IMPLEMENTATION OF MULTI-CRITERIA DECISION MAKING (MCDM) IN SUPPLIER SELECTION FOR RAW MATERIAL

Selvy Athia[1], Rahmad Wijaya[2], Kenny Roz[3*]

Faculty Economics and Business, Management, University Muhammadiyah of Malang, INDONESIA.

[1] selvyathia@gmail.com, [2] rahmad@umm.ac.id, [3]firdauskenny@umm.ac.id

ABSTRACT

The purpose of this study is to determine the priority order of the criteria, sub-criteria, then determine which suppliers CV Sumber Logam company can choose. The population in this study is the decision maker and management of CV Sumber Logam. The sampling technique used was purposive sampling in order to obtain 7 people. The data analysis technique in this study used the Analytical Hierarchy Process (AHP), while the analytical tool used was expert choice 11. The results of the analysis of this study obtained the importance weight of the criteria with the first priority is quality (0.44), price (0,30), delivery (0.11), warranty & service complaints (0.07), the last priority is performance history (0.06). Meanwhile, the results of the assessment of the level of alternative importance in supplier selection show that supplier X (0.479) has the highest weight, the second supplier Y (0.291), and the third supplier Z (0.230). The results of this calculation can be used by the company as a consideration in determining the next supplier selection policy.

Keywords: Analytical Hierarchy Process (AHP), expert choice, supplier selection, supply chain management

INTRODUCTION

Companies engaged in manufacturing are companies that change or convert raw materials and their supporting materials into finished goods. One of the activities that cannot be separated and important for manufacturing companies is supply chain management. Heizer & Render (2014) explain that Supply Chain Management (SCM) or supply chain management is a series of integrated activities, from procuring materials and services, then turning them into semi-finished or finished goods, and distributing them to consumers. Supply Chain Management is also an integrated operating system that starts with purchasing, production, and stops at consumers (Jihadi et al., 2020). Companies also need good quality raw materials so that the products they produce are good too. Therefore, raw material suppliers who have good credibility and can be trusted are needed, so that the raw materials supplied are raw materials with guaranteed quality so that they can increase the company's competitiveness in terms of products (Andani & Koesdiningsih, 2019).

CV Sumber Logam is a manufacturing company engaged in aluminum smelting. The resulting product is in the form of aluminum ingot bars. The products produced by this company will be distributed to three companies, namely PT Sinar Mas Autopart, PT Roixin Logam, and PT SASS Nakayama. These three companies are companies that produce vehicle spare parts. Therefore, the production demand for aluminum ingots in table 1 is constant every month. There are obstacles that occur within the company, namely the raw materials supplied by two

* Corresponding author: Kenny Roz, firdauskenny@umm.ac.id

Leena and Luna International, Chikusei, Japan.
(株) リナアンドルナインターナショナル, 筑西市,日本
ISSN: 2186-845X ISSN: 2186-8441 Print
www.ajmse. leena-luna.co.jp

suppliers are not sufficient because the supplier only has a maximum raw material capacity of 550 tons per month and 300 tons per month, while the company also has other regular customers.

Table 1. Production Data CV Sumber Logam 2020-2021

Month	Raw Material	Production
January	170 ton	50 ton
February	170 ton	50 ton
March	170 ton	50 ton
April	170 ton	50 ton
May	170 ton	50 ton
June	170 ton	50 ton
July	170 ton	50 ton
August	170 ton	50 ton
September	170 ton	50 ton
October	170 ton	50 ton
November	170 ton	50 ton
December	170 ton	50 ton
January	510 ton	150 ton
February	510 ton	150 ton
March	510 ton	150 ton

Souce: Data Report (2021)

The raw material in the form of aluminum scrap which is supplied as much as 170 tons is only able to produce 50 tons of aluminum ingot because the material goes through the melting process and the filtering process with the final result being the weight per 1 aluminum ingot bar of 15 kg. With the constraints that occur if you only depend on two suppliers, CV Sumber Logam is ultimately unable to meet consumer demand on time. For this reason, a supplier of new raw materials is needed to meet the needs of the two new customers. Until now, CV Sumber Logam has had difficulties in selecting a supplier because the company choose the supplier based on relationship factors with suppliers and do not pay attention to criteria that can affect company performance.

CV Sumber Logam has selected three potential suppliers and the criteria for selecting suppliers will be adjusted to the condition of the company and the standard of the products to be produced. To make it easier to make new supplier selection decisions and knowing the criteria that can be considered by the company in selecting suppliers there is an analysis tool, namely Analytical Hierarchy Process (AHP). The AHP method is an easy-to-understand method and a framework for making decisions effectively on complex problems by simplifying and accelerating the decision-making process by solving complex problems by structuring a hierarchy of criteria, interested parties, results and by drawing various considerations in order to develop weights. or priority (Alam Syah, 2014)

LITERATURE REVIEW

Supply Chain Management

Supply chain is a system in which an organization distributes its products and services to its customers. This chain consists of a network of various interconnected organizations that have the same goal, namely the best possible procurement of these goods (Setiawan & Setiyadi,

2017) . Heizer & Render (2017) reveal that the purpose of supply chain management is to coordinate companies tend to determine suppliers activities in the supply chain to maximize the competitive advantage and benefits of the supply chain for the end consumer. Supply chain management is increasingly becoming a major management tasks so that supply chain managers need to be moved to the position of top management to ensure that the allocation of duties, responsibilities and authority of the supply chain is handled at the strategic level (Purwani & Nurcholis, 2016).

Today's competitive industrial environment, it is impossible to successfully produce at a low cost, and produce quality products without a satisfactory supplier. According to Heizer & Render (2014) supplier selection must consider various factors, namely strategic fit, supplier competence, delivery and quality performance factors. Proper identification of vendors is important for increasing the efficiency of service organisation as per the need (Kumar & Roy, 2011). The criteria according to Pirogo & Rumita (2017) are quality, cost, flexibility, delivery, responsiveness (QCFDR). Companies must be able to have competence in various areas and be able to have extraordinary competences. Supplier selection can be an important process. According to Dickson, (1966) twenty-one criteria for selecting and evaluating suppliers can be seen in table 2 :

Table 2. Supplier Selection / Evaluation Criteria

No	Criteria
1	Quality
2	Delivery
3	Performance History
4	Warranties and Claim Policies
5	Price
6	Technical Capability
7	Financial Position
8	Prosedural Compliance
9	Communication System
10	Reputation and Position in Industry
11	Desire for Business
12	Management and Organization
13	Operating Controls
14	Attitudes
15	Impression
16	Packaging Ability
17	Labor Relations Records
18	Geographical Location
19	Amount of past business
20	Training Aids
21	Reciprocal Arrangements

Source : Suci Oktri Viarani (2015) ; Heizer & Render (2014)

Analytical Hierarchy Process

Bahadir & Kursun (2015) Multi-criteria decision methods (MCDM) are used to solve a variety of decision-making problems through an evaluation method based on selection of multiple criteria among alternatives. One of the MCDM methods is AHP. Analytical Hierarchy Process is a decision making method that involves a number of criteria and alternatives that are selected based on the consideration of all related criteria. This method

Leena and Luna International, Chikusei, Japan.
(株) リナアンドルナインターナショナル, 筑西市,日本
ISSN: 2186-845X ISSN: 2186-8441 Print
www.ajmse. leena-luna.co.jp

can be used for complex structures, multi-person, multi- attribute, and multi-period hierarchical problems (Viarani, 2015). AHP is a highly flexible decision-making methodology that can be applied in a wide variety of situations with problems of multiple criteria, including supplier- selection decisions, facility-location decisions, forecasting, risks and opportunities modeling, choice of technology, plan and product design, and so on. AHP allows decision makers to structure complex problems in the form of hierarchical manner or a set of integrated levels, having a certain number of levels from the root (objective) to the leaves (alternatives) (Chan & Kai, 2010).

Haryanto & Sadeyah (2018) to solve problems with the AHP method, there are several basic principles that must be understood, including decomposition (creating a hierarchy) solve or divide a complete problem into its elements into a hierarchical form of the decision-making process, where each element or element is interrelated. Then, comparative judgment (assessment of criteria and alternatives). Criteria and alternatives are carried out by pairwise comparisons. According to Saaty, (1993) for various problems, a scale of 1 to 9 is the best scale for expressing opinions. Synthesis of Priority Synthesis of priority is carried out using the eigen vector method to obtain relative weights for decision-making elements. Weights or priorities are calculated by matrix manipulation or by solving mathematical equations. Last, logical consistency, consistency has two meanings. First, similar objects can be grouped according to uniformity and relevance. Second, regarding the level of relationship between objects based on certain criteria.

METHOD

The research conducted is a quantitative descriptive study. The population of this study were the decision makers and management of CV. Sumber Logam, as many as 7 people from operational managers, supervisors in the production department who are responsible for maintaining the stability of raw materials.. The sampling technique was carried out by purposive sampling, namely sampling based on certain considerations. Respondents who are involved must also have sufficient knowledge and experience about the problem. Therefore, the respondents in this study were the main director, head of purchasing and warehousing, head of production, head of finance, two employees in warehousing and purchasing, and employees in the production department. Data obtained from interviews, questionnaires and documentation.

The variables used for supplier selection in this study were obtained from the results of in-depth interviews, namely the first criterion is price. Price focuses on the price agreement made or nominal value measured in units of money between the supplier and the company. Price criteria are developed into suitability for raw material prices (H1), ability to provide discount orders in a certain amount (H2), suitability in providing raw material shipping costs (H3). The second criterion is quality. The quality of aluminum scrap raw materials is measured by the level of cleanliness of the raw materials, no sand or paper, no mixing of iron or other materials other than aluminum, and the dryness of the materials in the sense that the raw materials are not wet. This criterion was further developed into sub-criteria, namely the suitability of goods with the desired specifications (Q1), the ability to provide consistent quality (Q2). The third criterion is warranties and claim policies (warranty and service complaints). This attribute focuses on warranty and service complaints against suppliers. This attribute was further developed into ease of claim processing (W1), guarantee of goods on time (W2), speed of responding to complaints (W3), responsiveness in resolving customer complaints (W4). The fourth criterion is delivery. This attribute focuses on the supplier's ability to timeliness (how long it takes to complete, respond to, correct, or complete). This

attribute is further developed into the ability to deliver goods according to the agreed date (D1), the ability to select the means of transportation for the delivery of raw materials (D2), the accuracy of the quantity in the shipment of raw materials (D3).The fifth criterion is performance history (previous performance achievements). This attribute focuses on the supplier's fulfillment ability based on the company's previous performance. This attribute is further developed into the ability to comply with the set schedule (P1), the ability to maintain contract agreements (P2).

The data analysis used in this research is AHP (Analitycal Hierarchy Process) method. Calculations can use manual or Microsoft Excel help and expert choice software. The steps in the AHP method are as follows the first is to construct a hierarchical structure of the problem. (Oktavia et al., 2017) The hierarchical form consists of the criteria and sub-criteria used for supplier selection

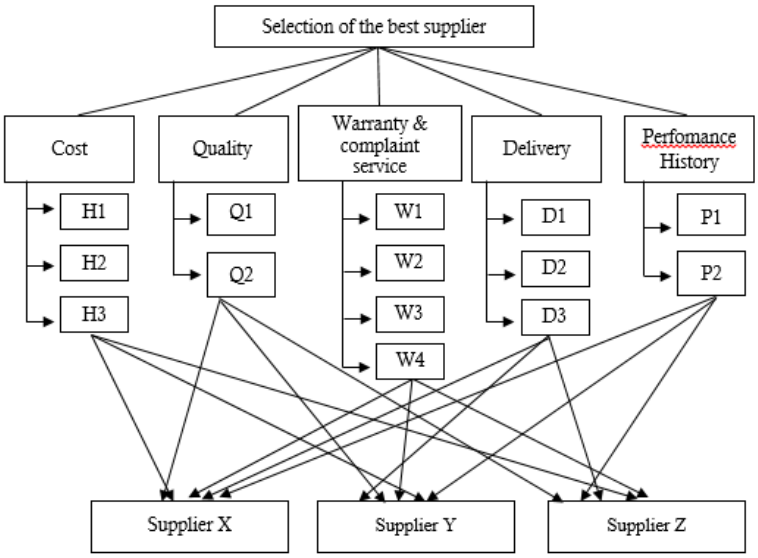

Figure 1. Structur Hierarchy CV Sumber Logam

Second, calculate the weight / priority at level 1 (criteria) by making pairwise comparisons of each criterion. To get the value from pairwise comparisons, that is to calculate the geometric mean from the results of respondents' assessments

$G = \sqrt[n]{X_1, X_2, X_3, \dots\dots, X_n}$……..

G = geometric mean

Xn = Respondent's assessment 1,2,3… .n

N = Number of ratings

Create a pairwise comparison matrix from the value of each paired comparison, then divide each element by the sum value. The results are normalized to obtain the matrix eigenvector by averaging the number of rows against the criteria. The eigenvector value is the priority weight for each criterion. Furthermore, the consistency measurement, multiplying the initial comparison matrix value by the weight, multiplying the number of rows by the weight. λmaks is obtained from the result of adding the multiplication result above with n. Consistency index formula:

CI = (λmax - n) / (n - 1)

CI = consistency index

λmax = maximum eigenvalue

n = Number of elements

Leena and Luna International, Chikusei, Japan.
(株) リナアンドルナインターナショナル, 筑西市,日本
ISSN: 2186-845X ISSN: 2186-8441 Print
www.ajmse. leena-luna.co.jp

Then the priority synthesis is carried out. This consistency measurement is to see the inconsistency of the responses given by respondents.

CR = CI / RI
CR = Consistency Ratio
CI = Consistency Index
RI = Index Random Consistency

If the Index Random Consistency (CR) value is <0.1 then the pairwise comparison value in the given criteria matrix is consistent and vice versa if the Index Random Consistency (CR) value is> 0.1 then the paired comparison value on the given criteria matrix is not consistent. So if the values are not consistent, it is necessary to repeat the values in the paired matrix on the criteria and alternative elements. Next, calculate the weight / priority of each variable at level 2 (sub-criteria) of each criterion as in the second step above. Then determine the global priority by multiplying the local priority / priority of each sub-criteria with the priority criteria. Calculating the weight / priority of each variable at level 3 (alternative), namely the weight of each supplier compared to each sub-criteria as in the second calculation above. After knowing the weight of each sub-criteria and each supplier, then to find out which supplier can be selected, namely the overall value of the multiplication of supplier weights and sub-criteria weights. The supplier chosen is the one with the highest weight / value.

RESULT AND DISCUSSION

There are three levels to be analyzed using the AHP method with the aim of knowing the weight / priority importance of each variable. At level 1 (criteria), namely price, quality, warranty and service complaints, delivery, and performance history, level 2 (sub-criteria), and level 3 alternative suppliers. The data used to measure the priority interests of the sub-criteria for each supplier selection criteria were obtained through a questionnaire distributed to 7 respondents. Measurement of priority importance and criteria is carried out from respondents' ratings, then the results are averaged using geometric mean (geometric mean). This is done because AHP only requires one answer, the results of the geomean from 7 respondents in table 3 are as follows

Table 3. Assessment of Priority Interest Criteria in Supplier Selection

Criteria	**Cost**	**Quality**	**Warranty& Complaints Service**	***Delivery***	***Perfomance History***
Cost	1	0,51	3,77	4,40	4,51
Quality	1,96	1	5,01	5,19	4,72
Warranty & Complaints Service	0,27	0,20	1	0,39	1,11
Delivery	0,23	0,19	2,56	1	2,15
Perfomance History	0,22	0,21	0,90	0,47	1

From the calculation of pairwise comparisons between variables in choosing suppliers, the following figure 2 weights are obtained:

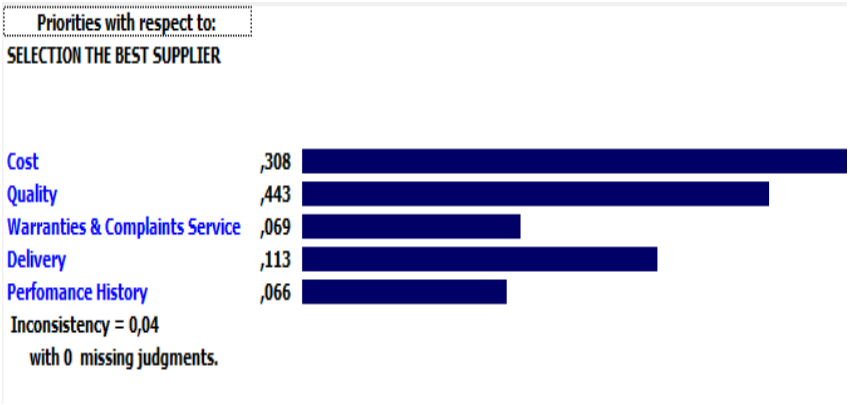

Figure 2. Synthesis of Raw Material Selection Criteria

Based on Figure 2, the quality criteria have the highest first weight with a total of 0.44, then the second priority is the price criteria with a weight of 0.30, the third priority is the delivery criteria with a weight of 0.11, the fourth priority is warranty and complaint services with a weight of 0, 07, the fifth priority is performance history criteria with a total weight of 0.06. As for calculating level 2 sub-criteria and level 3 alternative suppliers for each sub-criteria is the same as the calculation for level 1 (criteria). After getting the values on the criteria and alternatives, a synthesis is carried out in order to get the overall weight value and get the best supplier results.

Table 4. Priority Global

Level 0 (Goals)	Level 1 (Criteria)	Level 2 (Subcriteria)	Weight	Alternative	Weight
Selection of the best supplier	Cost (0,30)	H1	0,19	Supplier X	0,089
				Supplier Y	0,076
				Supplier Z	0,025
		H2	0,07	Supplier X	0,039
				Supplier Y	0,010
				Supplier Z	0,021
		H3	0,04	Supplier X	0,019
				Supplier Y	0,005
				Supplier Z	0,016
	Quality (0,44)	Q1	0,33	Supplier X	0,170
				Supplier Y	0,103
				Supplier Z	0,057
		Q2	0,11	Supplier X	0,046
				Supplier Y	0,043
				Supplier Z	0,021
	Warranties & Complaints Service (0,07)	W1	0,01	Supplier X	0,002
				Supplier Y	0,007
				Supplier Z	0,001
		W2	0,01	Supplier X	0,007
				Supplier Y	0,002
				Supplier Z	0,001

Leena and Luna International, Chikusei, Japan.
(株) リナアンドルナインターナショナル, 筑西市,日本
ISSN: 2186-845X ISSN: 2186-8441 Print
www.ajmse. leena-luna.co.jp

	W3	0,02	Supplier X	0,010
			Supplier Y	0,006
			Supplier Z	0,004
	W4	0,03	Supplier X	0,004
			Supplier Y	0,023
			Supplier Z	0,003
Delivery (0,11)	D1	0,06	Supplier X	0,022
			Supplier Y	0,014
			Supplier Z	0,012
	D2	0,02	Supplier X	0,005
			Supplier Y	0,003
			Supplier Z	0,008
	D3	0,05	Supplier X	0,018
			Supplier Y	0,014
			Supplier Z	0,006
Perfomance History (0,06)	P1	0,01	Supplier X	0,005
			Supplier Y	0,003
			Supplier Z	0,002
	P2	0,05	Supplier X	0,030
			Supplier Y	0,012
			Supplier Z	0,009

The next step that can be taken is adding up the weight of each alternative as a whole in the global priority of each supplier. The following table is the result of the calculation for each alternative and Figure 3 of the calculation results using expert choice

Figure 3. Synthesis Priority Supplier

From figure 3 shows that supplier X has the highest weight, namely 0.479 as the first priority to be selected as a supplier of raw material for aluminum scrap CV Sumber Logam. The second priority is supplier Y with a weight of 0.291, then the last priority is supplier Z with a weight of 0.230.

Based on table 4 there are alternative weight of supplier in every criteria. The following figure is a hierarchical structure in selecting in the best supplier.

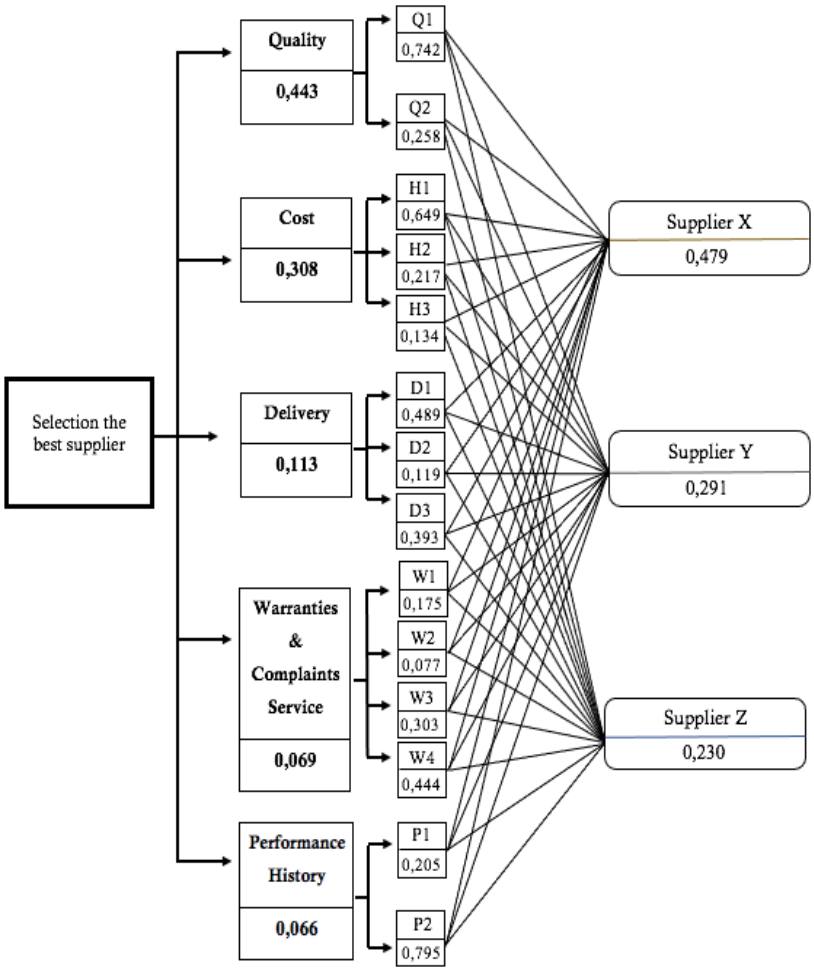

Figure 4. Structure Hierarchy Priority Weight CV Sumber Logam

This shows that supplier X can be used as an alternative supplier of raw materials that can be selected as a supplier partner and table 4 is the result of supplier weight in each criterion :

Table 5. Alternative Weight (Supplier) Based on Criteria

Criteria	Supplier X	Supplier Y	Supplier Z
Cost	0,500	0,224	0,276
Quality	0,465	0,280	0,255
Warranty & Complaints Service	0,384	0,464	0,152
Delivery	0,426	0,414	0,160
Perfomance History	0,540	0,280	0,180

The results of table 5 are that supplier X is superior in several criteria, namely price criteria with a weight of 0.500, quality criteria with a weight of 0.465, delivery criteria with a weight of 0.455 and criteria for performance history with a weight of 0.464. In the price criteria supplier X ranks first with a weight of 0.500, then supplier Z with a weight of 0.276 and finally supplier Y with a weight of 0.224. Furthermore, the quality criteria, supplier X with the first order with a weight of 0.465, the second order is supplier Y with a weight of 0.280 and the last is occupied by supplier Z. Criteria for warranty and service complaints, the first order with the largest weight is occupied by supplier Y with a weight of 0.464, then second with supplier Y with a weight of 0.464. with a weight of 0.384, namely supplier X, finally

Leena and Luna International, Chikusei, Japan.
(株) リナアンドルナインターナショナル, 筑西市,日本
ISSN: 2186-845X ISSN: 2186-8441 Print
www.ajmse. leena-luna.co.jp

supplier Z with a weight of 0.169. The last criterion is performance history, the first alternative that has the largest weight is supplier X with a weight of 0.540, the second order is supplier Y with a weight of 0.280 and the last is supplier Z with a weight of 0.180.

Consistency measurement. This measurement is to see the assessment given by the respondent. If CR <0.1 or less than 10%, then the pairwise comparison value on the given criteria matrix is consistent, on the other hand, if CR> 0.1 or more than 10%, there is no consistency.

Table 6. Consistency Ratio Respondent Assessment

Pairwise Comparison	**CR**	**Information**
Criteria (level 1)	0,04	Consistent
Cost subcriteria	0,02	Consistent
Quality subcriteria	0,00	Consistent
Warranty and complaint service subcriteria	0,04	Consistent
Delivery subcriteria	0,04	Consistent
Performance history subcriteria	0,00	Consistent
Alternatives to the H1 subcriteria	0,00	Consistent
Alternatives to the H2 subcriteria	0,00	Consistent
Alternatives to the H3 subcriteria	0,00	Consistent
Alternatives to the Q1 subcriteria	0,00	Consistent
Alternatives to the Q2 subcriteria	0,00	Consistent
Alternatives to the W1 subcriteria	0,00	Consistent
Alternatives to the W2 subcriteria	0,00	Consistent
Alternatives to the W3 subcriteria	0,00	Consistent
Alternatives to the W4 subcriteria	0,00	Consistent
Alternatives to the D1 subcriteria	0,00	Consistent
Alternatives to the D2 subcriteria	0,00	Consistent
Alternatives to the D3 subcriteria	0,00	Consistent
Alternatives to the P1 subcriteria	0,00	Consistent
Alternatives to the P2 subcriteria	0,00	Consistent

The value of table 6 shows that all ratings given by respondents are consistent because the value is not more than 10% or CR> 0.1. Then the calculation results do not need to be repeated.

CONCLUSSIONAND RECOMMENDATION

The results of the data analysis show that there are 5 criteria, the order of criteria that influence the selection of raw materials for aluminum scrap at CV Sumber Logam, namely the criteria for quality, price, delivery, warranty and service complaints, performance history. In the global priority sub-criteria sequentially according to priority, namely the suitability of goods with the desired specifications (0.33), the suitability of raw material prices (0.19), the ability to provide consistent quality (0.11), the ability to give a certain quantity ordering discount (0.07), the ability to deliver goods according to the agreed date (0.06), the ability to maintain the contract agreement and the accuracy of the number of shipments (0.05), the ability to provide raw material shipping costs (0.04), responsiveness to resolve customer complaints (0 , 03), speed of responding to complaints (0.02), ease of claim processing, guarantee of goods on time, ability to maintain contract agreements have the same weight (0.01). Based on the overall calculation using AHP, supplier with the highest weight, then supplier Y, supplier Z.

Recommendation that can be given are that companies in the future in analyzing suppliers can use AHP analysis calculations to make decisions because if there are new criteria or sub-criteria that are relevant to the company or in accordance with new company policies, the company can change the criteria and sub-criteria, currently used. It consists of the conclusion, clarity of new findings, new theories and the possibility of future research development.

Leena and Luna International, Chikusei, Japan.
(株) リナアンドルナインターナショナル, 筑西市,日本
ISSN: 2186-845X ISSN: 2186-8441 Print
www.ajmse. leena-luna.co.jp

REFERENCES

[1]. Alam Syah, D. P. (2014). Analytical Hierarchy Process Method: Database Software Recommender System. *Informatic of Journal*, *1*(2), 59–73. https://doi.org/10.31311/ji.v1i2.51

[2]. Andani, W., & Koesdiningsih, N. (2019). Supplier Selection Analysis Using Analytical Hierarchy Process (AHP) Method. *Journal of Management*.

[3]. Bahadir, M. C., & Kursun, S. (2015). Selection of appropriate e-textile structure manufacturing process prior to sensor integration using AHP. *International Journal of Advanced Manufacturing Technology*, *76*(9–12), 1719–1730. https://doi.org/10.1007/s00170-014-6399-x

[4]. Chan, F. T. S., & Kai, H. (2010). An AHP model for selection of suppliers in the fast changing fashion market. *International Journal of Advanced Manufacturing Technology*, *51*(9–12), 1195–1207. https://doi.org/10.1007/s00170-010-2683-6

[5]. Dickson, G. W. (1966). An Analysis Of Vendor Selection Systems And Decisions. *Journal of Purchasing*, *2*(1), 5–17. https://doi.org/10.1111/j.1745-493x.1966.tb00818.x

[6]. Haryanto, K. W., & Sadeyah, S. A. (2018). Decision Support System for Raw Material Supplier Selection In Cv . Mighty Great Rays Use. *Jurnal Spirit*, *10*(2), 1–8.

[7]. Heizer, J. & B. R. (2017). *Operation Management* (D. Irawan (ed.); Sebelas). Salemba Empat.

[8]. Heizer Jay dan Barry Render. (2014). *Manajemen Operasi* (Tujuh). Salemba Empat.

[9]. Jihadi, M., Usman, I., Giyanto, Ambarwati, T., Asrini, & Musnaini. (2020). The impact of corporate governance in forming a strong supply chain: Evidence from Indonesia. *International Journal of Supply Chain Management*, *9*(2), 469–476.

[10]. Kumar, J., & Roy, N. (2011). Analytic Hierarchy Process (AHP) for a Power Transmission Industry to Vendor Selection Decisions. *International Journal of Computer Applications*, *12*(11), 26–30. https://doi.org/10.5120/1727-2336

[11]. Oktavia, E., Marimin, M., & Djohar, S. (2017). Strategic Architecture in Poultry Company. *Jurnal Dinamika Manajemen*, *8*(2), 245–258. https://doi.org/10.15294/jdm.v8i2.12764

[12]. Pirogo, B., & Rumita, R. (2017). Application of Selection of Suppliers of Cast Iron Raw Materials Part Handle Using Analytical Hierarchy Process Method (Case Study: CV Surya Cipta Inti Pratama, Semarang). *Industrial Engineering Online Journal*, *6*(1).

[13]. Purwani, T., & Nurcholis, L. (2016). Supply Chain Performance Improvement Strategy Through Quality of Synergy in The Automotive Components Industry. *Jurnal Dinamika Manajemen*, *7*(1), 32. https://doi.org/10.15294/jdm.v7i1.5757

[14]. Saaty, T. L. (1993). *The Analytical Hierarchy Process: Planning, Priority Setting, Resource Allocation.* University of Pittsburgh Pers.

[15]. Setiawan, E. B., & Setiyadi, A. (2017). Iimplementasi Supply Chain Management (Scm) Dalam Sistem Informasi Gudang Untuk meningkatkan. Stmik Amikom, *4*(Febuari), 13–25.

[16]. Suci Oktri Viarani, H. R. Z. (2015). *Supplier Selection Analysis Using Analytical Hierarchy Process Method. 14*(1), 50–65.