Application of Analytical Hierarchy Method in Selection of Raw Material Suppliers at PT Integrated Services Claims

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ARTICLE INFO

Article history
Received : 01-03-2024
Revised : 01-04-2024
Accepted : 02-04-2024

Keywords
Supplier Selection;
AHP;
Supplier Criteria;

ABSTRACT

Raw material prices are an important concern for companies in creating cost efficiencies. Price is one of the purchasing considerations, prices that are too low make buyers doubt the quality of goods to make purchases and vice versa, prices that are too expensive make buyers switch to other vendors. PT. Klaai Integrated Services is a company engaged in the catering industry that serves several large companies in Bekasi Regency such as PT. Unilever Indonesia, PT. Astra Honda Motor, PT. Suzuki Indomobil Motor, PT. Kalbe Farma, Tbk, PT. Yasulor Indonesia and others. PT. Integrated Services Claims are very selective in vendor selection. The high frequency of changing vendors every month was allegedly influenced by price differences between several vendors, so the company took the initiative to switch to vendors with more competitive prices. This study aims to determine the priority order of criteria and suppliers to be selected for purchasing raw materials at PT Klaai Jasa Terkomunikasi. This research is a descriptive research with the method approach used, namely descriptive qualitative and quantitative research. Data collection was carried out by observing, interviewing and distributing questionnaires by means of data analysis using the AHP approach. The results of this study indicate that the most influential criteria in the selection of wood suppliers at PT Klaai Jasa TerIntegrated are quality criteria with a weight of 0.486, while for the second priority, namely price criteria with a weight of 0.371, and delivery accuracy is the third priority with a weight of 0.143.

1. INTRODUCTION

Industrial competition does not only occur within the country but also in international industry. Where things that hinder the world's free market have been wide open due to government policies that support export and import activities. Companies must be able to create dynamic strategies or continuously and sustainably to be able to survive amidst competition. The company's challenge is the extent to which it is able to improve its business strategies, to the extent that the company is able to survive.

Companies must be able to produce effectively and efficiently, so that companies implement supply chain management strategies. The benefit of supply chain management is that it ensures the smooth supply of goods starting from the product (manufacturer), vendors, the company itself, wholesalers, retailers, to the end user. The series of journeys from raw materials to finished goods and received by users or customers is the origin of a long chain that needs to be managed well [1]**.**

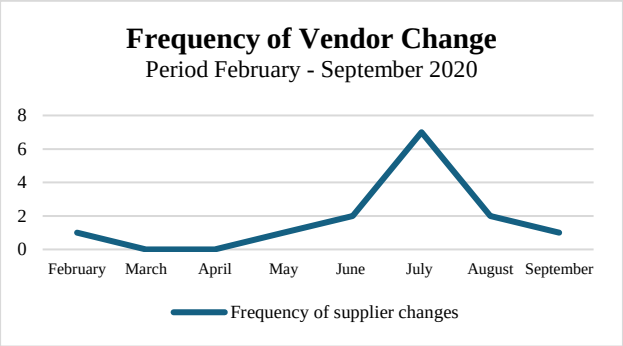
Raw material prices are an important concern for companies in creating cost efficiency. Price is one consideration for purchasing, prices that are too cheap make buyers doubt the quality of the goods to make a purchase and vice versa, prices that are too expensive make buyers switch to other vendors. Therefore, companies must be able to find suppliers who provide competitive prices and standard product quality so that the company's potential to gain profits is much greater.

Several previous studies have examined supplier selection, such as selecting stationery in a bank and selecting truck vendors [2] [3]. These studies used the AHP (Analytical Hierarchy Process) method. The next research is selecting transport suppliers, using the ANP (Analytical Network Process) method

[4], while other research is selecting raw material suppliers for restaurants [5]. using the Fuzzy AHP method.

PT Klaai Jasa Terintegra is a company operating in the industrial catering sector that meets ISO 22000 standards. This company serves several large companies in Bekasi Regency such as PT. Unilever Indonesia, PT. Astra Honda Motor, PT. Suzuki Indomobil Motor, PT Kalbe Farma, Tbk, PT Yasulor Indonesia and others. The number of employees in this company is 150 people with contract and daily status.

PT The Integrated Services Company is very selective in selecting vendors, this can be seen in the graph below:



Picture 1. Substitution Frequency GraphVendors in the period February 2020 to September 2020

From the picture above, it can be seen that vendor changes often occur every month, but in July there was quite a high number of vendor changes, namely 7 times. It is suspected that there is an influence of price differences between several vendors so that companies take the initiative to switch to vendors who have more competitive prices.

Price is one of the factors considered in selecting vendors, PT. Klaai Integrated Services made a change of vendor due to the offer of a new vendor with the same quality but at a cheap price. The following is a comparison table of price differences between vendors A and B:

Table 1. Comparison of Price Differences for Vendors A and B

No.	Name of goods	Vendor A's price		Vendor B's price		Price gap		Daily Request	Total Price Difference	
1	Banana	Rp	1,350	Rp	1,200	Rp	150	3500 pcs	Rp	525,000
2	Cooking oil	Rp	12,700	Rp	11,500	Rp	1,200	160 liter	Rp	192,000
3	Chicken Carcass 1	Rp	28,500	Rp	27,500	Rp	1,000	300 ekor	Rp	300,000
4	Medan Oranges	Rp	15,000	Rp	13,000	Rp	2,000	80 kg	Rp	160,000
5	LPG gas	Rp	145,000	Rp	138,000	Rp	7,000	25 tabung	Rp	175,000
SUB TOTAL									Rp	1,352,000

The table above is a small example of a comparison of price differences from all PT vendors. Integrated Services Class. The price difference between vendor A and vendor B when calculated in one month has quite a large value, namely IDR 1,352,000 x 26 days = IDR. 35,152,000. This price difference is a consideration for the company when selecting a vendor.

Based on the explanation of the problems at PT Klaai Jasa Terintegra, research was carried out regarding the analysis of raw material supplier selection using the Analytical Hierarchy Process (AHP) method. This method is considered appropriate, because this research aims to determine the priority order of criteria and suppliers to be selected when purchasing raw materials at PT Klaai Jasa Terintegra.

2. RESEARCH METHODOLOGY

This research is descriptive research carried out using observations, interviews and distributing questionnaires to explain what actually happened regarding the actual situation in the field. Based on its objectives, this research is descriptive quantitative research, namely research that seeks to describe phenomena that occur in a real, realistic, current, actual and current manner, because this research is to create systematic, factual and accurate descriptions, images or paintings regarding the facts , the properties and relationships between the phenomena being investigated [6]**.**

The data used in this research was obtained from observations, interviews and distributing questionnaires. Determination of the sample in this research was carried out using a purposive sampling technique, where the selection was carried out deliberately based on predetermined criteria and determined based on the research objectives. This is because the AHP method requires reliance on a group of experts according to the type of specialist involved in decision making. Therefore, the respondents in this research are parties who have authority in decision making and employees who receive goods directly from suppliers as well as academics who are experts in this field.

In essence, AHP is a comprehensive decision-making model that takes into account qualitative and quantitative matters [7]**.** The main tool of this model is a functional hierarchy with the main input being human perception.

The procedures or steps in the AHP method include [8]**:**

1. Identify the problem and determine the desired solution, then arrange a hierarchy of the problems faced.
2. Determining element priority:
   a. Make pairwise comparisons, that is, compare elements in pairs according to the given criteria.
   b. The pairwise comparison matrix is filled in using numbers to represent the relative importance of one element to other elements.
3. Synthesis is where considerations from pairwise comparisons are synthesized to obtain overall priorities.
4. Measuring consistency to find out how good the consistency is.
   a. Multiply each value in the first column by the relative priority of the first element, the value in the second column by the relative priority of the second element and so on.
   b. Add up each row.
   c. The result of adding rows is divided by the relative priority element in question.
   d. Add up the quotient above with the number of elements present, the result is called λmax.
5. Calculating Consistency Index CI with the formula:
   $CI = (\lambda max - n) / (n - 1)$ (1)
   With, n = number of elements
6. Calculate the Consistency Ratio (CR) with the formula:
   $$CR = \frac{CI}{IR} \quad (2)$$
   CR = Consistency Ration
   CI = Consistency Index
   IR = Random Consistency Index
7. Checking Hierarchy Consistency

   If the value is more than 10%, then the judgment data assessment must be corrected. However, if the consistency ratio (CI/IR) is less or equal to 0.1, then the calculation results can be declared correct.

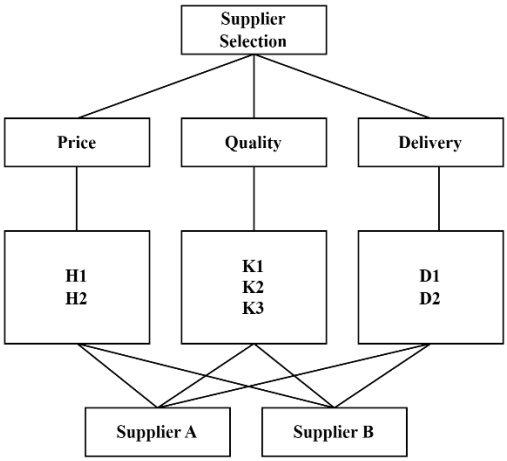
3. RESULT AND DISCUSSION

AHP Analysis Method

1. Hierarchy Arrangement

E ISSN 2621 6462

In the AHP method, the criteria are usually arranged in a hierarchical form. The criteria and sub-criteria in this research are the criteria and sub-criteria used by companies in selecting suppliers, which were obtained from the results of preliminary interviews. The supplier selection problem at PT Klaai Jasa Terintegra is arranged in three hierarchical levels as in Figure IV.1. Level 0 is the goal, namely selecting the best (optimal) supplier, the first level is the criteria for selecting suppliers, level 2 is the sub-criteria which is an elaboration of the first level (criteria), while level 3 is the alternative, which supplier should be chosen.



Picture 2. Hierarchical Structure of PT Klaai Integrated Services Supplier Selection Problems

2. Create A Pairwise Comparison Matrix That Describes The Relative Contribution of The Influence of Each Element to Each Objective of The Criteria At The Level Above It.

a. Pairwise Comparison Matrix for Each Criteria in Supplier Selection at PT Klaai Jasa Terintegra.

Table 2. Pairwise Comparison Matrix of Objectives between Criteria in Selection Suppliers

Criteria	Price	Quality	Delivery Accuracy
Price	1		
Quality		1	
Delivery Accuracy			1

(Source: Primary Data Processed by AHP)

b. Pairwise Comparison Matrix of Subcriteria for Each Criteria in Supplier Selection at PT Klaai Jasa Terintegra.

Table 3. Pairwise Comparison Matrix of Objectives Between Subcriteria in Price Criteria

Subcriteria	Appropriateness of Price to Quality (H1)	Ability to Give Discounts (H2)
Appropriateness Of Price to Quality (H1)	1	
Ability to Give Discounts (H2)		1

(Source: Processed Primary Data)

Table 4. Pairwise Comparison Matrix of Objectives Between Subcriteria in Quality Criteria

Subcriteria	Conformity of Goods to Specified Specifications (Q1)	Provision of Goods Without Defects (Q2)	Ability to Provide Consistent Quality (Q3)
Conformity of Goods to Specified Specifications (Q1)	1		
Provision of Goods Without Defects (Q2)		1	
Ability to Provide Consistent Quality (Q3)			1

(Source: Processed Primary Data)

Table 5. Pairwise Comparison Matrix of Objectives Between Subcriteria in Delivery Accuracy Criteria

Subcriteria	Ability to Deliver Goods According to The Agreed Date (D1)	Ability to Handle Transportation Systems (D2)
Ability to Deliver Goods According to The Agreed Date (D1)	1	
Ability to Handle Transportation Systems (D2)		1

(Source: Processed Primary Data)

c. Alternative Pairwise Comparison Matrix in Supplier Selection.

1) Price Criteria

Table 6. Pairwise Comparison Matrix of Objectives Between Alternatives on the Subcriteria of Price Appropriateness and Good Quality

Alternative	Supplier A	Supplier B
Supplier A	1	
Supplier B		1

(Source: Processed Primary Data)

Table 7. Pairwise Comparison Matrix of Objectives Between Alternatives on the Discount Ability Subcriteria

Alternative	Supplier A	Supplier B
Supplier A	1	
Supplier B		1

(Source: Processed Primary Data)

2) Quality Criteria

Table 8. Pairwise Comparison Matrix Between Alternatives on Subcriteria for Conformity of Goods with Defined Specifications

Alternative	Supplier A	Supplier B
Supplier A	1	

Supplier B	1

(Source: Processed Primary Data)

Table 9. Pairwise Comparison Matrix of Objectives Between Alternatives on the Subcriteria for Providing Goods Without Defects

Alternative	Supplier A	Supplier B
Supplier A	1	
Supplier B		1

(Source: Processed Primary Data)

Table 10. Pairwise Comparison Matrix of Objectives Between Alternatives on the Ability to Provide Consistent Quality Subcriteria

Alternative	Supplier A	Supplier B
Supplier A	1	
Supplier B		1

(Source: Processed Primary Data)

3) Delivery Accuracy Criteria

Table 11. Pairwise Comparison Matrix Between Alternatives on the Sub-Criteria of Ability to Deliver Goods on the Agreed Date

Alternative	Supplier A	Supplier B
Supplier A	1	
Supplier B		1

(Source: Processed Primary Data)

Table 12. Pairwise Comparison Matrix of Objectives Between Alternatives on the Capability Subcriteria in Handling the Transportation System

Alternative	Supplier A	Supplier B
Supplier A	1	
Supplier B		1

(Source: Processed Primary Data)

3. Calculate The Weight/Priority of Importance of Each Variable At Level 1 (Criteria), Namely Price, Quality, Service, Accuracy Of Delivery, and Accuracy of Quantity.

Table 13. Assessment of Priority Importance of Criteria in Supplier Selection

Criteria	Price	Quality	Delivery Accuracy
Price	1	0,357	4,336
Quality	2,801	1	5,441
Delivery Accuracy	0,231	0,184	1

(Source: AHP Processing Results)

From the results of pairwise comparison calculations between variables in selecting suppliers above, the weights shown in the following table are obtained.

Table 14. Priority of Importance (Weight) Criteria in Supplier Selection

Criteria	Bobot	Priority
Price	0,277	II
Quality	0,486	II
Delivery Accuracy	0,237	III

(Source: AHP Processing Results)

The table above shows that in selecting raw material suppliers, PT Klaai Integrated Services' first priority is quality criteria with a weight of 0.486, then the second priority is price criteria with a weight of 0.277, the next priority is delivery accuracy, namely 0.237.

4. Calculate The Importance Weight/Priority of Each Variable at Level 2 (Subcriteria)

a. Price Criteria

Table 15. Priority Assessment of the Importance of sub-criteria in Price Criteria in Supplier Selection

Subcriteria	Appropriateness of Price to Quality (H1)	Ability to Give Discounts (H2)
Appropriateness of Price to Quality (H1)	1	1,723
Ability to Give Discounts (H2)	0,581	1

(Source: AHP Processing Results)

From the results of pairwise comparison calculations between variables in the price criteria above, the weights shown in the following table are obtained:

Table 16. Priority of Importance (Weight) of Subcriteria in Price Criteria in Supplier Selection

Subcriteria	Bobot	Priority
Appropriateness of Price to Quality (H1)	0,633	I
Ability to Give Discounts (H2)	0,367	II

(Source: AHP Processing Results)

b. Quality Criteria

Table 17. Priority Assessment of Subcriteria Importance in Criteria in Supplier Selection

Subcriteria	Conformity of Goods to Specified Specifications (Q1)	Provision of Goods Without Defects (Q2)	Ability to Provide Consistent Quality (Q3)

Conformity of Goods to Specified Specifications (Q1)	1	0,504	0,730
Provision of Goods Without Defects (Q2)	1,982	1	1,575
Ability to Provide Consistent Quality (Q3)	1,369	0,635	1

(Source: AHP Processing Results)

Table 18. Priority of Importance (Weight) of Subcriteria in Quality Criteria in Supplier Selection

Subcriteria	Bobot	Priority
Conformity of Goods to Specified Specifications (Q1)	0,229	III
Provision of Goods Without Defects (Q2)	0,466	I
Ability to Provide Consistent Quality (Q3)	0,305	II

(Source: AHP Processing Results)

c. Delivery Accuracy Criteria

Table 19. Assessment of Priority Importance of Subcriteria in Delivery Accuracy Criteria in Supplier Selection

Subcriteria	Ability to Deliver Goods According to The Agreed Date (D1)	Ability to Handle Transportation Systems (D2)
Ability to Deliver Goods According to The Agreed Date (D1)	1	2,826
Ability to Handle Transportation Systems (D2)	0,354	1

(Source: AHP Processing Results)

Table 20. Priority of Importance (Weight) of Subcriteria in Delivery Accuracy Criteria in Supplier Selection

Subcriteria	Bobot	Priority
Conformity of Goods to Specified Specifications (Q1)	0,739	I
Provision of Goods Without Defects (Q2)	0,261	II

(Source: AHP Processing Results)

5. Calculate The Weight/Priority of Each Variable At Level 3 (Alternative), Namely The Weight of Each Supplier Compared to Each Sub-Criteria

a. Price Criteria

1) Subcriteria for Price Appropriateness with Quality (H1)

Table 21. Priority Assessment of Alternative Interests on the Suitability of Price and Quality Subcriteria

Alternative	Supplier A	Supplier B
Supplier A	1	3,173
Supplier B	0,315	1

(Source: AHP Processing Results)

From the results of pairwise comparison calculations between variables in the sub-criteria of appropriateness of price and quality above, the weights shown in the following table are obtained:

Table 22. Priority of Importance (Weight) of Alternatives in the Suitability of Price and Quality Subcriteria

Alternative	Bobot	Priority
Supplier A	0,603	I
Supplier B	0,397	II

(Source: AHP Processing Results)

The table above shows that in the sub-criteria of price appropriateness to quality (H1), supplier A is the supplier that best meets this sub-criterion with a weight of 0.603. Next is supplier B, namely 0.397.

2) Subcritieria Ability to Provide Discounts (Discounts) on Orders of a Certain Quantity (H2)

Table 23. Assessment of Priority of Alternative Interests on the Ability to Provide Discount Subcriteria

Alternative	Supplier A	Supplier B
Supplier A	1	2,188
Supplier B	0,457	1

(Source: AHP Processing Results)

From the results of calculating pairwise comparisons between variables in the sub-criteria for the ability to provide discounts above, the weights shown in the following table are obtained:

Table 24. Priority of Importance (Weight) of Alternatives in the Ability to Provide Discount Subcriteria

Alternative	Bobot	Priority
Supplier A	0,477	II
Supplier B	0,523	I

(Source: AHP Processing Results)

The table above shows that in the sub-criterion of ability to provide discounts (H2), supplier B best meets this sub-criterion with a weight of 0.523. The next priority in this sub-criterion is supplier B with a weight value of 0.477.

b. Quality Criteria

1) Subcriteria for Conformity of Goods with Established Specifications (Q1)

Table 25. Priority assessment of alternative interests based on sub-criteria for conformity of goods with specified specifications

Alternative	Supplier A	Supplier B
Supplier A	1	0,615
Supplier B	1,626	1

(Source: AHP Processing Results)

From the results of calculating pairwise comparisons between variables in the sub-criteria for conformity of goods with the specifications set out above, the weights shown in the following table are obtained:

Table 26. Priority of Importance (Weight) of Alternatives in Sub-Criteria for Conformity of Goods with Established Specifications

Alternative	Bobot	Priority
Supplier A	0,445	II
Supplier B	0,555	I

(Source: AHP Processing Results)

The table above shows that in the sub-criteria for conformity of goods with specified specifications (Q1), supplier B best meets this sub-criterion with a weight value of 0.555. The next priority is supplier Y with a weight value of 0.455.

2) Subcriteria for Providing Goods Without Defects (Q2)

Table 27. Priority Assessment of Alternative Interests in the Subcriteria for Providing Goods Without Defects

Alternative	Supplier A	Supplier B
Supplier A	1	3,891
Supplier B	0,257	1

(Source: AHP Processing Results)

From the results of calculating pairwise comparisons between variables in the sub-criteria for providing goods without defects above, the weights shown in the following table are obtained:

Table 28. Priority of Importance (Weight) of Alternatives in the Subcriteria for Providing Goods Without Defects

Alternative	Bobot	Priority
Supplier A	0,662	I
Supplier B	0,338	II

(Source: AHP Processing Results)

The table above shows that supplier A with a weight of 0.662 is the supplier that best meets the sub-criteria for providing goods without defects (Q2). Meanwhile, supplier B is the next priority with the same weight value, namely 0.338.

3) Subcriteria Ability to Provide Consistent Quality (Q3)

Table 29. Priority Assessment of Alternative Interests on the Ability to Provide Consistent Quality Subcriteria

Alternative	Supplier A	Supplier B
Supplier A	1	4,254
Supplier B	0,235	1

(Source: AHP Processing Results)

Table 30. Priority of Importance (Weight) of Alternatives in the Ability to Provide Consistent Quality Subcriteria

Alternative	Bobot	Priority
Supplier A	0,586	I
Supplier B	0,414	II

(Source: AHP Processing Results)

c. Delivery Accuracy Criteria

1) Subcriteria Ability to Send Goods According to the Agreed Date (D1)

Table 31. Priority Assessment of Alternative Interests in the Sub-criterion of Ability to Deliver Goods according to the Agreed Date

Alternative	Supplier A	Supplier B
Supplier A	1	2,712
Supplier B	0,369	1

(Source: AHP Processing Results)

Table 32. Priority of Importance (Weight) of Alternatives in the Subcriteria Ability to Deliver Goods according to the Agreed Date

Alternative	Bobot	Priority
Supplier A	0,585	I
Supplier B	0,415	II

(Source: AHP Processing Results)

2) Subcriteria for Capability in Handling Transportation Systems (D2)

Table 33. Priority Assessment of Alternative Interests on Capability Subcriteria for Handling Transportation Systems

Alternative	Supplier A	Supplier B
Supplier A	1	0,590
Supplier B	1,694	1

(Source: AHP Processing Results)

Table 34. Alternative Importance Priorities (Weights) in Capability Subcriteria in Terms of Handling Transportation Systems

Alternative	Bobot	Priority

Supplier A	0,477	II
Supplier B	0,523	I

(Source: AHP Processing Results)

6. Choosing the Optimal Supplier

Table 35. Global Priority (Global Priority)

Level 0	Level 1	Level 2	Bobot	Alternative	Bobot
Choosing The Optimal Supplier (Best Supplier)	Price (0,277)	H1	0,175	Supplier A	0,105
				Suppier B	0,035
		H2	0,102	Supplier A	0,033
				Suppier B	0,016
	Quality (0,486)	Q1	0,111	Supplier A	0,024
				Suppier B	0,037
		Q2	0,226	Supplier A	0,150
				Suppier B	0,038
		Q3	0,148	Supplier A	0,072
				Supplier B	0,018
	Delivery Accuracy (0,073)	D1	0,054	Supplier A	0,015
				Supplier B	0,007
		D2	0,019	Supplier A	0,005
				Supplier B	0,008

(Source: AHP Processing Results)

Table 36. Global Priority (Global Priority)

Alternative	Bobot	Priority
Supplier A	0,567	I
Supplier B	0,433	II

(Source: AHP Processing Results)

Table 37. WeightAlternative (Supplier) Relating to Criteria

Criteria	Supplier A	Supplier B
Price	0,590	0,410
Quality	0,579	0,421
Delivery Accuracy	0,466	0,524

(Source: Processed Primary Data)

7. Consistency

With the AHP model which uses human perception as input, inconsistencies may occur because humans have limitations in expressing their perceptions consistently, especially if they have to compare many criteria. Based on this condition, humans can state whether their perceptions will be consistent in the future or not.

This consistency measurement is intended to see the inconsistency of the responses given by respondents. If CR < 0.1 then the pairwise comparison values in the given criterion matrix are consistent. If CR > 0.1 then the pairwise comparison values in the given criteria matrix are inconsistent. So if it is not consistent, then filling in the values in the pairwise matrix for the criteria and alternative elements must be repeated. The following table shows the consistency ratio (CR) values from respondents' assessments:

Table 38. Consistency Ratio (CR) of Respondents' Assessments

Pairwise Comparison	CR	Information
Between criteria (level 1)	0,02	Consistent
Between price subcriteria	0,00	Consistent
between quality subcriteria	0,00	Consistent
between service subcriteria	0,02	Consistent
between sub-criteria of delivery accuracy	0,00	Consistent
between alternatives to subcriteria H1	0,00	Consistent
between alternatives to subcriteria H2	0,00	Consistent
between alternatives to subcriterion Q1	0,00	Consistent
between alternatives to subcriterion Q2	0,00	Consistent
between alternatives to subcriterion Q3	0,01	Consistent
between alternatives to subcriterion D1	0,03	Consistent
between alternatives to subcriterion D2	0,00	Consistent

(Source: AHP Processing Results)

The table above shows that all respondent's assessments are consistent, and do not need to be repeated.

4. Conlusion

Based on the research objectives and research results above, the following can be concluded:

The most influential criterion in selecting a wood supplier at PT Klaai Jasa Terintegra is the quality criterion with a weight of 0.486. The second influential priority is the price criterion with a weight of 0.371, and delivery accuracy is the third priority with a weight of 0.143.

Global priority (global priority) sub-criteria in selecting suppliers sequentially from first priority to last priority are as follows: subcriteria provision of goods without defects (Q2) with a weight of 0.226; sub-criteria of price appropriateness to the quality of goods produced (H1) with a weight of 0.175; sub-criteria of ability to provide consistent quality (Q3) with a weight of 0.148; sub-criteria for conformity of goods with specified specifications (Q1) with a weight of 0.111; sub-criteria of ability to provide discounts (H2) with a weight of 0.102; sub-criteria for the ability to deliver goods according to the agreed date (D1) with a weight of 0.054; sub-criteria for ability to handle the transportation system (D2) with a weight of 0.019.

Based on quality and price criteria, supplier A occupies first priority with a weight value of 0.590 for quality and 0.579 for quality. Meanwhile, supplier B only excels in delivery accuracy with a weight of 0.524.

Based on the criteria and sub-criteria in supplier selection, overall supplier A is rated as the best supplier with a weight value of 0.567. Next is supplier B with a weight value of 0.433. This shows that overall the best supplier of raw materials for the company to serve as a long-term partner/partner is supplier A because overall this supplier has the highest value compared to supplier B.

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