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Analysis of Supplier Selection Using The Analytical Hierarchy Process Method (Case Study at PT. Seaport Services Indonesia)

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ABSTRACT

Suppliers in the manufacturing industry have an important role because they determine product quality. Supplier selection is necessary so that the services produced are of quality according to the standards determined by the company. If the supplier's quality does not meet the criteria, it will cause several obstacles in the operational process. So, this research aims to find the best suppliers with priority criteria according to PT standards. Seaport Services Indonesia. The population in this study is marine engine suppliers owned by PT. Seaport Services Indonesia. The samples are from 3 marine engine suppliers who provide seawage at PT. Seaport Services Indonesia. The sampling technique uses Purposive Sampling. The analysis results show that the best supplier for PT. Seaport Services Indonesia is Supplier B with the highest weight compared to the other two suppliers. The priority criterion is Flexibility.

INTRODUCTION

Purchasing is defined as an effort to meet the company's needs for goods and services required by the company, received on time with appropriate quality and profitable prices (Suarsana, 2007). In order for supplies to be fulfilled by getting suppliers that match what is needed, it is necessary to determine various considerations as a reference in selecting the right supplier (Kho, 2017). This explains that choosing a supplier must support business and operational processes within the company. Choosing a supplier that is outside the company's criteria will have a positive impact on operational activities within the company. Decreased operational activities can affect the service provided by the company.

Choosing a supplier that meets the company's criteria will help operational activities. Decreased operational activities can affect the service provided by the company. Things like this

can be minimized using a particular assessment system that assesses the capabilities of prospective suppliers who will collaborate with the company.

PT. Seaport Services Indonesia is a company engaged in the service sector which started operating in May 2015. The company's main business activities are procuring goods and services for marine engines and ships. The company is positioned as a contractor that provides goods related to marine and services capable of servicing ships from suppliers who work with the company to the user. PT. Seaport Services has suppliers who supply the goods needed for the procurement and needs of goods in the ship servicing process.

PT. Seaport Services Indonesia experienced several problems in project work, such as unfulfilled supplies, late deliveries, and deliveries. The company itself has not determined the criteria for selecting suppliers and has not conducted an analysis. In achieving focus in the purchasing process to meet supplies, one is getting a supplier that suits the company's needs by setting various considerations as a reference in selecting the right supplier (Kho, 2017). Therefore, choosing a supplier with capabilities that can support business and operational processes within the company is a problem. With the benefits of the Analytical Hierarchy Process or AHP, companies can analyze suppliers to get the best suppliers with specified criteria for consideration (Darmanto, 2014).

Purchasing is one of the most critical functions in successful operations in a company. With this purchasing activity, the quantity and quality of materials must be obtained at the time needed at a price that follows the prevailing Price (Assauri, 2016). Achieving focus in the purchasing process so that supplies can be met is getting a supplier that suits the company's needs by setting various considerations as a reference in selecting the right supplier (Kho, 2017).

A supplier is a company or individual whose activities are to provide the resources the company needs to produce goods or services. In deciding to purchase goods or services that will be resold, it is necessary to select a quality supplier. Companies will look for suppliers with quality and efficiency that can be maintained because supplier development has an essential influence on the implementation of marketing within a company (Fauzi, 2016).

Choosing the right supplier is crucial, with wide-ranging implications in the supply chain. Suppliers play an essential role in the supply chain. Because of this, strategic relationships with suppliers with good performance must exist in the supply chain. Suppliers need to be evaluated with several criteria. Supplier selection is essential in choosing a complete strategy (Omadevi et al., 2012).

Analytical Hierarchy Process (AHP) is a concept for making decisions on a multicriteria basis (many criteria). Several criteria compared with each other (level of importance) are the main emphasis of the AHP concept (Nugeraha, 2017). AHP is included in the decision method with many criteria, which has been a reference for various industries for almost two decades (Darro et al., 2018).

The AHP survey was conducted to strengthen qualitative findings by determining priority burdens (Ho et al., 2016). The advantage of using AHP is that the assessment is consistent. The level of inconsistency and acceptable level of inconsistency can be measured with AHP (Matthew & Robert, 2007).

AHP provides a comprehensive and rational framework for creating decision structures, describing elements, connecting elements with goals, and evaluating alternative solutions (Alireza, 2013).

Table 1 Supplier selection criteria according to TY Choi and JL Hartley

Categories	***Criteria***
Finances	*Financial conditions Profitability* *Financial Information availability* *Performance awards*
Consistency	*Product Conformity* *Consistent Delivery Times* *Quality Philosophy* *Response times*
Relations Capacity	*Long-term relations* *Closeness in relations* *Openness in communication* *Reputation*
Flexibility	*Changes in production volumes* *Reduction of equipping times reduction of delivery times* *Resolutions of conflicts*
Technological Capabilities	*Design Capabilities* *Technical Capabilities*
Services	*Post-sales assistance* *Sales representative competence*
Reliability	*Incremental improvements* *Product reliability*
Price	*initial Price*

Source: (Ghianni et al., 2013)

According to Sudaryono (2010), when solving problems using the Analytical Hierarchy Process (AHP) method, several basic concepts need to be understood, including:

1. Create a hierarchical system that is complex and understandable by breaking it down into supporting elements, arranging these elements hierarchically, and combining them.
2. Pairwise comparisons assess criteria and alternatives. For various issues, 1 to 9 is the best scale for interpreting opinions (Saaty, 2008).
3. Priority is determined for each criterion, and alternative pairwise comparisons must be made. The relative comparative values of all alternative criteria can be adjusted to the judgment that has been determined to determine weights and priorities. Weights and priorities are calculated by solving mathematical equations.
4. Logical Consistency has two meanings. First, similar objects can be grouped according to uniformity and relevance. They were second, transporting the level of Relationship between objects based on specific criteria.

The following are the steps in the Analytical Hierarchy Process (AHP) method according to Kursini (2007):

1. Identify existing problems and determine the desired solution, then arrange a hierarchy of existing problems.
2. First, determine the priority of the elements by making pairwise comparisons, namely comparing elements in pairs according to the given criteria. Second, the pairwise comparison matrix is assessed (providing judgment), which is carried out using numbers from 1 to 9 to represent the relative importance of an element to other elements.
3. Synthesis

Considerations of pairwise comparisons are synthesized to obtain overall priorities. The things to do in this third step are:

a. Add up the values from each column in the existing matrix.
b. Divide each column value by the number of pools to obtain the normalization matrix.
c. Add up the values from each row and divide by the number of elements to get the average value.

4. Measuring Consistency
   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 row sum result is divided by the relative priority elements.
   d. Add the quotient to the number of elements present; the result is called max.
5. Calculate Consistency Index (CI)

$$CI = (\lambda max - n)/n$$

Where :

n = number of elements.

6. Calculate Consistency Ratio (CR)

$$CR = CI/RI$$

Where :

CR = Consistency Ratio

CI = Consistency Index

RI = Random Consistency Index

7. Check the Consistency of the hierarchy. If the value is more than 10% or 0.1, then the assessment data judgment (assessment) must be corrected. The calculated results can be declared correct if the Consistency Ratio is less or equal to 0.1.

A list of Random Consistency Index (RI) to see the values can be seen in the following Table 2:

Table 2 List of Random Consistency Index

Matrix Size	IR value
1,2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49
11	1.51
12	1.48
13	1.56
14	1.57
15	1.59

Source: Saaty and Tran (2007)

RESEARCH METHOD

Data collection technique

The data collection techniques in this research are primary data and secondary data. Primary data is data obtained directly from informants or main sources closely related to the central theme of the problem in the research. Researchers can make direct observations or observations, conduct interviews, or give questionnaires to obtain primary data. In this study, primary data was obtained through observation, interviews with the Main Director, and filling out questionnaires by Directors, Managers, and Chief Technicians at PT. Seaport Services Indonesia. Secondary data is data that is indirectly obtained because data is available, which supports primary data to obtain research results. Secondary data is usually displayed in the form of tables and diagrams. This data can be obtained from company documents or literature. In this study, secondary data can be in documents regarding suppliers and literature related to supplier selection.

Data analysis techniques

The data analysis used in this research is the Analytical Hierarchy Process (AHP) method using an application called Expert Choice. Expert Choice can facilitate the analysis of priority (selected) suppliers by entering the criteria, suppliers, and pair comparison results that have been filled in in the questionnaire. Expert Choice can display the results of the analysis of the questionnaire results filled in on comparing criteria and suppliers. Starting from the weighting results, the level of Consistency of the weighting to the results of prioritized suppliers (selected suppliers).

The following are the steps in solving problems using the Analytical Hierarchy Process (AHP) method:

1. Questionnaire filling
   Respondents filled out the questionnaire to find out the assessment, the results of which would be used to weigh criteria and suppliers.
2. Carry out weighting of the criteria.
   Criteria weighting is done with the aim that the value of each criterion can be known and performed as pairwise comparison values.
3. Carrying out supplier weighting
   Supplier weighting is carried out to know the value of each supplier, which will be carried out as a comparison value of one supplier with another supplier.
4. Selection Criteria & Priority Suppliers
   Priority Criteria & Supplier for selected companies.

Assumptions in the Analytical Hierarchy Process (AHP):

1. The minimum number of respondents is two.
2. Respondents are influential people in policy.
3. A pair comparison in the Analytical Hierarchy Process (AHP) is said to be consistent if the pair comparison value is not more than 0.1 (10%).

RESULTS AND DISCUSSION

Data Collection and Processing

In this study, data on the number of suppliers used by the research object was obtained by conducting interviews with interested parties to determine suppliers within the company. Data for processing in determining priority criteria and priority suppliers (selected) are taken using a questionnaire by providing an assessment of the level of importance using the Saaty pair comparison scale, which has a score from 1 to 9. The questionnaire is filled out by three people who have an interest in making supplier decisions within the company, namely the Director, Deputy Director, and Chief Engineer.

Weighting using the AHP (Analytical Hierarchy Process) Method

Hierarchy Arrangement

Establishing a hierarchy is the first stage in weighting values using the AHP method. The purpose of compiling a hierarchy is to explain the problem in a structured way and to make it easy to understand. The following is a hierarchical structure for this study.

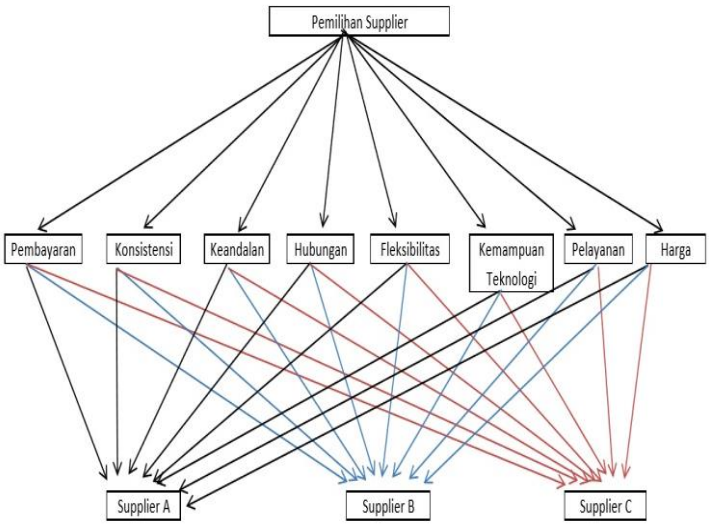
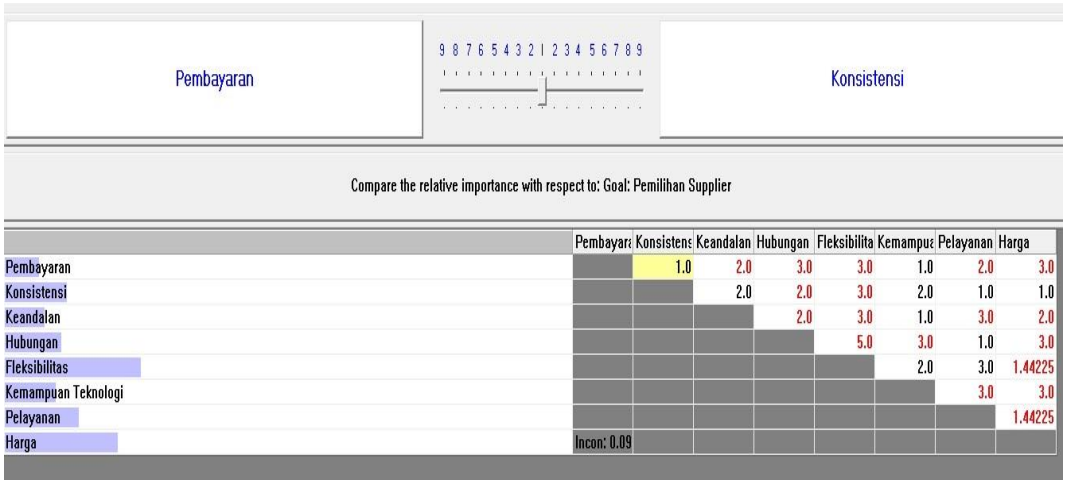


Figure 1 Hierarchy Structure

Weighting Between Criteria

At this stage, the weighting is done in pairwise comparisons between criteria. The numbers in the questionnaire filled in by three respondents were input into the Expert Choice application. The following results from a pairwise comparison of criteria using the Expert Choice application.

Figure 2 Results of Pair Comparisons between Criteria



	Pembayar	Konsisten	Keandalan	Hubungan	Fleksibilita	Kemampua	Pelayanan	Harga
Pembayaran		1.0	2.0	3.0	3.0	1.0	2.0	3.0
Konsistensi			2.0	2.0	3.0	2.0	1.0	1.0
Keandalan				2.0	3.0	1.0	3.0	2.0
Hubungan					5.0	3.0	1.0	3.0
Fleksibilitas						2.0	3.0	1.44225
Kemampuan Teknologi							3.0	3.0
Pelayanan								1.44225
Harga	Incon: 0.09							

(Source: Processed data, 2019)

Information :

a. Black numbers indicate that the first criterion (decreasing) scores higher than the second criterion (even).
b. The red numbers indicate that the second criterion (even) scores higher than the first (declining) criterion.

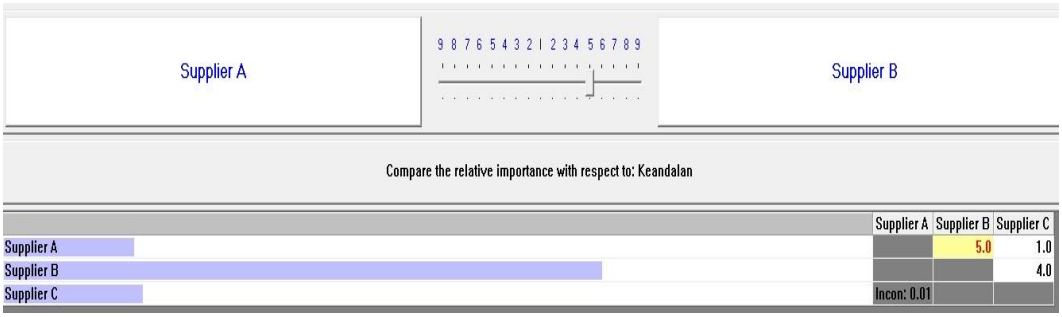
With these results, it can be concluded that the pairwise comparison assessment given by the three respondents has valueIncon/Consistency Ratio, which is smaller than 0.10 as the maximum limit of the Inconsistency Ratio value, with Flexibility selected as the priority criterion.

Based on Figure 2, it can be seen that the Incon/Consistency Ratio value is 0.09. This value is less than 0.10. With the results obtained after the data value comparison of the criteria pair is carried out, the calculation results can be consistent.

Supplier Selection Assessment Weighting Based on Each Criterion

At this stage, weighting is carried out in pairwise comparisons in assessing suppliers based on each criterion. The numbers filled in in the questionnaire, which three respondents have filled in, are input into the Expert Choice application. The following are the results of a pairwise comparison of criteria using the Expert Choice application.

Figure 3 Supplier Assessment According To Payment Criteria



(Source: Processed data, 2019)

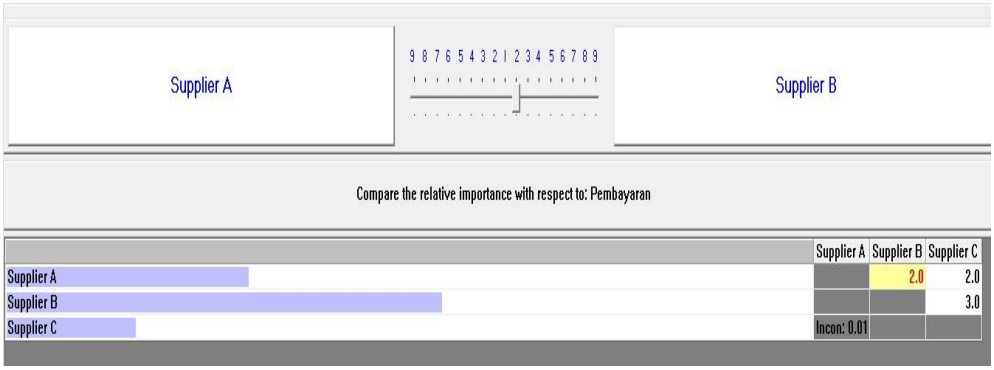
Information :

a. The black number shows that the first supplier (descending) scores higher than the second criterion (horizontal).
b. The red numbers show that the second supplier (even) scores higher than the first criterion (decreases).

With these results, it can be concluded that the pairwise comparison assessment given by the three respondents has a value*Incon/Consistency Ratio*, which is smaller than 0.10 as the maximum limit of the Incon/Consistency Ratio value. Supplier B was selected as the best supplier in the Payment criteria

Based on Figure 3, it can be seen that the value *icon/Consistency ratio* is 0.01. This value is less than 0.10. With the results obtained after comparing supplier pair value data is done, the calculation results are consistent

Figure 4 Supplier Assessment According to Consistency Criteria



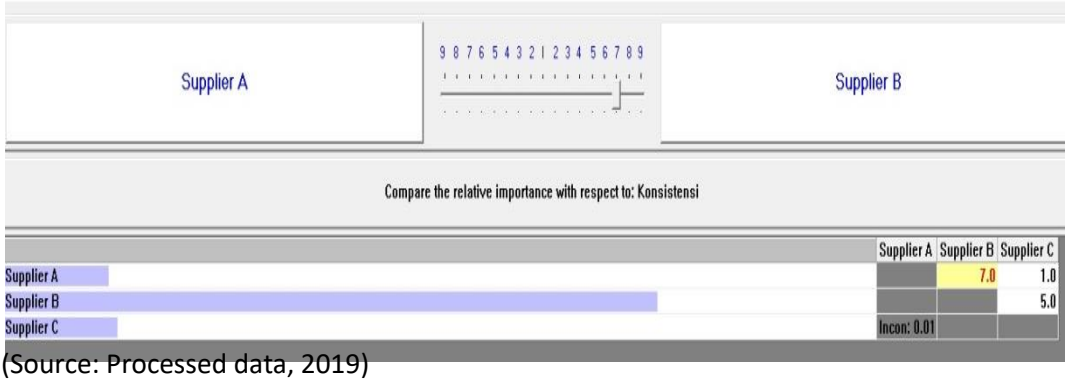
(Source: Processed data, 2019)

Information :

a. The black number shows that the first supplier (descending) scores higher than the second criterion (horizontal).
b. The red numbers show that the second supplier (even) scores higher than the first criterion (decreases).

With these results, it can be concluded that the pairwise comparison assessment given by the three respondents has a value *icon/Consistency Ratio*, which is smaller than 0.10 as the maximum limit of the Inconsistency Ratio value. Supplier B was selected as the best supplier in the Consistency criteria. Based on Figure 4, the value can be seen *as/Consistency* ratio of 0.01. This value is less than 0.10. With the results obtained after comparing supplier pair value data, the calculation results can be consistent.

Figure 5 Supplier assessment according to Reliability criteria



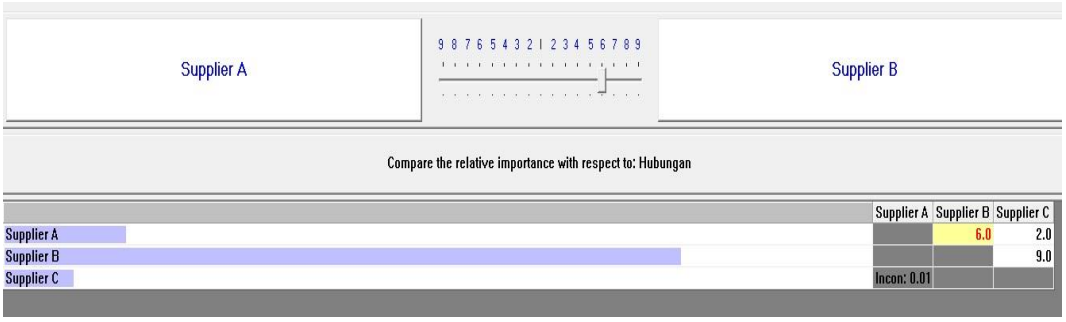
(Source: Processed data, 2019)

Information:

a. The black number shows that the first supplier (descending) scores higher than the second criterion (horizontal).
b. The red numbers show that the second supplier (even) scores higher than the first criterion (decreases).

With these results, it can be concluded that the pairwise comparison assessment given by the three respondents has a value*Incon/Consistency Ratio*, which is smaller than 0.10 as the maximum limit of the Incon/Consistency Ratio value. Supplier B was selected as the best supplier in the Reliability criteria. Based on Figure 5, it can be seen that the value icon*/Consistency ratio* is 0.01. This value is less than 0.10. With the results obtained after comparing supplier pair value data, the calculation results can be consistent.

Figure 6 Supplier assessment according to Relationship criteria



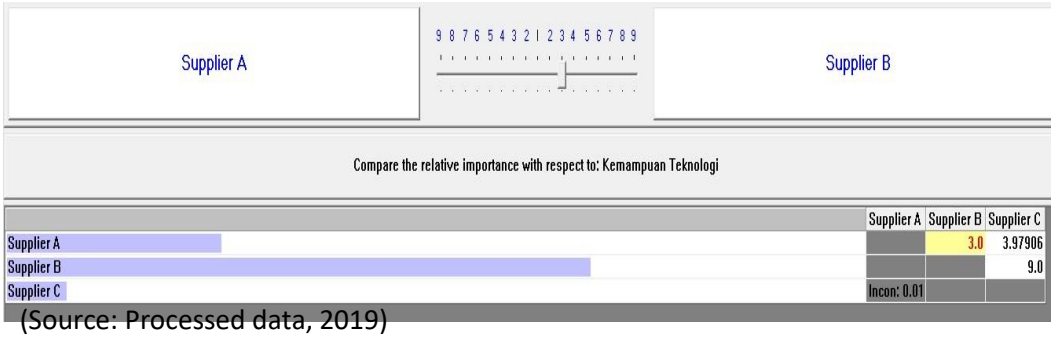
(Source: Processed data, 2019)

Information :

a. The black number shows that the first supplier (descending) scores higher than the second criterion (horizontal).
b. The red numbers show that the second supplier (even) scores higher than the first criterion (decreases).

With these results, it can be concluded that the pairwise comparison assessment given by the three respondents has a value*Incon/Consistency Ratio*, which is smaller than 0.10 as the maximum limit of the Incon/Consistency Ratio value. Supplier B was selected as the best supplier in the Relationship criteria. Based on Figure 6, the value can be seen *as/Consistency* ratio of 0.01. This value is less than 0.10. With the results obtained after comparing supplier pair value data, the calculation results can be consistent.

Figure 7 Supplier assessment according to Flexibility criteria



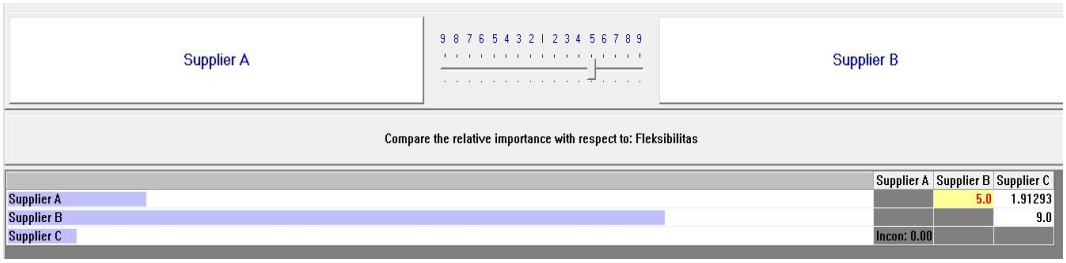
(Source: Processed data, 2019)

Information :

a. The black number shows that the first supplier (descending) scores higher than the second criterion (horizontal).
b. The red numbers show that the second supplier (even) scores higher than the first criterion (decreases).

With these results, it can be concluded that the pairwise comparison assessment given by the three respondents has a value *icon/Consistency Ratio*, which is smaller than 0.10 as the maximum limit of the Inconsistency Ratio value. Supplier B was selected as the best supplier in the Flexibility criteria. Based on Figure 7, the value can be seen *as/Consistency* ratio of 0.00039. This value is less than 0.10. With the results obtained after the comparison value data for supplier pairs is carried out, the calculation results can be consistent.

Figure 8 Supplier Assessment According to Technology Capability Criteria



(Source: Processed data, 2019)

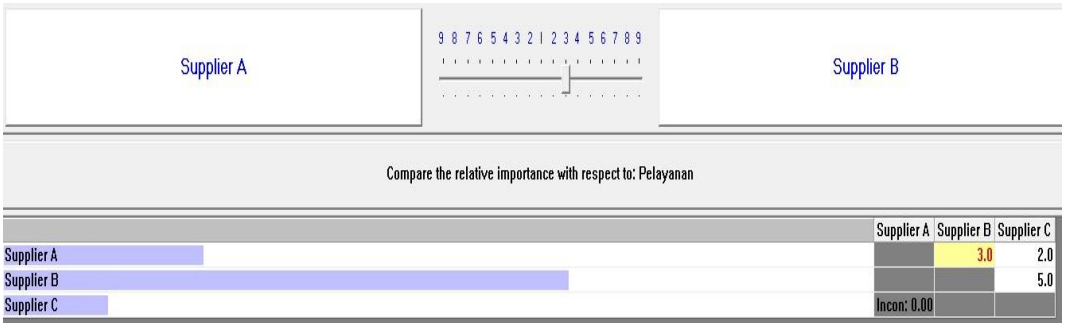
Information :

a. The black number shows that the first supplier (descending) scores higher than the second criterion (horizontal).

b. The red numbers show that the second supplier (even) scores higher than the first criterion (decreases).

With these results, it can be concluded that the pairwise comparison assessment given by the three respondents has a value*Incon/Consistency Ratio*, which is smaller than 0.10 as the maximum limit of the Incon/Consistency Ratio value. Supplier B was selected as the best supplier in the Technology Capability criteria. Based on Figure 8, it can be seen that the value*/Consistency ratio* is 0.01. This value is more than 0.10. With the results obtained after the supplier pair comparison value data was carried out, the calculation results are inconsistent. This happened due to a neutral assessment from one of the respondents.

Figure 9 Supplier Assessment According to Service Criteria



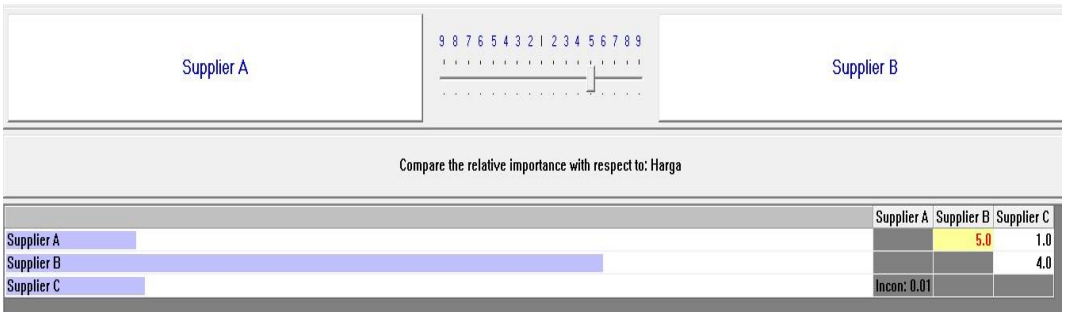
(Source: Processed data, 2019)

Information :

a. The black number shows that the first supplier (descending) scores higher than the second criterion (horizontal).
b. The red numbers show that the second supplier (even) scores higher than the first criterion (decreases).

With these results, it can be concluded that the pairwise comparison assessment given by the three respondents has a value *icon/Consistency Ratio*, which is smaller than 0.10 as the maximum limit of the Inconsistency Ratio value. Supplier B was selected as the best supplier in the Service criteria. Based on Figure 9, it can be seen that the Incon/Consistency Ratio value is 0.00352. This value is less than 0.10. With the results obtained after the pair comparison value data *suppliers* are done, the calculation results are consistent.

Figure 10 Supplier Assessment According to Price Criteria



(Source: Processed data, 2019)

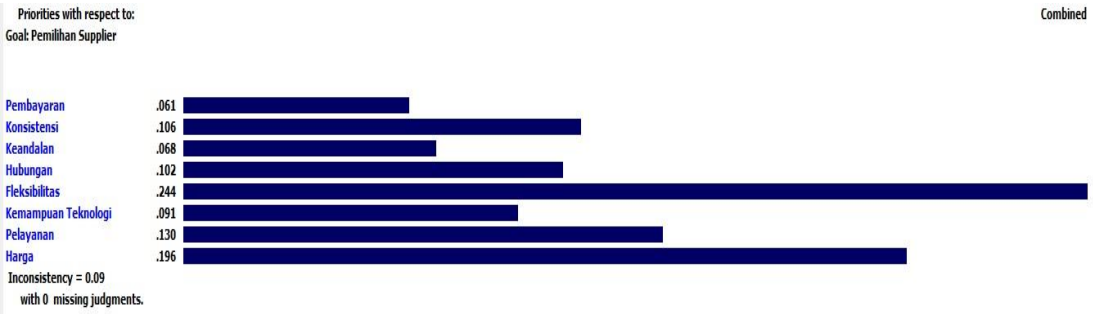
Information:

a. The black number shows that the first supplier (descending) scores higher than the second criterion (horizontal).
b. The red numbers show that the second supplier (even) scores higher than the first criterion (decreases).

With these results, it can be concluded that the pairwise comparison assessment given by the three respondents has a value *icon/Consistency Ratio*, which is smaller than 0.10 as the maximum limit of the Inconsistency Ratio value. Supplier B was selected as the best supplier in the price criteria. Based on Figure 10, the value can be seen *as/Consistency* ratio of 0.01. This value is less than 0.10. With the results obtained after comparing supplier pair value data, the calculation results can be consistent.

Selection of Priority Criteria

Figure 11 Priority Criteria



(Source: Processed data, 2019)

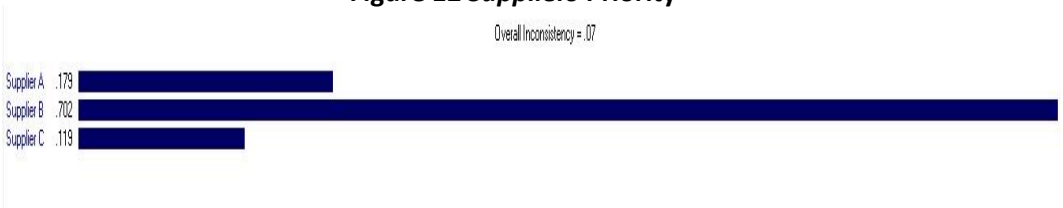
Based on Figure 11, it can be concluded that the results of data processing obtained from the results of the selected priority criteria questionnaire are Flexibility, which has the highest weight. Based on the priority ranking, the highest weighting criteria is Flexibility with a value of 0.244, followed by Price with a value of 0.196, Service with a value of 0.130, Consistency with a value of 0.106, Relationship with a value of 0.102, Technological Capability with a weight of 0.017, Reliability with a value of 0.068. At the same time, the last is a payment with a value of 0.061. The assessment carried out has an Incon/Consistency Ratio value smaller than 0.10 as the maximum limit for the Incon/Consistency Ratio value. Based on Figure 11, it can be seen that the Incon/Consistency Ratio value is 0.09. This value is less than 0.10.

Table 2 Tabulation of the best suppliers on each criterion

Kritera	Supplier Terpilih
Pembayaran	Supplier B
Konsistensi	Supplier B
Keandalan	Supplier B
Hubungan	Supplier B
Fleksibilitas	Supplier B
Kemampuan Teknologi	Supplier B
Pelayanan	Supplier B
Harga	Supplier B

Priority Supplier Selection

Figure 12 *Suppliers* Priority



(Source: Processed data, 2019)

Based on Figure 12, it can be concluded that from the data processing results obtained from the questionnaire results, the selected priority supplier is Supplier B, which has the highest weight. Based on the priority ranking, the highest supplier weight belongs to Supplier B, with a value of 0.702, followed by Supplier A, with a value of 0.179, and Supplier C, with a value of 0.119. The value of priority suppliers is consistent because the value*/Consistency ratio* is 0.07. This value is less than 0.10. With the results obtained after comparing supplier pair value data, the calculation results can be consistent.

The results of data analysis, pair comparison assessment, and consistency test of at most 0.1 have fulfilled what has been stipulated in the calculation*Analytical Hierarchy Process*(AHP) by Saaty. Saaty stipulates that a comparison matrix is consistent if the value of CR is not more than 0.1 (10%) (Adam et al., 2012).

According to Budi Kho (2017), to achieve a focus on purchasing so that supply can be fulfilled, one of them is to choose suppliers that the company needs by setting various considerations or criteria as a reference in selecting the right supplier. Decision-making can be done with the AHP method, which has a concept based on criteria (Nugeraha, 2017). Selection of the best supplier, namely supplier B, can be decided based on the criteria needed by the company using the AHP method.

CONCLUSION

AHP is a method for overcoming selection problems involving many interrelated criteria and alternatives. This method is beneficial in various contexts, including business decision-making, project planning, product appraisal, investment selection, etc. AHP results show the best supplier for PT. Seaport Services Indonesia is Supplier B with the highest weight compared to the other two suppliers. The priority criterion for the AHP method in selecting suppliers is Flexibility.

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