ISSN No:-2456-2165

Vendor Selection Analysis using Analytical Hierarchy Process (AHP) Method in Engineering, Procurement and Construction (EPC) Business Pt. Rekadaya Elektrika

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Abstract:- Vendors have an important role in Supply Chain Management which will have an impact on company performance. One of method that can be used in vendor selection is the Analytical Hierarchy Process (AHP) method. This research was conducted at the company PT Rekadaya Elektrika which is engaged in the national electric power EPC. The sample of this research wereall employees in the SCM Unit. The sampling technique used in this research is judgment sampling.Based on the results from thisresearch, it was found that the most influential criteria in the selection of transmission tower material fabrication vendors were the priority I is lead time (0.390), priority II is quality (0.246), priority III is price (0.169), priority IV is quantity(0.111) and priority V is service (0.084). From the results of the assessment of alternative priority levels, priority I is Vendor D (0.386), priority II is Vendor E (0.230), priority III is Vendor C (0.195), priority IV is Vendor B (0.105) and priority V is Vendor A (0.066).Based on the results of the analysis Vendor D is the vendor that has the highest overall value.

Keywords:- *Vendor Selection, Analytical Hierarchy Process (AHP), Supply Chain Management, software expert choice*.

I. INTRODUCTION

Vendors are important in Supply Chain Management which will have an impact on company performance. Therefore, the selection of vendors is an important part in sustaining the running of a project, with a supply of materials that are in accordance with demand, delivery schedules and affordable costs will result in maximum project profits. So companies need to conduct vendor assessments carefully and precisely.

Based on this, management is required to be able to select vendors carefully and precisely. In selecting vendors, the first step that must be done by the company is to determine the criteria as a reference for the assessment process. This is in accordance with the opinion of Pujawan and Mahendrawati (2017) who argue that the criteria used in the selection of suppliers are important things that can reflect the supply chain strategy and the characteristics of the goods to be supplied.

PT RekadayaElektrikahad the experience in the Engineering, Procurement and Construction (EPC) in Indonesia, and is a member of the PLN Group. There are 4 (four) main business lines run by PT RekadayaElektrika including; EPC for Power Plant, EPC for Transmission and Distribution, Trading and Services, and Consulting Services. In running its EPC business, PT RekadayaElektrika cannot run alone so that PT RekadayaElektrika requires cooperation and support from vendors to running thebusiness line. This is because with the planning and development of a solid strategy from the provider of raw material to the role of logistics, it will produce a qualified product or service. This statement is supported by Pujawan and Mahendrawati (2010) Explain the importance of all parties from suppliers, manufacturers, distributors, retailers and customers in developing affordable, high quality and fast products.

Currently, many projects have been completed by PT RekadayaElektrika spread throughout Indonesia. After the project is declared complete, the project team is required to make a project close out report. This project close out report serves to problems and the history of a project that can be used as lessons learned for planning and executing new projects. Problems that arise at PT RekadayaElektrika, based on project close out report data from previous projects, there are problems that arise in the selection of vendors for the procurement of transmission tower materials. There are 5 (five) Vendors as a sample with various Purchase Order issuance times and fabrication delays. In terms of the length of the Purchase Order issuance process, it occurs due to the determination of the criteria in the process of determining the bidder list which changes, so that it requires a fairly long clarification time. Regarding the delay in fabrication, it is more indicated by the performance of vendors who are less qualified. So the need for the selection of vendors that fit the needs of the company.

The next process is to determine the analytical tools to solve the problem. Some of the criteria that influence this vendor selection decision are qualitative and quantitative. Therefore, a method is needed to cover both. The Analytical Hierarchy Process (AHP) method can be used to solve problems in selecting the vendor (Mubarok, 2017). This method is used to solve complex problems by building a hierarchy of criteria, prospects and outcomes, using different considerations as weights or priorities (Mubarok, 2017).

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II. RESEARCH METHOD

A. Research Design

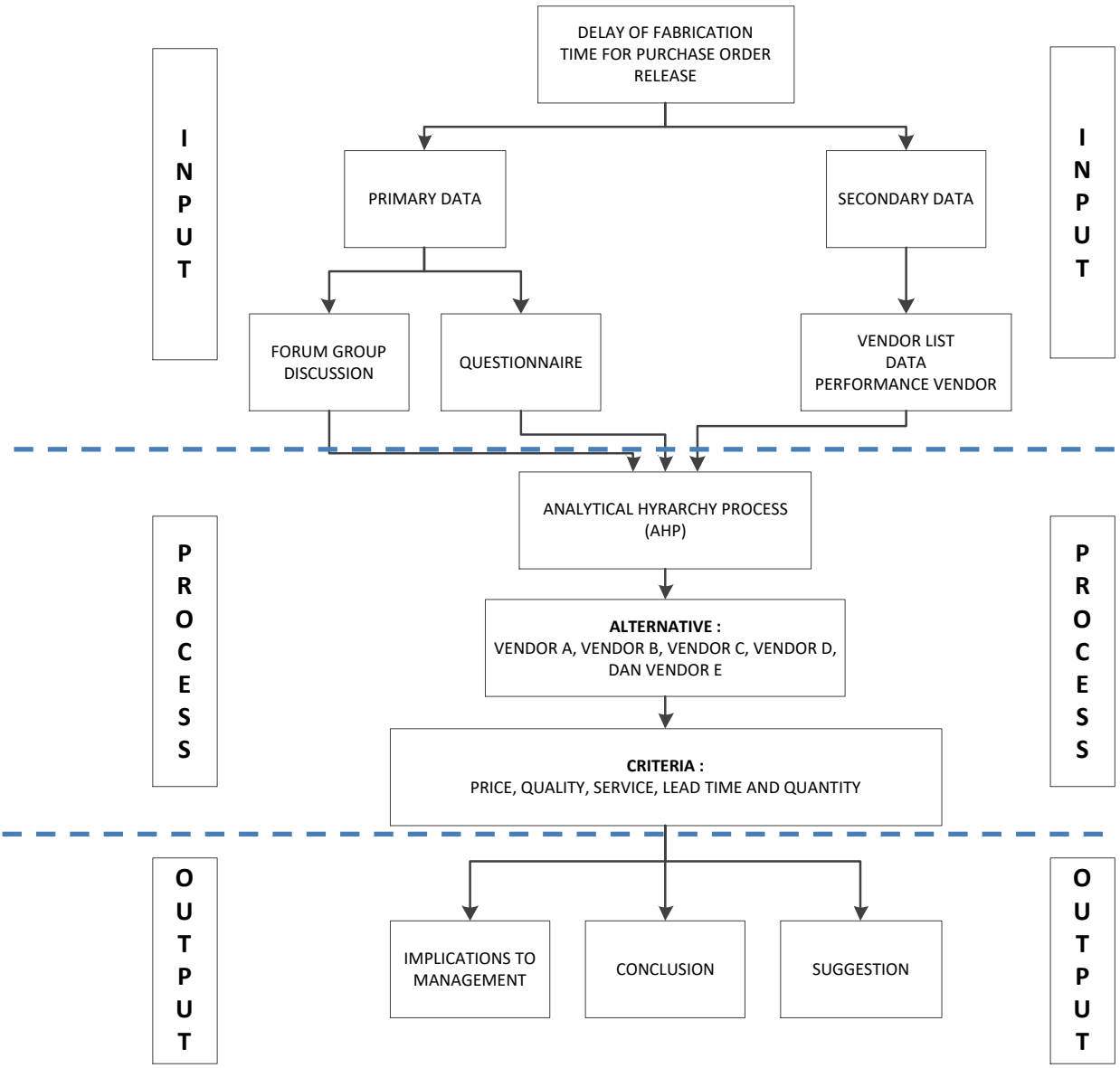

Fig. 1: Research Flowchart

Source: Personal Processed Data, 2022

B. Research Instrument

Data used in this study include:

- Primary data, in the form of questionnaires and the results of forum group discussion for employees who provide an assessment of suppliers.
- Secondary Data, in the form of data derived from historical data or vendor performance records and vendor lists as well as company tender documents.

C. Data Processing

In this study the method used is the Analytical Hierarchy Process (AHP) method. The calculation of the AHP method can be done using the help of expert choice software. Here are some steps that must be taken in the selection of vendors.

1. Develop a hierarchy of problems
   The hierarchical structure is formed based on the criteria and subcriteria that will be used in the selection of the transmission tower material fabrication vendor. The hierarchical structure in this study can be described as follows.

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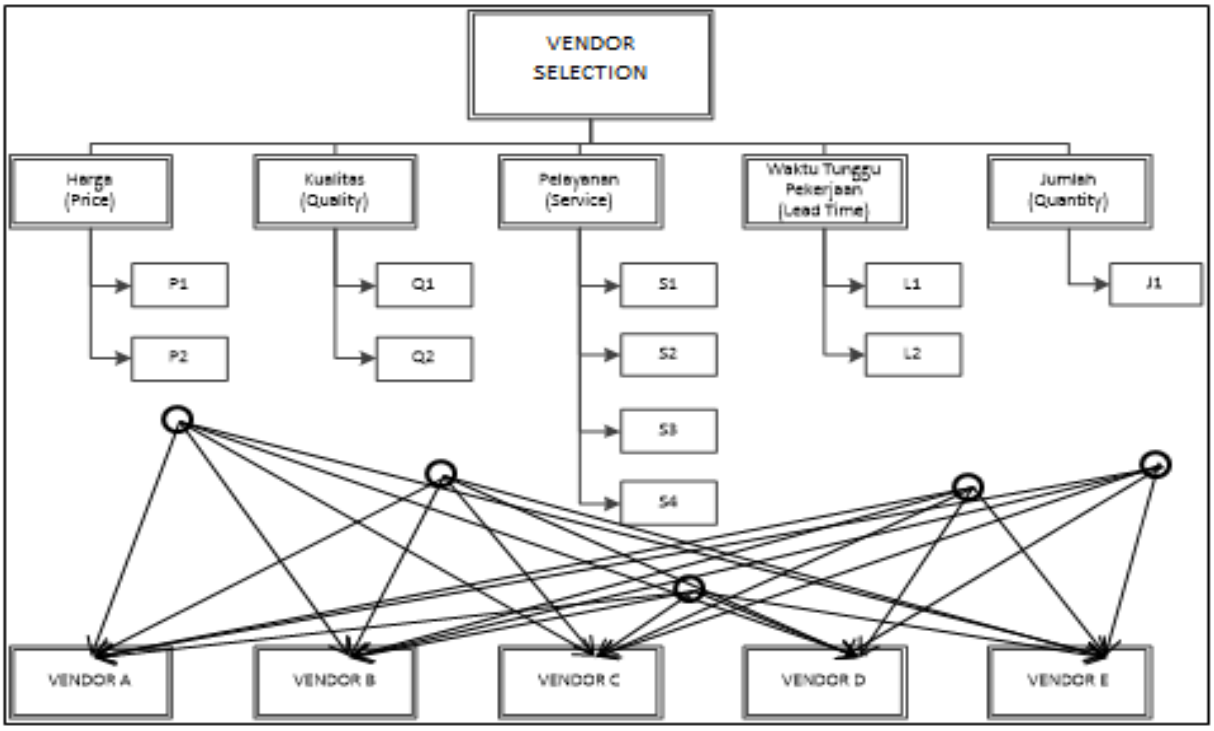

Fig. 2: Research Hierarchy Model

Source: Personal Processed Data, 2022

From the Figure 2.2, it can be seen that level one is the criteria that will be used including: Price, Quality, Service, Lead Time and Quantity. Level two is a subcriteria where there are eleven subcriteria used in this study. Next for level three are alternative vendors to be selected, including: Vendor A, Vendor B,Vendor C, Vendor Dand Vendor E.

2. Compile a pairwise comparison matrix that has accommodated the relative influence of each element on each criterion objective at the level above.
3. Perform calculations weight or priority on each criterion variable. The following are the steps in calculating the weights for each criterion.
   a. For each criterion, make of pairwise comparisons
   b. Performing the average calculation of the respondents' assessment results using the geometric mean. Averaging these values is mandatory because AHP only knows one answer for the comparison matrix. Mathematically the geometric mean theory can be written with the followingformula.

      $aij = (Z1, Z2, Z3, \dots, Zn)^{1/n}$

      Description :

      aij : The average value of pairwise comparisons, criteria Ai with Aj for n respondents

      Z1 : The comparison value between Ai and Aj for respondent I, with i = 1, 2, 3, .., n

      N : Number of respondents
   c. The results obtained from pairwise comparisons are then displayed in the form of a pairwise comparison matrix or pairwise comparison
   d. Divide each element in a certain column by the value of the number of that column
   e. The results in step (d) are then normalized to obtain the eigenvector matrix by averaging the number of rows with the criteria used. The calculation above shows the eigenvector which is the priority weight of the criteria used against the goal.

      The Formula is :

      $A.w = \lambda.w$

      Description :

      w : eigenvector

      λ : eigenvalue

      A : square matrix
   f. Perform the calculation of the consistency ratio as follows:
      i. Multiply the value of the initial comparison matrix by the weight
      ii. Multiply the number of rows by the weight
      iii. Calculate max by adding up the product above divided by n.

      $\lambda maks = (\sum x)/n$
      iv. Calculating the consistency index can be measured through CI which is formulated:

      $$CI = \frac{(\lambda maks - n)}{(n - 1)}$$

      Description :

      CI : consistency index

      λmaks : maximum eigenvalue

      n : matrix orde
      v. Calculate the consistency ratio with the following formula:

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

Description :
CR : consistency ratio
RI : random index

4. Calculating of weight or priority on each subcriteria that has been determined with the same stages in point 3 above. Next, determine the global priority by multiplying the local priority for each subcriteria against the priority criteria.
5. Calculating of weight or priorityfor each alternative vendor that has been determined with the same stages in point 3 above.
6. Determine the vendor to be selected by adding up the whole of the multiplication of vendor weights with subcriteria weights. The overall value of each vendor is what will determine which the best vendor,it is the vendor with the highest value.

D. Operational Variables

VARIABLES	DIMENSIONS	INDICATORS
Price	Price feasibility versus quality (P1)	Bidding Document
	Ability to provide discounted prices (P2)	Percentage of Discount
Service	Communication (S1)	Response and Feedback
	Responsiveness to consumer requests (S2)	Response and Feedback
	Ability to solve problems (S3)	Response and Feedback
	Ability to provide routine fabrication progress (S4)	Progress Report
Quality	Production of materials without defects (Q1)	Inspection Report
	Material conformity with approved specifications (Q2)	Drawing and Spesification
Lead Time	Speed of supply raw material (L1)	Material Schedule
	Ability to complete fabrication in accordance with the agreement (L2)	Contractual Documents
Quantity	Conformity with order quantity (J1)	Order Quantity / Packing list

Table 1: Table of Operational Variables

Source: Personal Processed Data, 2022

III. RESULTS AND DISCUSSION

A. Priority of Criteria

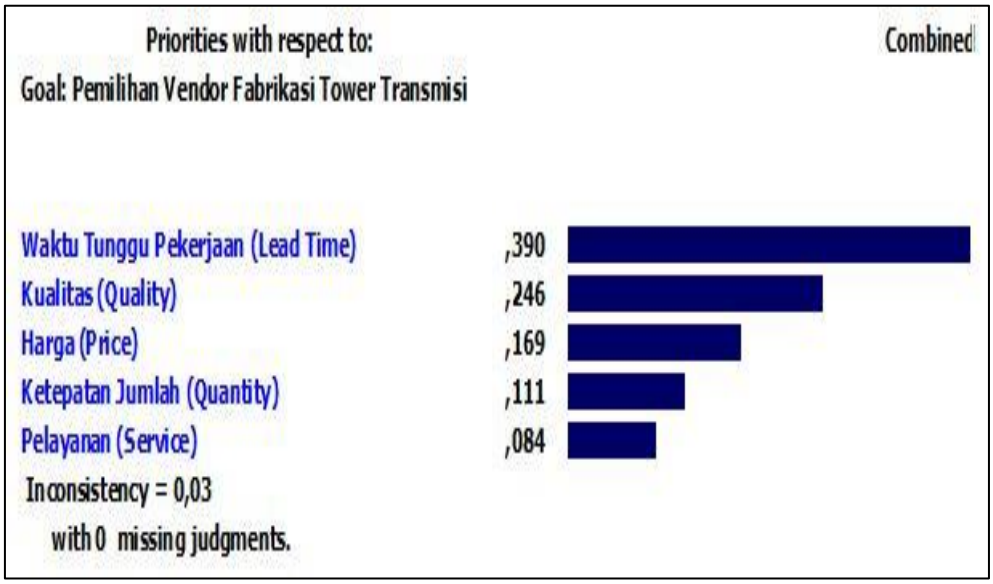

Fig. 3: Vendor Selection Based on Priority of Criteria

Source: AHP Processing Result, 2022

Selection of the transmission tower material fabrication vendor from all the criteria used result is, the first priority criteria used is lead time with a weight of 0.390, then the second priority is quality with a weight of 0.246 , the third priority is the price with a weight of 0.169, the fourth priority is the quantity with a weight of 0.111 and the last or fifth priority is the service with a weight of 0.084.

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B. Vendor Selection Based on Criteria

Vendor Selection Based on Price Criteria

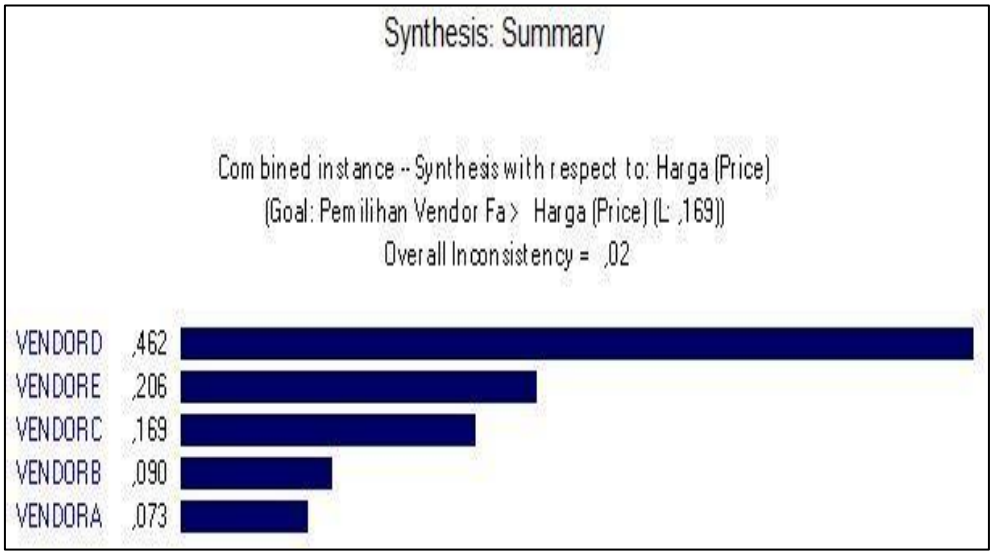

Fig. 4: Vendor Selection Based on Price Criteria

Source: AHP Processing Result, 2022

In the price criteria, the first priority is Vendor D with a weight of of 0.462, the second priority is Vendor E with a weight of 0.206, the third priority is Vendor C with a weight of 0.169, the fourth priority is Vendor B with a weight of 0.090 and the fifth priority is Vendor A with a weight of 0.073.

C. Vendor Selection Based on Service Criteria

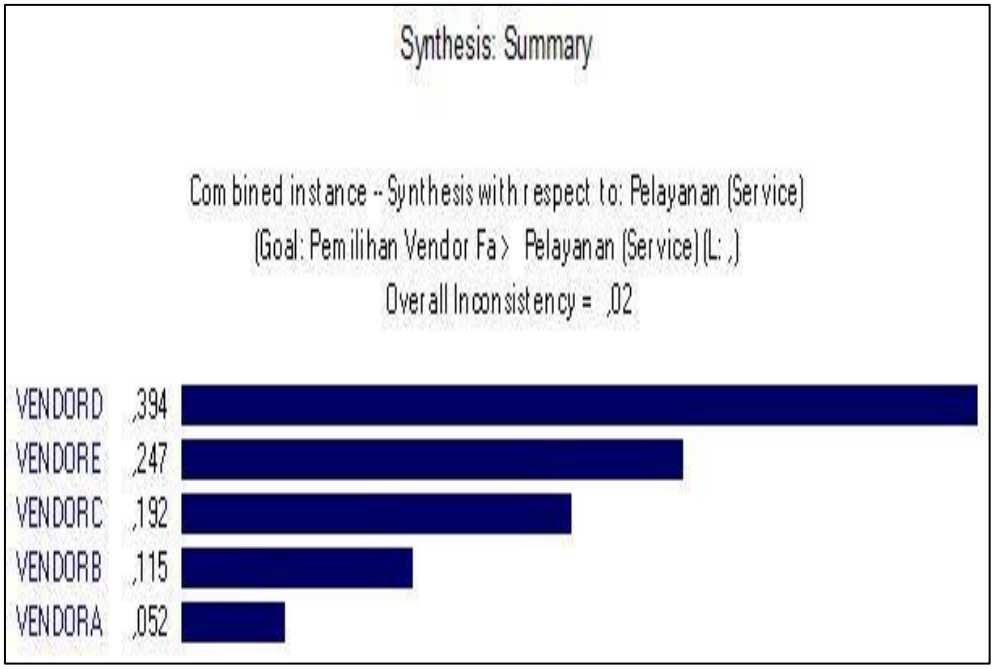

Fig. 5: Vendor Selection Based on Service Criteria

Source: AHP Processing Result, 2022

In the service criteria, the first priority is Vendor D with a weight of 0.394, the second priority is Vendor E with a weight of 0.247, the third priority is Vendor C with a weight of 0.192, the fourth priority is Vendor B with a weight of 0.115 and the fifth priority is Vendor A with a weight of 0.052.

D. Vendor Selection Based on Quality Criteria

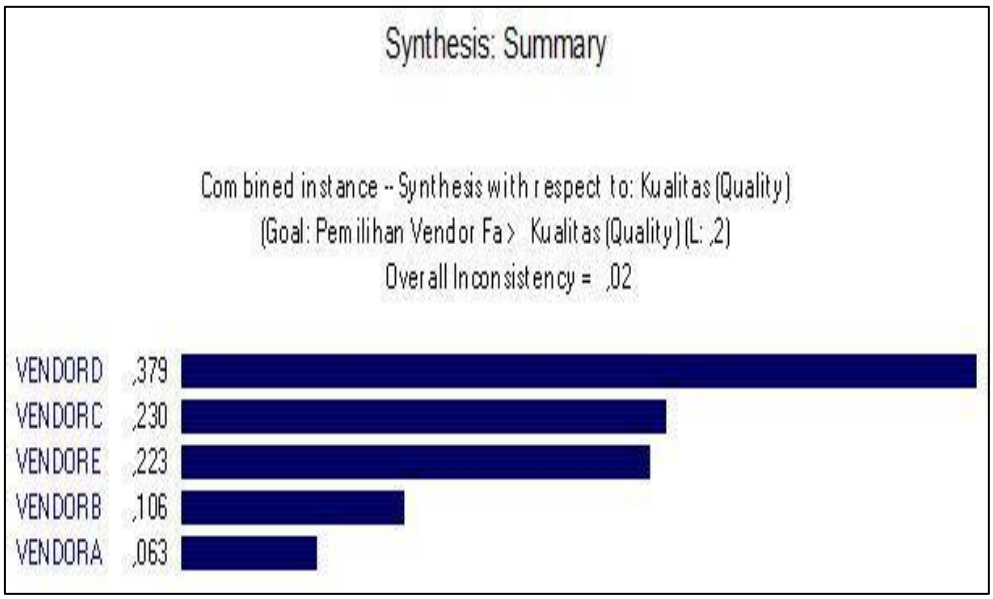

Fig. 6: Vendor Selection Based on Quality Criteria

Source: AHP Processing Result, 2022

In the quality criteria, the first priority is Vendor D with a weight of 0.379, the second priority is Vendor C with a weight of 0.230, the third priority is Vendor E with a weight of 0.223, the fourth priority is Vendor B with a weight of 0.106 and the fifth priority is Vendor A with a weight of 0.063.

E. Vendor Selection Based on Lead Time Criteria

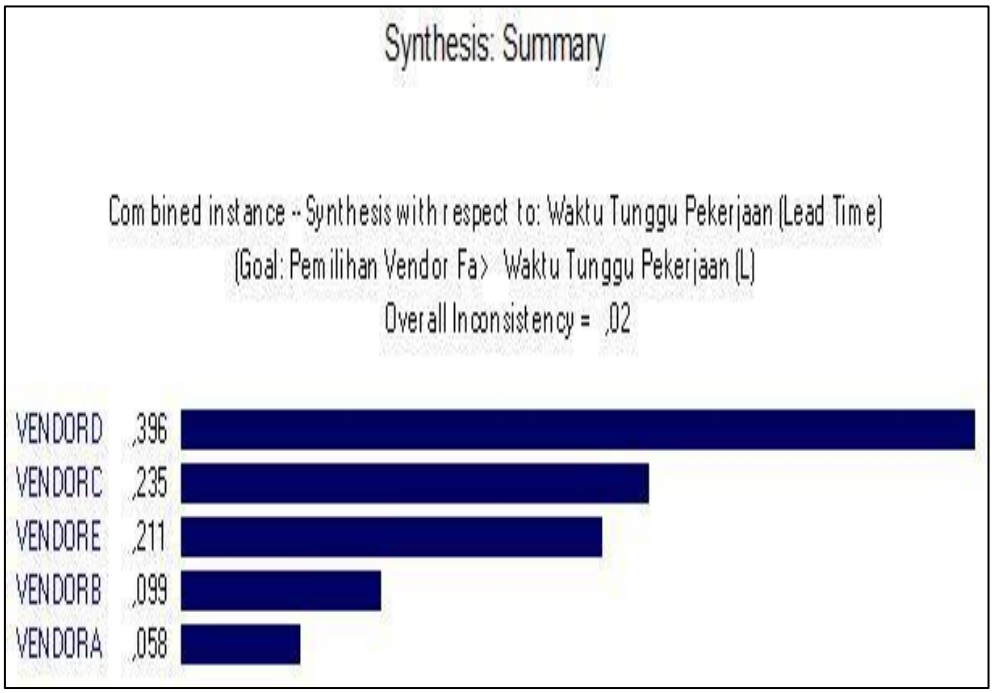

Fig. 7: Vendor Selection Based on Lead Time Criteria

Source: AHP Processing Result, 2022

In the lead time criteria, the first priority is Vendor D with a weight of 0.396, the second priority is Vendor C with a weight of 0.235, the third priority is Vendor E with a weight of 0.211, the fourth priority is Vendor B with a weight of 0.099 and the fifth priority is Vendor A with a weight of 0.058.

F. Selection of Vendors Based on Quantity Criteria

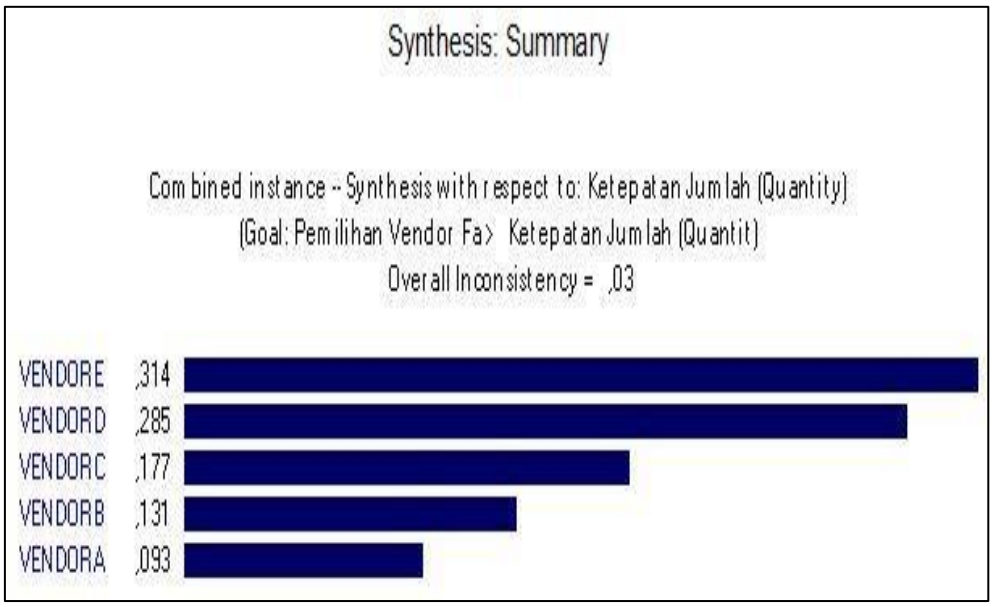

Figure 3.6 Selection of Vendors Based on QuantityCriteria
Source : AHP Processing Result, 2022

In the quantity criteria, the first priority is Vendor E with a weight of 0.314, the second priority is Vendor D with a weight of 0.285, the third priority is Vendor C with a weight of 0.177, the fourth priority is Vendor B with a weight of 0.131, and the fifth priority is Vendor A with a weight of 0.093.

G. Consistency

Pairwise Comparison	CR	Description
Betweencriteria	0,03	Consistent
Between price subcriteria	0,00	Consistent
Between servicesubcriteria	0,01	Consistent
Between qualitysubcriteria	0,00	Consistent
Between lead timesubcriteria	0,00	Consistent
Between alternatives to subcriteriaP1	0,02	Consistent
Between alternatives to subcriteriaP2	0,02	Consistent
Between alternatives to subcriteriaS1	0,02	Consistent
Between alternatives to subcriteriaS2	0,02	Consistent
Between alternatives to subcriteriaS3	0,04	Consistent
Between alternatives to subcriteriaS4	0,03	Consistent
Between alternatives to subcriteriaQ1	0,01	Consistent
Between alternatives to subcriteriaQ2	0,02	Consistent
Between alternatives to subcriteriaL1	0,02	Consistent
Between alternatives to subcriteriaL2	0,02	Consistent
Between alternatives to criteria quantity	0,03	Consistent

Table 3.1 Consistency Ratio of Respondents' Assessment

Source : AHP Processing Result, 2022

From Table 3.1 can be seen that there is no CR value that exceeds 0.1 so that all respondents' assessments can be declared consistent and can be used.

H. Discussion

Executive Summary AHP Processing	
Objectives	Selection of the best vendor fabrication tower transmission
Subcriteria Priority	Price Subcriteria 1. Ability to provide discounted prices (P2) (0,762) 2. Price feasibility versus quality (P1) (0,238) ServiceSubcriteria 1. Ability to provide routine fabrication progress (S4)(0,465) 2. Ability to solve problems (S3)(0,275) 3. Communication (S1)(0,161) 4. Responsiveness to consumer requests (S2)(0,098) Quality Subcriteria 1. Material conformity with approved specifications (Q2) (0,751) 2. Production of materials without defects (Q1) (0,249) Lead Time Subcriteria 1. Ability to complete fabrication in accordance with the agreement (L2) (0,813) 2. Speed of supply raw material (L1) (0,187)
Criteria Priority	1. Lead Time (0,390) 2. Quality (0,246) 3. Price (0,169) 4. Quantity (0,111) 5. Services (0,084)
Alternative Priority	1. Vendor D (0,386) 2. Vendor E (0,230) 3. Vendor C (0,195) 4. Vendor B (0,105) 5. Vendor A (0,066)

Table 3.2: Executive Summary AHP Processing

Source: Personal Processed Data, 2022

Based on the results of the AHP processing above, it can be seen that the most influential criteria in the selection of transmission tower material fabrication vendors are lead time criteria with a weight of 0.390, the next criteria is the quality criteria on the second priority with a weight of 0.246, the third priorityis the price with a weight of 0.169, the fourth priority is the quantity with a weight of 0.111 and the last priority is the service with a weight of 0.084.

The lead time criteria in this research include 2 (two) sub criteria, the speed of supply of raw materials (L1) and the ability to complete the fabrication in accordance with the agreement (L2). Of the two subcriteria, the subcriteria for the ability to complete the fabrication in accordance with the agreement (L2) occupies the first priority with a weight of 0.813 and the second priority is occupied by the sub criteria for the speed of supply raw materials (L1) with a weight of 0.187.

The most influential of the priority lead time and sub-criteria Ability to complete the fabrication in accordance with the agreement (L2) in the selection of the transmission tower material fabrication vendor. It can be seen that PT.RekadayaElektrika prioritizes punctuality in the fabrication of transmission tower materials. This is not without reason because the delay in the transmission tower material fabrication schedule,take effect in a delay the material on site schedule, thus disrupting field activities. The delay of material on site schedule will affect the overall project schedule and the biggest impact is the project cost (overhead cost) which is still running even though the work on the main material has not yet started. Not to mention if it results in a delay in the project completion schedule so that PT Rekadaya Elektrika has the potential to get a liquidated damages from the owner.

Overall result in the selection of transmission material fabrication vendors, Vendor D has the first priority with a weight of 0.386, the second priority is occupied by Vendor E with a weight of 0.230, the third priority is Vendor C with a weight of 0.195, the fourth priority is Vendor B with a weight of 0.105 and the last or fifth priority. occupied by Vendor A with a weight of 0.066. Vendor D wins absolutely for the 4 (four) criteria, it is the criteria for price, service, quality and lead time. However, for the quantity criteria of Vendor D is only able to occupy the second priority, where for the first priority is occupied by Vendor E.

ISSN No:-2456-2165

IV. CONCLUSION AND RECOMMENDATION

A. *Conclusion*

Based on discussion and results of the research, it can be concluded several things including the following:

- The most influential criteria in the selection of the transmission tower material fabrication vendor is lead time criteria with a weight of 0.390 as the first priority, then the second priority is quality with a weight of 0.246, the third priority is price with a weight of 0.169, the fourth priority is the quantity with a weight of 0.111 and the last or fifth priority is service with a weight of 0.084.
- Based on the criteria and subcriteria used in the selection of the transmission tower material fabrication vendor, it can be concluded that Vendor D is the best vendor in the transmission tower material fabrication with a weight of 0.386, then for the second priority is occupied by Vendor E with a weight of 0.230, the third priority is Vendor C with a weight of 0.195, the fourth priority is Vendor B with a weight of 0.105 and the last or fifth priority is occupied by Vendor A with a weight of 0.066.

B. *Recommendation*

Based on the results and conclusions of this study, the authors provide suggestions regarding several things to the company:

- In the bidder list selection process, it is expected that the bidder list has been filtered on the financial capabilities of the bidders and weighted the criteria for determining the bidder list. So it is hoped that the selection process will produce the best vendor according to the company's needs.
- If at another time there are new criteria that are more in line with the vendor selection process, it is expected to be able to re-weight each criteria to be used so that the results of determining the criteria are not more subjective.

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