01

b. Calculate Consistency Index

CI = (λmax -n) / (n-1)

λmax is largest eigenvalue of order n

n is the number of criteria or sub criteria.

n = 4

CI = (4.01 -4) / (4-1)

CI= 0.002079207 ≈ 0.002

c. Calculate Ratio Index

RI = 1.98 (n-2) / (n)

= 1.98 (4-2) / (4)

RI = 0.99

d. Calculate Consistency Ratio

CR = CI / RI

= 0.002079207 /0.99

CR = 0.00210021 ≈ 0.002

From Consistent Ratio calculations. the data of the weight between the criteria of the value is consistent. because 0.002 <0.1.

After calculating the Comparison criteria matrix. then we will calculate the matrix comparisons between the criteria and the alternative contractor's function to find the consistent criteria for alternative contractors.

4. Calculate the Value of Matrix Comparison Criteria on the Contractors

a. Pre-Qualification to Contractors

Table 5. Pre-Qualification Comparation Matrix

PQ	Contractor 1	Contractor 2	Contractor 3	Contractor 4	Total Row	Eigen Factor
Contractor 1	0.10	0.10	0.08	0.13	0.41	0.10
Contractor 2	0.30	0.30	0.23	0.40	1.23	0.31
Contractor 3	0.40	0.40	0.30	0.20	1.30	0.33
Contractor 4	0.20	0.20	0.40	0.27	1.07	0.27
Tot. Column	1.00	1.00	1.00	1.00	4.00	

From the calculation of Pre-Qualification with the contractor the result is consistent with the value of 0.041, because <0.1.
From table 5. best priority is Contractor 3 (three) with value 0.33, and worst contractor is Contractor 1 (one) with value 0.10.

b. Project Management to Contractors

Table 6. Project Management Comparation Matrix

PM	Contractor 1	Contractor 2	Contractor 3	Contractor 4	Total Row	Eigen Factor
Contractor 1	0.30	0.30	0.26	0.34	1.20	0.30
Contractor 2	0.40	0.40	0.34	0.46	1.60	0.40
Contractor 3	0.20	0.20	0.17	0.09	0.66	0.16
Contractor 4	0.10	0.10	0.23	0.11	0.54	0.14
Tot. Column	1.00	1.00	1.00	1.00	4.00	

From the calculation of Pre-Qualification with the contractor the result is consistent with the value of 0.042, because <0.1.
From table 6. best priority is Contractor 2 (two) with value 0.40, and worst contractor is Contractor 4 (four) with value 0.14.

c. Technical to Contractors

Table 7. Technical Comparation Matrix

T	Contractor 1	Contractor 2	Contractor 3	Contractor 4	Total Row	Eigen factor
Contractor 1	0.25	0.25	0.23	0.27	1.00	0.25
Contractor 2	0.25	0.25	0.23	0.27	1.00	0.25
Contractor 3	0.25	0.25	0.23	0.20	0.93	0.23
Contractor 4	0.25	0.25	0.31	0.27	1.07	0.27
Tot. Column	1.00	1.00	1.00	1.00	4.00	

From the calculation of Pre-Qualification with the contractor the result is consistent with the value of 0.003, because <0.1.
From table 7. best priority is Contractor 4 (four) with value 0.27, and worst contractor is Contractor 3 (three) with value 0.23.

d. Commercial to Contractors

Table 8. Commercial Comparation Matrix

C	Contractor 1	Contractor 2	Contractor 3	Contractor 4	Total Row	Eigen Factor
Contractor 1	0.10	0.10	0.08	0.13	0.41	0.10
Contractor 2	0.30	0.30	0.23	0.40	1.23	0.31
Contractor 3	0.40	0.40	0.30	0.20	1.30	0.33
Contractor 4	0.20	0.20	0.40	0.27	1.07	0.27
Tot. Column	1.00	1.00	1.00	1.00	4.00	

From the calculation of Pre-Qualification with the contractor the result is consistent with the value of 0.041, because <0.1.

From table 8. The best priority is Contractor 3 (three) with value 0.33, and the worst contractor is Contractor 1 (one) with value 0.10.

5. Final Choice Alternative from contractors

Table 9. Matrix Normalization

Contractor 1	Contractor 2	Contractor 3	Contractor 4
0.111	0.214	0.286	0.222
0.333	0.286	0.143	0.111
0.444	0.286	0.286	0.444
0.111	0.214	0.286	0.222
1.00	1.00	**1.00**	1.00

The final selection of AHP method is presented in (table 9.) in this table explain summary data with the following values:

Table 10. Final Assessment Between Contractors

	Contractor 1	Contractor 2	Contractor 3	Contractor 4
Pre-Qualification	0.055	0.106	0.141	0.110
Project Manager	0.082	0.070	0.035	0.027
Technical	0.046	0.030	0.030	0.046
Commercial	0.017	0.033	0.045	0.035
Total	0.201	0.239	**0.250**	0.218

From the scores presented in (table 10), it can be concluded that the contractor (3) is a contractor with the best value of 25%. it means that the company can decide on the first option in making the project fall on the contractor 3 (three). because the Contractor 3 (three) is superior in Pre-Qualification and Commercial Criterion test.

CONCLUSION

Based on the results obtained, it can be concluded that the decision-making process for the selection process of contractors using the AHP method has several assessment criteria, namely: Pre-Qualification, Project Management, Technical and commercial. Where the criterion value is consistent (CR) with 0,002, ratio index (RI) is 0.99 and in the final selection of alternatives, the first rank is contractor 3 (three) with the best value of 25%. It means that the company can decide on the first option in making the project fall on contractor 3 (three).

Because this Contractor 3 (tree) also excels in Pre-Qualification and Commercial Criteria testing. There are no restrictions in making criteria or sub-criteria in AHP, the above criteria are used in PT. KDA, this case study is used as an example or basic reference for an organization or company as an alternative in making decisions, each organization or company can differ in terms of criteria or sub-criteria or final weighting results, because it will be adjusted to the assessment of each organization or company.

This AHP is very relevant and can be expanded with various additional methods such as fuzzy or other, if the goal is ranking the results of decision-making.

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