Decision Support System in Detrmination of Project Tender Winner Using the Analytical Hierarchy Process (AHP) Method

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Abstract. Decision Support System (DSS) is a system that can help someone in making accurate and targeted decisions. Many problems can be solved by using DSS, one of which is the determination in the winner of the project tender. There are several methods that can be used in building a DSS, including Analytic Hierarchy Process (AHP). AHP is the most widely used method in solving multi-criteria problems, such as in determining the winner of a project tender. This study uses the AHP method in determining the winner of a project tender in the Procurement Services Unit (ULP) IAIN Bukittinggi. In determining the winner of a tender, there are several criteria that form the basis of decision making including administrative evaluation, technical evaluation, price evaluation and qualification evaluation. From the four criteria, it is processed according to alternative data, namely bidders. The application used in determining the winner of this tender is the Expert Choice software. The final results in this study are the results of global priority criteria that are sorted from highest to lowest, so that the committee can determine the winner of the tender**.**

Keywords*: Decision Support System, Analytic Hierarchy Process, Project Tender, Expert Choice software.*

1. Introduction

The decision support system is an interactive information system that provides information, modeling and data manipulation. Decision support system is part of the information system used to support in making a decision by a company or organization. Many methods used in this decision support system include the Analytical Hierarchy Process (AHP) method[1]. This method can help decision making that is quite complex with a multi-criteria system.

One of the decision support systems is determining the winner of the project tender. During this time the process of determining the winner of the project tender is still based on considerations that are influenced by subjective factors[2], so that the results of the decisions obtained do not satisfy the parties concerned. With the existence of a decision support system using the AHP method, it can produce a fair, objective and transparent tender winner decision[3].

2. Literature Study and Hypothesis

For Decision Support Systems many methods can be used, one of the methods used in this study is the Analytical Hierarchy Process (AHP) method. The concept of the AHP method is to change qualitative values into quantitative values. So the decisions made can be more objective. At this time the AHP method has also been used by several researchers, for example for Web GIS determination of business potential[4], in the selection of outstanding employees using the analytical hiearchy (AHP) process method (Case Study: PT. Capella Dinamik Nusantara Takengon)[5], and A decision support system for supplier selection using an integrated analytic hierarchy process and linear programming[6].

Basically the steps in the AHP method include:

1. Determine the types of criteria that will be requirements to choose the items to be loaded first.
2. Arrange the criteria in the form of a paired matrix.
3. Add up the column matrix
4. Calculate the value of the criteria column element by the formula for each column element divided by the number of column matrices.
5. Calculate the priority value of the criteria with the formula adding up the row matrix of the results of step 4 and the result 5 divided by the number of criteria.
6. Determine the alternatives that will be chosen.
7. Arrange alternatives that have been determined in the form of a paired matrix for each criterion. So there will be as many as *n* pairs of matrices between alternatives.
8. Each matrix pairing between alternatives is *n* matrixes, each matrix is added per column.
9. Calculate the alternative priority values of each paired matrix between alternatives with formulas such as step 4 and step 5.
10. Test the consistency of each paired matrix between alternatives with the formula of each paired matrix element in step 2 multiplied by the priority value of the creation. The results of each row are added up, then the results are divided by each creative priority value as many times $\lambda_1, \lambda_2, \lambda_3, \ldots\ldots\ldots, \lambda_n$
11. Calculate Lamda max with a formula

$$\lambda \text{ max} = \frac{\sum \lambda}{n}$$

12. Calculate CI With a Formula

$$\text{CI} = \frac{\lambda\, max}{n-1}$$

13. Calculate *CR* With a Formula

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

Where CR is a value derived from a random table such as table 1.

Table 1. RANDOM INDEX

N	1	2	3	4	5	6	7	8	9	10	11
RI	0,00	0,00	0,58	0,901	1,12	1,24	1,32	1,41	1,45	1,49	1,51

3. Research Methods

By paying attention to the scope of research activities in terms of the period of time for conducting research activities, how to obtain the information needed, research objectives and refer further to the views of a number of experts. This research is descriptive, because the purpose of this research is how to implement AHP to determine the winner of the project tender by carrying out several stages as shown in the following figure;

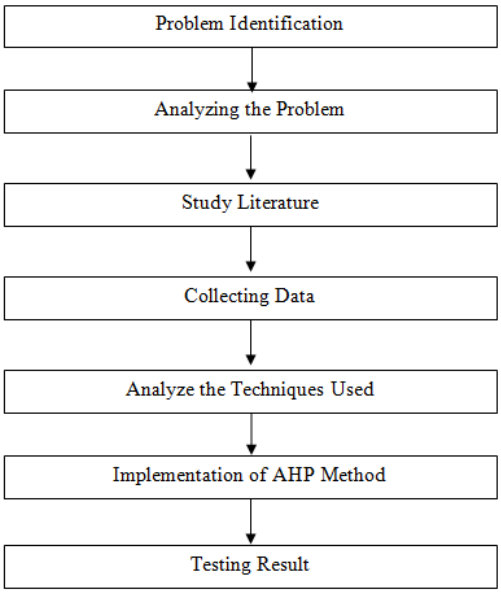


Figure 1. Research Methods

4. Results and Discussion

In the process of determining the winner of a project tender by using the DSS AHP goal method that will be generated is the selection of one tender winner from several tender participants.

For the process of testing this manual calculation system, the author uses the AHP application, Expert Choice. This software will provide proof whether the search performed is correct.

The steps in this research are:

1. Determine Criteria and Alternatives

In the hierarchy there are main objectives, criteria and alternatives that will be discussed. In determining the criteria and alternatives, the writer conducts direct interviews with the committee so that the following criteria can be obtained, administrative evaluation, technical evaluation, price evaluation

and qualification evaluation, while the alternatives are bidder 1 (IMS), bidder 2 (KRM), bidder 3 (RS) , bidder 4 (CMR), bidder 5 (SAM) and bidder 6 (AA).

Table 2. List of Criteria

No	Code	Criteria
1	EA	Administrative Evaluation
2	ET	Technical Evaluation
3	EH	Price Evaluation
4	EK	Qualification Evaluation

Table 3. List of Criteria

No	Code	Alternative
1	IMS	Offers 1
2	KRM	Offers 2
3	RS	Offers 3
4	CMR	Offers 4
5	SAM	Offers 5
6	AA	Offers 6

The composition of criteria and alternatives in a hierarchy consisting of 4 criteria and 6 alternatives can be seen in the following figure.

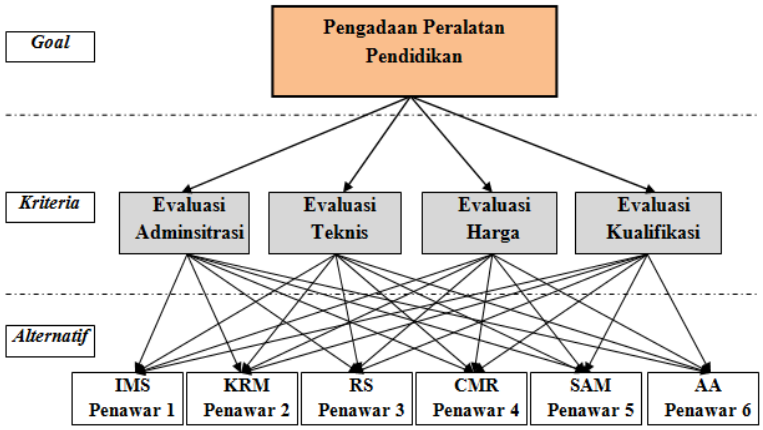


Figure 2. Composition of Criteria and Alternatives

2. Arrange a pair matrix between criteria.

The steps in calculating this comparison are based on the AHP formula discussed above. The AHP formula is used to find quality on alternatives and criteria. To find the quality of each criterion, data will be collected and then entered into a comparison matrix like this table.

Table 4. Comparative Comparison Matric Every Criteria

	EA	ET	EH	EK
EA	1	2	2	1
ET	0,5	1	1	2
EH	0,5	1	1	2
EK	1	0,5	0,5	1
Jml	**3**	**4,5**	**4,5**	**6**

Table 5. Matric In Decimal

	EA	ET	EH	EK
EA	0,33333	0,44444	0,44444	0,16667
ET	0,16667	0,22222	0,22222	0,33333
EH	0,16667	0,22222	0,22222	0,33333
EK	0,33333	0,11111	0,11111	0,16667

Table 6. Matric In Decimal

	EA	ET	EH	EK
EA	0,33333	0,33333	0,44444	0,16667
ET	0,16667	0,22222	0,22222	0,33333
EH	0,16667	0,22222	0,22222	0,33333
EK	0,33333	0,11111	0,11111	0,16667
Jml	**1,00000**	**1,00000**	**1,00000**	**1,00000**

Addition Result Matrix for each column

Table 7. The Sum Of Each Column

	EA	ET	EH	EK	JML	BOBOT
EA	0,33333	0,44444	0,44444	0,16667	1,38889	0,34722
ET	0,16667	0,22222	0,22222	0,33333	0,94444	0,23611
EH	0,16667	0,22222	0,22222	0,33333	0,94444	0,23611
EK	0,33333	0,11111	0,11111	0,16667	0,72222	0,18056
JML	**1,00000**	**1,00000**	**1,00000**	**1,00000**	**4,00000**	**1,00000**

Determining the value of [A] and [B]

Table 8. Quality value of [A] anD [B]

	Weight	A	B
EA	0,34722	1,47222	4,24000
ET	0,23611	1,00694	4,26471
EH	0,23611	1,00694	4,26471
EK	0,18056	0,76389	4,23077
Amount	**1,00000**	**4,25000**	**17,00018**

After obtaining the weight of each criterion, then the consistency index and consistency ratio to determine whether the comparison data is consistent or not. If the CR value <0.1 then the data is said to be consistent and can be continued, but if the CR> 0.1 then the data is inconsistent and the comparison of matrix values must be repeated.

Table 9. Criteria Rank

Criteria	Weight	Rank
Administrative Evaluation	0,34722	**1**
Technical Evaluation	0,23611	**2**
Price Evaluation	0,23611	**3**
Qualification Evaluation	0,18056	**4**

3. Arrange the pairing matrix for alternative levels.

a. Pairwise Comparison Metrics of Administrative Evaluation Criteria to the Alternatives

The method and formula used are the same as the search for determining the criteria weights above. With AHP steps, the results obtained from the scoring manual calculation like the following table:

Pairwise comparison of administrative evaluation criteria against alternatives.

Table 10. Comparison of evaluation criteria Administration Towards Alternatives

EA	IMS	KRM	RS	CMR	SAM	AA
IMS	1,00	1,00	1,00	2,00	1,00	2,00
KRM	1,00	1,00	2,00	1,00	2,00	5,00
RS	1,00	0,50	1,00	2,00	3,00	3,00
CMR	0,50	1,00	0,50	1,00	3,00	2,00
SAM	1,00	0,50	0,33	0,33	1,00	2,00
AA	0,50	0,20	0,33	0,50	0,50	1,00
JML	**5,00**	**4,20**	**5,17**	**6,83**	**10,50**	**15,00**

The results of the ranking of administrative evaluation criteria compared to alternatives.

Table 11. Criteria Rank

Alternative	Weight	Rank
IMS	0,19	**3**
KRM	0,25	**1**
RS	0,22	**2**
CMR	0,17	**4**
SAM	0,11	**5**
AA	0,07	**6**

With a CR value of 0.06 it means <0.1 and can be justified.

b. Pairwise Comparison Metrics Administrative Criteria Against Alternatives

Paired comparison data of technical evaluation criteria against alternatives.

Table 12. Comparison Of Technical Evaluation Criteria Against Alternatives

ET	IMS	KRM	RS	CMR	SAM	AA
IMS	1,00	1,00	2,00	1,00	2,00	1,00
KRM	1,00	1,00	1,00	1,00	2,00	1,00
RS	0,50	1,00	1,00	3,00	3,00	2,00
CMR	1,00	1,00	0,33	1,00	3,00	2,00
SAM	0,50	0,50	0,33	0,33	1,00	2,00
AA	1,00	1,00	0,50	0,50	0,50	1,00

The results of the ranking of the technical evaluation criteria against alternatives can be seen in the following table.

Table 13. The Rank of Technical Evaluation Criteria Against Alternatives

Alternatif	Bobot	Rangking
IMS	0,20	**2**
KRM	0,17	**4**
RS	0,23	**1**
CMR	0,18	**3**
SAM	0,10	**6**
AA	0,12	**5**

With a CR value of 0.08 it means <0.1 and can be justified.

c. Pairwise Comparison Metrics of Administrative Prices Against Alternatives

Data pairwise comparison of price evaluation criteria against alternatives.

Table 14. Comparison of Price Evaluation Against Alternatives

EH	IMS	KRM	RS	CMR	SAM	AA
IMS	1,00	1,00	2,00	1,00	3,00	9,00
KRM	1,00	1,00	1,00	1,00	1,00	6,00
RS	0,50	1,00	1,00	3,00	3,00	3,00
CMR	1,00	1,00	0,33	1,00	3,00	5,00
SAM	0,33	1,00	0,33	0,33	1,00	5,00
AA	0,11	0,17	0,33	0,20	0,20	1,00

The results of the ranking of the evaluation criteria of price against alternative.

Table 15. Rank of Price Evaluation Criteria Against Alternative

Alternative	Weight	Rank
IMS	0,26	**1**
KRM	0,18	**4**
RS	0,23	**2**
CMR	0,18	**3**
SAM	0,11	**5**
AA	0,04	**6**

With a CR value of 0.08 it means <0.1 and can be justified.

d. Pairwise Comparison Metrics for Evaluation of Qualifications toward Alternatives

Paired comparison data on qualification evaluation criteria against all alternatives.

Table 16. Comparison of Qualification Evaluation Criteria Against Alternative

EK	IMS	KRM	RS	CMR	SAM	AA
IMS	1,00	1,00	1,00	1,00	1,00	1,00
KRM	1,00	1,00	1,00	1,00	1,00	1,00
RS	1,00	1,00	1,00	3,00	5,00	3,00
CMR	1,00	1,00	0,33	1,00	3,00	3,00
SAM	1,00	1,00	0,20	0,33	1,00	1,00
AA	1,00	1,00	0,33	0,33	1,00	1,00

The results of the ranking of criteria for evaluation of qualifications against all alternatives.

The Rank of Qualification Evaluation Criteria Against Alternatives

Table 17. Qualification Evaluation Criteria Against Alternatives

Alternative	Weight	Rank
IMS	0,15	**3**
KRM	0,15	**3**
RS	0,29	**1**
CMR	0,19	**2**
SAM	0,10	**6**
AA	0,11	**5**

With a CR value of 0.08 it means <0.1 and can be justified.

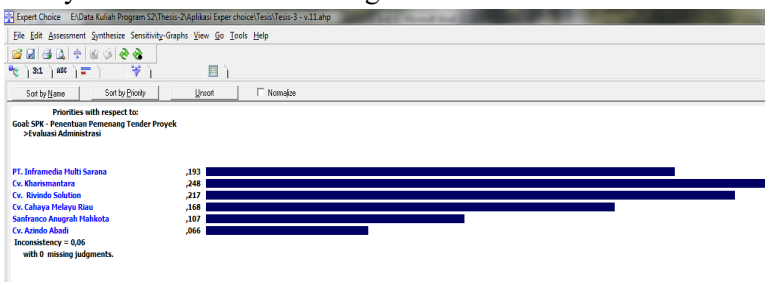
After all alternatives have been processed and analyzed, then all the recapitulation of ranks obtained from the total weight obtained from each alternative are as described in table 8 below. From the total ranks we can draw conclusions that CV. Rivindo Solution became the first rank in the bidding process.

Table 18. Total of alternative rank

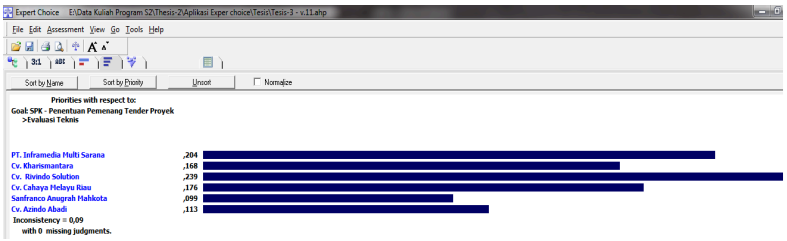
Prshan	Kriteria Evaluasi								Jumlah	Rengking
	E. Administrasi		E. Teknis		E. Harga		E. Kualifikasi			
	0,347	**Rank**	**0,236**	**Rank**	**0,236**	**Rank**	**0,181**	**Rank**		
IMS	0,192	3	0,200	2	0,263	1	0,154	3	**0,204**	2
KRM	0,249	1	0,168	4	0,183	4	0,154	3	**0,197**	3
RS	0,215	2	0,233	1	0,225	2	0,293	1	**0,236**	1
CMR	0,167	4	0,179	3	0,185	3	0,187	2	**0,177**	4
SAM	0,110	5	0,102	6	0,110	5	0,103	6	**0,107**	5
AA	0,067	6	0,118	5	0,035	6	0,109	5	**0,079**	6

From the manual calculation above, the author has conducted a test with a computer system using Expert Choice software with the same results. Following can be seen the priority results of each alternative to all the existing criteria.

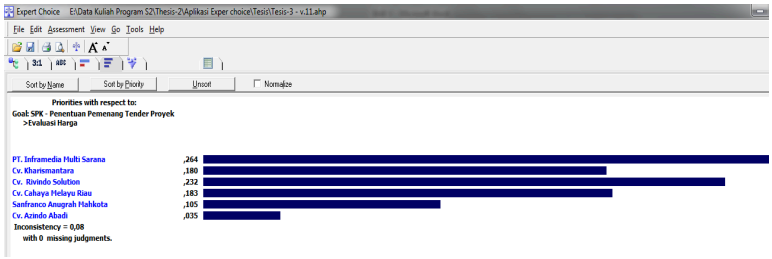
1. Comparison of priority administrative criteria against all alternatives



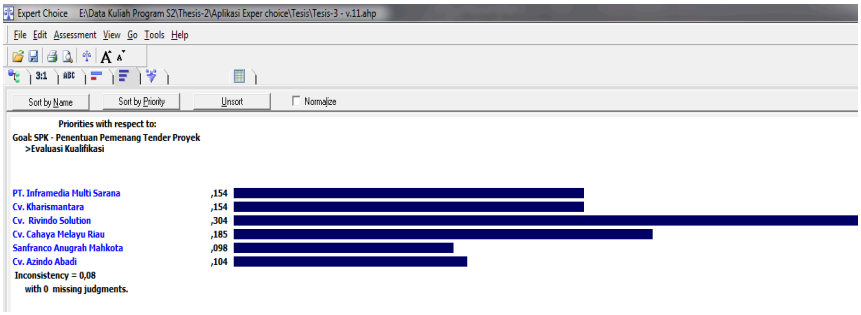
2. Comparison of priority technical criteria against all alternatives.



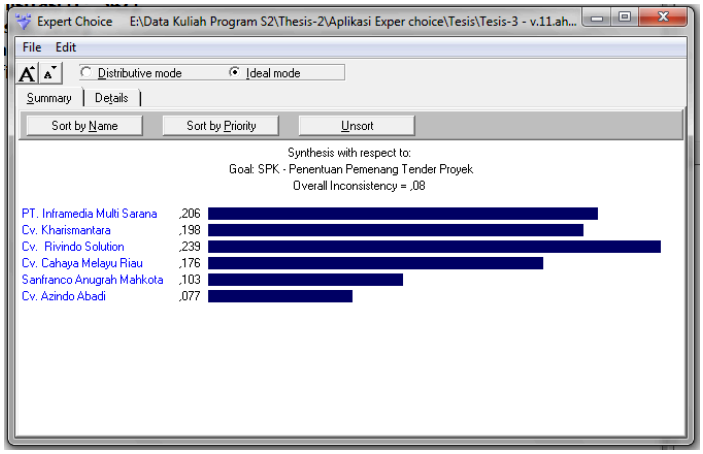
3. Comparison of priority price criteria for all alternatives



4. Comparison of priority criteria for qualifications against all alternatives.



5. The results of the project tender winner are based on a system test using the Expert Choice application.



5. Conclusions

From the manual process above, the order of winning project tenders is obtained based on the value of comparisons between each criteria and alternatives. Where is CV. Rivindo Solution became the first rank in the winner of the tender for the procurement of educational equipment at IAIN Bukittinggi. After testing with the expert choice application, the same results were obtained.

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