

# Analytical Hierarchy Process (AHP) Implementation in Determining Document Evaluation Criteria of Post Qualification E-Tendering Knockout Phase

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# Analytical Hierarchy Process (AHP) Implementation in Determining Document Evaluation Criteria of Post Qualification E-Tendering Knockout Phase

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**Abstract:** The development of a country is directly proportioned to its growing infrastructure needs. One of the most needed infrastructure in Indonesia is medical facility. The construction of public hospital especially in its tendering phase needs to refer to the stated presidential decree that includes a specific rule and policy. The tender process needs to be done carefully to ensure the most beneficial offer is selected. This research will utilize e-tendering method to select the right construction partner. The criteria for the tender requirement will be chosen with the Analytical Hierarchy Process (AHP) which finally would be evaluated to determine the tender winner. AHP should help to elaborate the problem into multiple complex criteria, forming a hierarchy. The AHP implementation requires primary data from questionnaire and secondary data from existing research and policies. AHP calculation process is then used to process the data in the form of scores from the distributed questionnaire. The result of the AHP calculation was used to evaluate each offer from the goods and services providers, while finally done using the method of knockout by passing grade. The dominant factors that influenced the final decision making includes financial power (30.79%), Materials and equipments (8.55%), health and safety (4.59%), technical competence (8.91%), and experience (2.9%). AHP was proven to be very effective when utilized to evaluate e-tendering offer documents

**Index Terms:** AHP, e-tendering, knockout by passing grade system, tender evaluation

## I. INTRODUCTION

The development of a country is directly proportioned to its growing infrastructure needs. One of the most needed infrastructure in Indonesia is medical facility. Medical facility is one of the basic need of every citizen. In Indonesia, the construction of hospitals is divided to 5 regions. The province of Banten is included in region 1, whereas the construction of hospitals in Banten compared to the available hospital beds per 100,000 citizens could be observed[1]. in figure 1.

No	Region 1	A	B	C	D	Non Kelas	Total RS	TT	Tt/100.000 Penduduk
Per April 2018									
1	DKI Jakarta	16	62	64	28	26	196	26,389	275
2	Jawa Barat	8	60	191	74	24	357	48,070	112
3	Jawa Tengah	8	34	142	116	0	300	48,862	151
4	DI Yogyakarta	3	12	26	35	5	81	8,147	236
5	Jawa Timur	10	55	176	131	29	401	54,054	144
6	Banten	1	22	75	7	4	109	12,775	120
	Total	46	245	674	391	88	1,444	198,297	1,037

Figure 1 Number of hospitals based on their class and TT / 100,000 population

Source : [2]

Meanwhile, the public funding for the medical sector have not reached 5% of the state budget even though the hospital requirements of Indonesia in 2017 have reached 11.57%. The growth of the requirement is directly proportioned to the construction activities, especially tendering [3][2].

The data of the amount of hospitals have included government hospitals and public hospitals. The growing number of the citizens of Banten have pushed the need to have more hospitals available. The regional police force of Banten have constructed their own medical facilities to accommodate the medical needs of their members, with another new addition. The construction of this newest police hospital in Banten had to go through a series of procurement procedure in accordance to the presidential decree no. 54/2010 from the tendering phase to the construction phase. This research will utilize e-tendering method to select the right construction partner. The criteria for the tender requirement will be chosen with the Analytical Hierarchy Process (AHP) which finally would be evaluated to determine the tender winner[4]. The contractor selection process is done with a decision making on the middle management level to give opinions and inputs to the top management, in which case the general manager is entitled to determine the contractor that would finish the construction work[5].The offer evaluation using elimination system with passing grade is a prime process if the decision making method used is Analytic Hierarchy Process (AHP) due to its ability to select the criteria and weight of every scoring element which will be used.

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The score of each goods and services provider would be done with a scale, and the result will be significant enough with the correct specification [6].

### II. AHP AND OFFER EVALUATION

#### A. Analytic Hierarchy Process (AHP)

A decision making process that involves a system or an organization should not be done just using intuition. The decision making process should have utilized a more complex decision making process that could cover more aspects involved. The decision making method that will be used in this research is AHP. This process should help to elaborate the problem into multiple complex criteria, forming a hierarchy. Utilizing the hierarchy, the criteria regarding the problem should be more structured [7][4].

As the outcome of AHP, the resulting hierarchy could ease the decision makers in considering the various decisions involved by graphically describing them in sequence based on their subjective scores[8].

#### B. Basic Principles of AHP

While utilized as a problem solving method, there are several principles that needs to be followed that includes [9]

1. Hierarchy construction

A complex system could be made simpler by breaking it into supporting elements and combining them in a hierarchy.

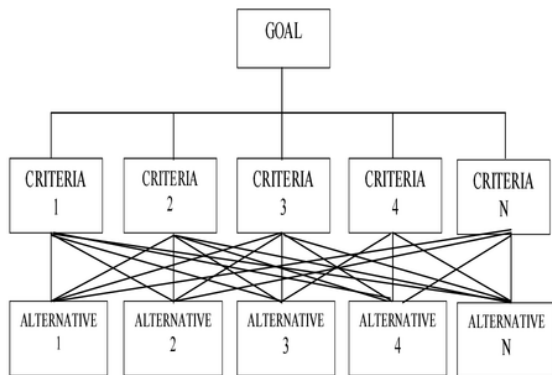


Figure 2. Structur AHP

Source :[8].

#### 2. Criteria and alternatives valuation.

The valuation of the criteria and alternatives are done in pairs. According [10], scaling them 1 to 9 is the most viable option in expressing opinions. The score and qualitative opinion could be measured by utilizing the data provided in figure 3

Intensity Interests	Information
1	Both elements are equally important
3	One element is a little more important than the other elements
5	One element is more important than the other elements
7	One element is clearly more important than the other elements
9	One element is absolutely important than the other elements
2,4,6,8	The values between two consideration values are close together
The opposite	If element i has one of the numbers from a comparison scale of 1 to 9 that has been set by Saaty when compared to the element j, then j has the opposite when compared to the element i

figure 3. Pair Comparative Rating Scale

Source:[11].

#### 3. Synthesis Of Priority

For every criteria and alternative, pair wise comparisons are needed. The relative comparison scores from all of the criteria and alternatives could be adjusted with the pre-determined judgment to produce weight and priority. The weight and priority could be calculated by manipulating the matrices or by solving them mathematically.

#### 4. Logical Consistency

The consistency involves two things, which are the categorization of similar objects according to their uniformity and relevance, and connecting the relation level between object based on certain criteria.

#### C. E-Tendering

According the presidential decree no.54/2010 and its addition of chapter 39, e-tendering is a method of selection for goods or services providers which is done openly and could be participated by all of the goods and services provider that is listed in the procurement system electronically. The e-tendering is participated by conveying one offer in the given time frame. The tendering process includes the phases of qualification, announcement and/or invitation, registration and documentation, briefing, offer document delivery, offer document evaluation, and winner confirmation[12][2].

#### D. Offer Evaluation

The presidential decree no.54/2010 and its changes in chapter 79 verse 1 stated that in doing an offer evaluation, the procurement officials must refer to the procedures or criteria that is stated on the procurement document. The procurement officials and the goods and services provider are forbidden to do a post bidding[13][14].

### III. AHP IMPLEMENTATION AND RESULT

The AHP implementation requires primary and secondary data. The secondary data for this research was acquired from previous research and decrees/policies. Meanwhile, the primary data was acquired from questionnaires and FGD[15][16].

#### A. Research Instruments

Based on the identification of criteria, sub criteria, and alternatives from previous related studies, a questionnaire was made and spread to the experts in related fields. The identification process itself was done by focus group discussion of 5 government procurement experts with the goal of distinguishing the most exact elements to be included in the questionnaire.

#### B. Evaluation of offers with AHP

The steps of offer evaluation using AHP could be observed in figure 4

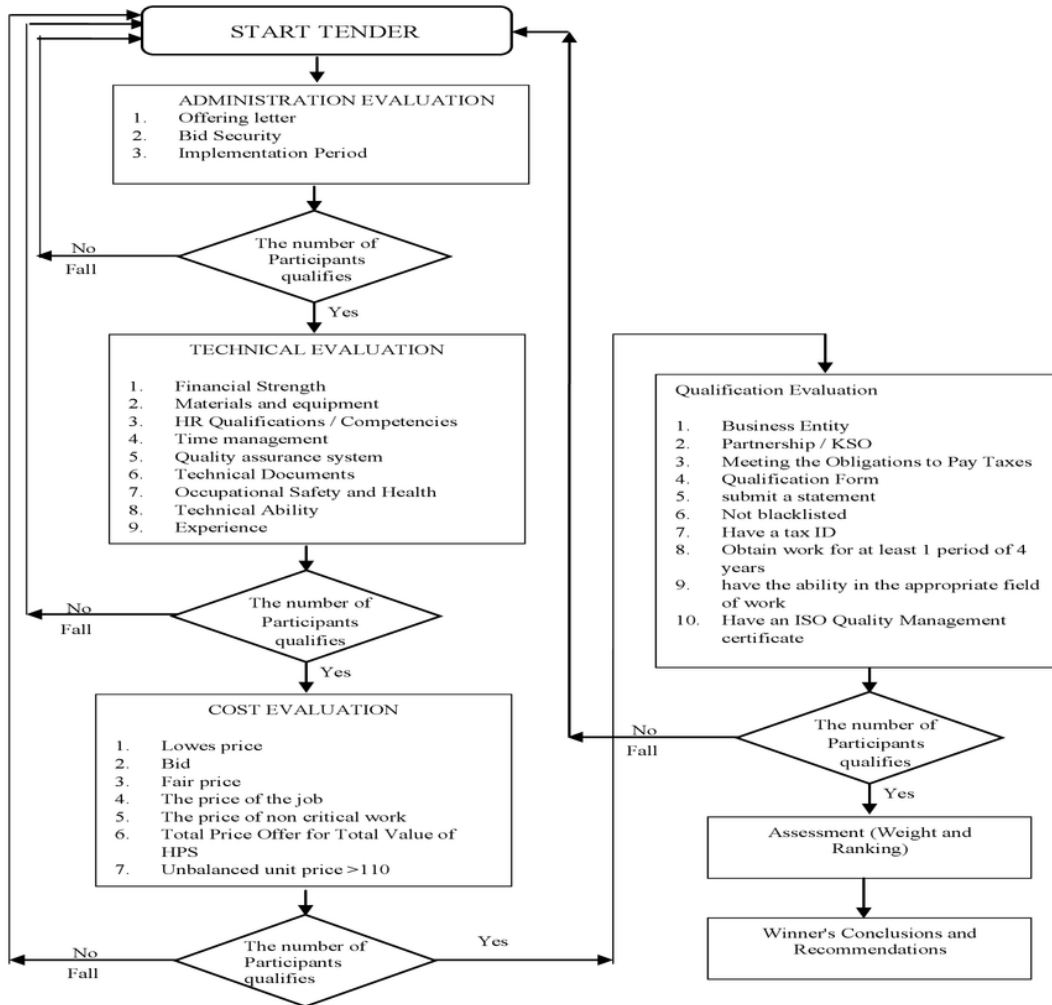


Figure 4. Flow Chart Evaluation of offers with AHP (Source : Processed Alone)



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### A. AHP Calculation Phases

The process of processing the results of the questionnaire by utilizing AHP is described in figure 4.

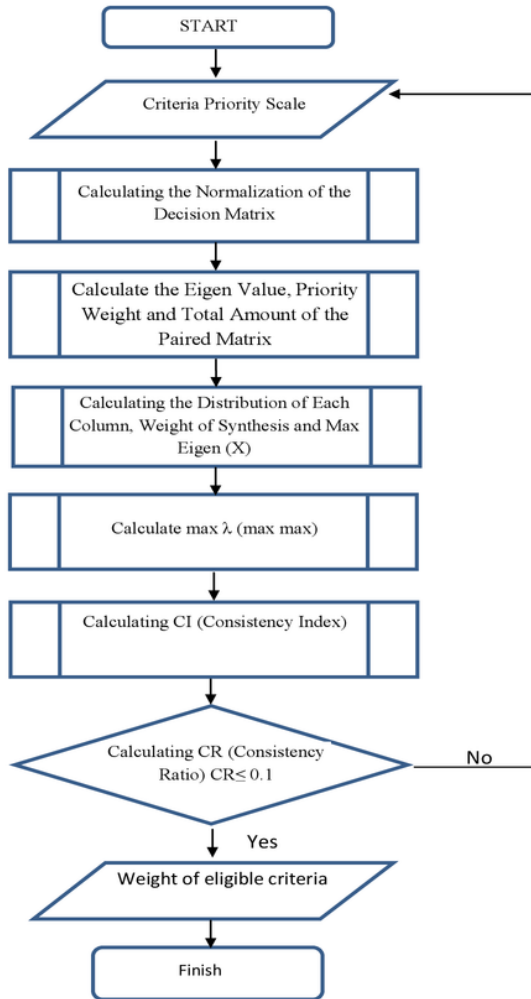


Figure 4 Flow Chart AHP  
(Source : Processed Alone)

The data from the questionnaire result that was acquired by AHP calculations and criteria comparisons are then used to calculate the Eigen Value with the following equation[17][18].:

The number of Column values paired horizontally for each criterion

$$\text{Eigen Value} = \frac{\text{Eigen Value}}{\text{Number of Eigen Value}} \dots\dots(1)$$

$$\text{Priority Weight} = \frac{\text{Eigen Value}}{\text{Number of Eigen Value}} \dots\dots(2)$$

The number of Column values paired horizontally for each criterion

$$\text{Eigen Value} = \frac{\text{Eigen Value}}{\text{Number of Eigen Value}} \dots\dots(3)$$

Before executing the calculation for the synthetic weight and the eigen max, the criteria scores must first be divided to

the number of columns. The results are then used to calculate the synthetic weight by adding up the value of each row, while finally doing the operation for the eigen max with the following equation

$$\text{Eign Maks} = \frac{\text{Baris bobot sintesa}}{\text{Bobot prioritas}} \dots\dots\dots(4)$$

The process is then continued by calculating the value of lambda max with the equation of:

$$\lambda \text{ maks} = \frac{\text{Total Eign Maks (X)}}{\text{N (Jml Kriteria)}} \dots\dots\dots(5)$$

After finding out the value of the lambda max, then the score of the consistency index could be calculated with the following equation:

$$\text{CI} = \frac{\lambda \text{ maks}}{\text{N (Number of Criteria) - 1}} \dots\dots\dots(6)$$

The final step of the AHP calculation consists of the operation to calculate the consistency ratio score with the equation of:

$$\text{CR} = \frac{\text{CI}}{\text{IR}} \dots\dots\dots(7)$$

IR was gained from the table of random indexes with the amount of the used criteria. If the score of  $\text{CR} < 0.1$ , then the value is consistent[19].

### B. AHP Calculation Results

In accordance to the phases described in figure 4, the offer evaluation by AHP utilization was done. Every phases resulted in the recapitulation of the criteria, sub criteria, and alternative calculations for the category of administration, technical, cost, and qualification. The result of this calculations could be observed in table 2-5

Table 2. Recapitulation of criteria calculation using AHP method

NO	CRITERIA	Eigen Value	Priority Weight	Sintesa Weight	Eign Maks (N)	λ maks (lambda maks)	CI (Consistency Indeks)	CR (Consistency Ratio)	Information
A	ADMINISTRATION	1.1643	0.2197	0.666363	3.032931	3.90195	-0.03268414	-0.03631571	KONSISTEN < 0,1
B	TECHNICAL	1.5462	0.2918	1.2913	4.4255				
C	COST	1.6265	0.3069	1.3776	4.4882				
D	QUALIFICATION	0.6648	3.6611	0.6648	3.6611				

Table 3. Recapitulation of the Administration criteria calculation with the AHP method

No	Subcriteria	Eigen Value	Priority weight	Sintesa Weight	Eign Maks (N)	λ maks (lambda maks)	CI (Consistency Indeks)	CR (Consistency Ratio)	Information
A	ADMINISTRATION								
1	Offering letter	0.9565	0.3186	0.9844	3.0897	3.0026	0.0013	0.0022	KONSISTEN < 0,1
2	Offer Period	1.0456	0.3483	1.0157	2.9160				
3	Bid Security	0.9999	0.3331	0.9999	3.0021				

Table 4. Recapitulation of technical subcriteria calculations using the AHP method

No	Subcriteria	Eigen Value	Priority weight	Sintesa Weight	Eign Maks (X)	$\lambda$ maks (lambda maks)	CI (Consistency Indeks)	CR (Consistency Ratio)	Information
B	TECHNICAL								
1	Financial strength	3.7523	0.3079	1.7457	5.6705	7.2556	-0.2180	-0.1504	KONSISTEN <0,1
2	Equipment material	2.6577	0.2181	1.5122	6.9348				
3	HR Qualifications / Competencies	1.7145	0.1407	1.0263	7.2962				
4	Time management	1.0419	0.0855	0.7725	9.0367				
5	Quality assurance system	0.5200	0.0427	0.3613	8.4686				
6	Technical Documents	0.5029	0.0413	0.2511	6.0857				
7	Occupational Health and Safety	0.5593	0.0459	0.3569	7.7770				
8	Technical Ability	1.0865	0.0891	0.8407	9.4315				
9	Experience	0.3533	0.0290	0.1333	4.5995				

Table 5. Recapitulation of cost subcategory calculations using the AHP method

No	Subcriteria	Eigen Value	Priority weight	Sintesa Weight	Eign Maks (X)	$\lambda$ maks (lambda maks)	CI (Consistency Indeks)	CR (Consistency Ratio)	Information
C	COST								
1	Lowest price	4.0799	0.4016	2.6291	6.5467	7.5527	0.0921	0.0698	KONSISTEN <0,1
2	Bid	2.4157	0.2378	1.5288	6.4297				
3	Fair price	1.4033	0.1381	0.9630	6.9716				
4	The price of the job	0.7946	0.0782	0.6487	8.2933				
5	The price of non critical work	0.7841	0.0772	0.7156	9.2708				
6	Total Price Offer for Total Value of HPS	0.3528	0.0347	0.2611	7.5198				
7	Unbalanced unit price >110	0.3289	0.0324	0.2538	7.8372				

Table 5. Recapitulation of calculation of qualification subcategories with the AHP method

No	Subcriteria	Eigen Value	Priority weight	Sintesa Weight	Eign Maks (X)	$\lambda$ maks (lambda maks)	CI (Consistency Indeks)	CR (Consistency Ratio)	Information
D	KUALIFIKASI								
1	Business Entity	12.2055	0.4281	3.1232	0.1371	1.1728	-0.9808	-0.6983	KONSISTEN <0,1
2	Partnership / KSO	7.0000	0.2455	2.0920	0.1174				
3	Fulfilling the Obligation to Pay Taxes	4.0146	0.1408	1.6232	0.0868				
4	Qualification Form	2.3024	0.0808	1.3071	0.0618				
5	submit a written statement / acknowledgment that the company in question is not under the supervision of the court, does not go bankrupt and is not being terminated	1.3205	0.0463	1.0677	0.0434				
6	Not blacklisted	0.7573	0.0266	0.8748	0.0304				
7	Have a tax ID	0.4343	0.0152	0.7132	0.0214				
8	Obtain work for at least 1 period of 4 years	0.2491	0.0087	0.4916	0.0178				
9	have the ability in the appropriate field of work	0.1429	0.0050	0.2986	0.0168				
10	Have an ISO Quality Management certificate	0.0819	0.0029	0.1370	0.0210				

#### IV. CONCLUSION

1. The knockout by passing grade evaluation was done by evaluating the administration document, while the cost and qualification was done without weight valuation. The technical document evaluation was done by evaluating the weight of the criteria, sub criteria and alternatives.
2. The dominant factors that influenced the passing grade of the technical offer documents in determining the winning provider by utilizing AHP includes the sub criteria of financial power (30.79%), materials and equipments (21.81%), labour competence qualification (14.07%), time management (8.55%), health and safety (4.59%), technical competence (8.91%), and experience (2.9%).
3. AHP was proven to be very effective when utilized to evaluate e-tendering offer documents

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