Analysis of Methanol Supplier Selection at PT Patlite Indonesia with the Analytical Hierarchy Process (AHP) Method

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Abstract. This study aims to analyze the selection of the best suppliers, especially methanol suppliers used by PT Patlite Indonesia. PT Patlite Indonesia is a manufacturing industry company that produces warning lighs. To maintain product quality, the company pays more attention to the production process, based on the results of observations in the field several times found the ineffectiveness of methanol liquid in the process of cleaning components from impurities. The problems that will be discussed in this study are what criteria are used in the selection of methanol suppliers along with the weight of each criterion and which supplier should be chosen to supply methanol for the needs of PT Patlite Indonesia. The method used in this study is the Analytical Hierarchy Process (AHP) method. Data in this study was obtained by distributing questionnaires to 3 respondents who are experts in decision-making. The results of this study show the level of importance of the most influential criteria in the selection of methanol suppliers at PT Patlite Indonesia, namely quality criteria (0.554), service criteria (0.144), price criteria (0.117), supplier profile criteria (0.111) and delivery criteria (0.074). While the alternative priority order is supplier Aik Moh (0.680), supplier Fanindo (0.215) and supplier Kangly (0.106).

Keywords: Analytichal Hierarchy Process, Best Supplier, Methanol Supplier Selection

1 Introduction

During the current Industrial Revolution 4.0, all industrial companies in the world are increasingly aggressively competing with each other. Especially in the Batam area, manufacturing industry companies are growing rapidly, so they are required to compete with each other, in order to maintain product sales from each company. By providing the best quality, companies can optimize sales and consumer demand. So that consumers feel satisfied with the products provided. To realize this, companies must pay attention to all aspects from the procurement stage of raw materials, the production stage to delivery to consumers [2]. The production process certainly cannot be separated from the procurement of raw materials. Procurement of raw materials is one of the most important processes in carrying out production. To meet the needs of raw materials with high quality and according to production needs, companies can find the right supplier.

Supplier selection is one of the most important stages carried out by the company, the purchase of raw materials and other items uses 40% to 80% of the total product cost and can have an impact on company performance [6]. Each company certainly has criteria that will be

used to select suppliers so that the company's raw material needs are met. To select suppliers, one effective method is the Analytical hierarchy process (AHP). AHP is a method used as a solution to a problem that is not sequential by arranging the problem into a form of hierarchy or as a decision-making method by measuring pairwise comparisons between criteria. PT Patlite Indonesia is part of Patlite Corporation Japan which was established in 1999. Initially produced Warning Light, as a public safety need the product has grown rapidly over time and consumer demand is increasing. Because the number and type of products produced are increasing, companies must pay more attention to the quality of the products produced so that consumers feel satisfied. In maintaining product quality, PT Patlite Indonesia is very dependent on suppliers.

The Purchasing Department at PT Patlite Indonesia is a department that carries out the main and supporting raw material purchasing activities, which is usually referred to as factory supply. Factory supply must be considered because the needs that include supporting materials, one of which is methanol in the production process of PT Patlite Indonesia, methanol is used as a cleaning fluid for product components from dirt. Suppliers owned by the company include suppliers PT. Aik Moh Chemical Indonesia (Supplier Aik Moh), supplier CV. Kangly Cunsindo Persada (Kangly Supplier), and supplier PT. Fanindo Ciptronic (Fanindo Supplier). Based on the results of observations in the field several times the ineffectiveness of methanol liquid in the process of cleaning components from impurities. This makes the company experience a decrease in production levels and has an impact on increasing production time. So, the company should make a selection to get the best supplier. The following price list of methanol used by PT Patlite Indonesia from year to year is:

Table 1. Methanol Price List

Years	Currency	Price	Years	Currency	Price
2012	IDR	200.000	2018	SGD	17.80
2013	SGD	17.00	2019	SGD	17.50
2014	SGD	19.00	2020	SGD	17.50
2015	IDR	186.200	2021	IDR	195.000
2016	IDR	186.200	2022	IDR	270.000
2017	IDR	178.809	2023	IDR	290.000

2 Literature Review and Frame of Mind

Table 2. Literature

No.	Researcher	Title	Variable
1.	Sundana dan Risdiyanti (2019) Jurnal Integrasi Sistem Industri (Vol 6 No 2)	Analysis of Optimal Case A Supplier Selection at PT ABC	1. Price 2. Delivery 3. Quality 4. Service
2.	Merry, dkk (2014) Jurnal Teknik & Ilmu Komputer (Vol 03 No 09)	Selection of Fruit Suppliers Using the Analytical Hierarchy Process (AHP) and TOPSIS Methods: Case Studies in Retail Companies	1. Quality 2. Price 3. Delivery 4. Service 5. Supplier Profile 6. Risk 7. Document Completeness

2.1 Supplier Selection

The selection of suppliers is very important and needs to be considered for companies to meet all the needs of the main or supporting raw materials. Supplier selection is one of the most important stages carried out by the company, the purchase of raw materials and other items uses 40% to 80% of the total product cost and can have an impact on company performance [6].

2.2 Analytical Hierarchy Process Method

The AHP method was first developed by Thomas L. Saaty in 1970. The AHP method is a method used for the mathematical decision-making process. AHP is a method of decision selection that can make users provide opinions and limits on a problem with estimates or guesses and can provide solutions to a problem [5].

2.3 Purchasing

Purchasing is an activity to meet the needs of goods needed by the company. Purchasing has become a very important activity for the company. To realize the purchase stage, there are several procedures that occur before arriving at this stage [4].

2.4 Frame of Mind
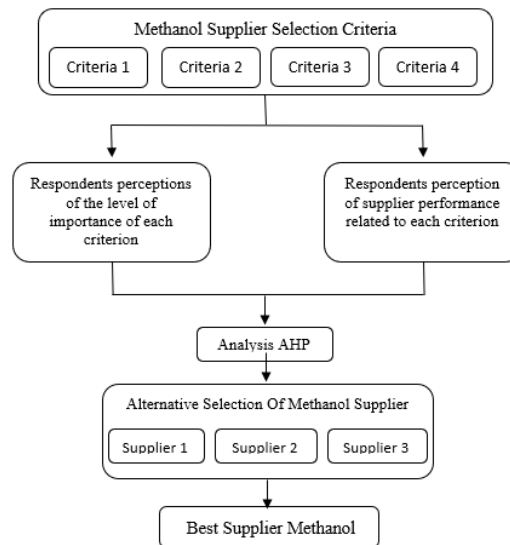
The framework of thinking in this study is as follows:

Fig. 1. Frame of Mind

3 Research Method

In this study, the authors used quantitative research derived from respondents' questionnaire responses. Quantitative data is a research method based on concrete data, the data to be used is in the form of numbers. Furthermore, it will be processed using statistics as a tool for examiners,

in accordance with the problems studied so that a conclusion is obtained [7].

The variables in this study are criteria and alternatives in the selection of methanol suppliers obtained from observations at the company and development from previous researchers. The criteria for selecting methanol suppliers are as follows: Price, Quality, Delivery, Service, and Supplier Profile. In this study, the alternative selection of existing suppliers is as follows: Supplier Aikmoh, Supplier Kangly, and Supplier Fanindo.

The samples used in this study were the purchasing department manager, purchasing department admin, and assembly department leader PT Patlite Indonesia. The sampling technique used in this study is a Nonprobability sampling technique with purposive sampling. The data used in this study was obtained from the observation and distribution of questionnaires in Word form filled out by employees at PT Patlite Indonesia.

4 Research Result

4.1 Making of methanol supplier selection hierarchy.

After getting the criteria and alternatives, then the next step, which is to compile a hierarchy of methanol supplier selection. By compiling a hierarchy of methanol supplier selection, you can see in detail about the objectives, criteria and alternatives to be analyzed so as to get the final results in the form of the best methanol supplier criteria and alternative.
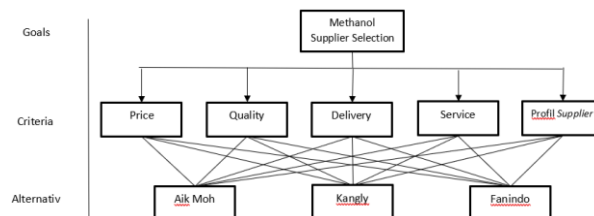

Fig. 2. Hierarchy Structure of Methanol Supplier Selection

4.2 Recapitulation of Importance Assessment Results

Data obtained from the distribution of questionnaires with three respondents for the measurement of importance (weight) between criteria and alternative methanol suppliers will be calculated geometric average value.

$$G = \sqrt[3]{0,14.0,14.0,14} = 0,14$$

The following results of the calculation of the geometric mean between criteria as a whole can be seen in the table:

Table 3. Recapitulation of Importance Assessment Results Between Criteria

Criteria	Respondents			Criteria	Geometric Mean
	R1	R2	R3		
Price	0,14	0,14	0,14	Quality	0,14
Price	1,00	3,00	0,20	Delivery	0,84
Price	5,00	3,00	0,33	Service	1,70
Price	3,00	2,00	0,33	Profile Supplier	1,26
Quality	5,00	7,00	5,00	Delivery	5,59
Quality	5,00	3,00	3,00	Service	3,56
Quality	9,00	5,00	7,00	Profile Supplier	6,80
Delivery	0,33	0,14	1,00	Service	0,36
Delivery	0,20	1,00	0,20	Profile Supplier	0,34
Service	0,33	3,00	5,00	Profile Supplier	1,70

The table above is a calculation for the geometric average of the answers given by respondents, for example for the price criterion compared to the quality criterion each respondent gives a value of 0.14 which means that the quality criterion is slightly more important than the price criterion.

4.3 Pairwise Comparison Matrix
The pairwise comparison matrix is calculated based on the consideration of the value of the importance of one element compared to other elements.

Table 4. Recapitulation of Importance Assessment Results Between Criteria

Criteria	Quality	Price	Delivery	Service	Profile Supplier
Quality	1,00	0,14	0,84	1,70	1,26
Price	7,14	1,00	5,59	3,56	6,80
Delivery	1,19	0,18	1,00	0,36	0,34
Service	0,59	0,28	2,78	1,00	1,70
Supplier Profile	0,79	0,15	2,94	0,59	1,00
Sum	10,71	1,75	13,15	7,21	11,10

The geometric average for the assessment between price to quality is 0.14, then vice versa for quality value to price becomes 1 divided by 0.14 so that a value of 7.14 and so on is obtained.

4.4 Weighting and Consistent Test Results Comparison.
In Table 6 there is a geometric average of the entire comparison matrix in pairs of criteria, to get the results of normalization of this criterion matrix the calculation is as follows:

$$a_{11} = \frac{1}{10,71} = 0,09$$

In the calculation of the geometric average of the entire criterion paired comparison matrix, the value of the price is compared with the quality which is 1, and the sum of the price criteria column is 10.71 if 1 is divided by 10.71 then the result of normalizing the matrix is 0.09.
Here's a table for the results of the criteria matrix normalization:

Table 5. Matrix Normalization Result Criteria

	Price	Quality	Delivery	Service	Profile Supplier	Sum	Priority Weight
Price	0,09	0,08	0,06	0,24	0,11	0,59	0,117
Quality	0,67	0,57	0,43	0,49	0,61	2,77	0,554
Delivery	0,11	0,10	0,08	0,05	0,03	0,37	0,074
Services	0,05	0,16	0,21	0,14	0,16	0,72	0,144
Profile Supplier	0,07	0,08	0,22	0,08	0,09	0,55	0,111

Table 6. Order of Weight and Ranking Criteria

Criteria	Weight/Priority	Ranking
Price	0,117	3
Quality	0,554	1
Delivery	0,074	5
Service	0,144	2
Profile Supplier	0,111	4

The table above is in order of weight and ranking criteria. To get the calculation results from the priority weight, which are as follows:

$$\text{Vector eigen} = \frac{0.59}{5} = 0{,}117$$

After obtaining the results of the pairwise comparison weighting normalization calculation, then calculate the Maximum Eigen Value (λmax) and the test is consistent with the following steps:

1. Multiplies each value in the first column by the priority of the first element, as follows:

First Matrix | | | | | | Weight | | Sum
$$\begin{vmatrix} 1{,}00 & 0{,}14 & 0{,}84 & 1{,}70 & 1{,}26 \\ 7{,}14 & 1{,}00 & 5{,}59 & 3{,}56 & 6{,}80 \\ 1{,}19 & 0{,}18 & 1{,}00 & 0{,}36 & 0{,}34 \\ 0{,}59 & 0{,}28 & 2{,}78 & 1{,}00 & 1{,}70 \\ 0{,}79 & 0{,}15 & 2{,}94 & 0{,}59 & 1{,}00 \end{vmatrix} \quad X \quad \begin{vmatrix} 0{,}117 \\ 0{,}554 \\ 0{,}074 \\ 0{,}144 \\ 0{,}111 \end{vmatrix} \quad = \quad \begin{vmatrix} 0{,}641 \\ 3{,}070 \\ 0{,}403 \\ 0{,}762 \\ 0{,}587 \end{vmatrix}$$

2. Then the sum of each row is divided by the corresponding weight/priority, as the following calculation:

Sum | Weight | Results
$$\begin{vmatrix} 0{,}641 \\ 3{,}070 \\ 0{,}403 \\ 0{,}762 \\ 0{,}587 \end{vmatrix} \quad \div \quad \begin{vmatrix} 0{,}117 \\ 0{,}554 \\ 0{,}074 \\ 0{,}144 \\ 0{,}111 \end{vmatrix} \quad = \quad \begin{vmatrix} 5{,}479 \\ 5{,}542 \\ 5{,}446 \\ 5{,}292 \\ 5{,}288 \end{vmatrix}$$

3. The result of the above division is calculated as follows:

$$\lambda max = \frac{27{,}046}{5} = 5{,}409$$

4. Next, calculate the consistency index (CI) value, as follows:

$$CI = \frac{5{,}409 - 5}{5 - 1} = 0{,}102$$

5. Then calculate the consistency ratio (CR) value. This calculation uses a 5x5 matrix (N = 5) with a value of 1.12 as follows:

$$CR = \frac{0,102}{1,12} = 0,091$$

Based on the calculation above, the result of the consistency ratio value of 0.091 which is smaller than 0.1 means that respondents' preferences are consistent with those stated by Thomas L. Saaty. Consistency between criteria and alternatives is shown in the table below:

Table 7. Respondent consistency table

Pairwise Comparison	CR	Explanation
Between Criteria	0,091	Consistent
Between Alternative to the price criteria	0,002	Consistent
Between Alternative to quality criteria	0,069	Consistent
Between Alternative against shipping criteria	0,046	Consistent
Between Alternative to service criteria	0,005	Consistent
Between Alternative to supplier profile criteria	0,023	Consistent

4.5 Calculation of Ranking and Determination of the Best Methanol Supplier

Table 8. All Results Weight/Priority of Each Criterion and Alternatives

Criteria		Weight/Priority	Alternative		
			Aik Moh	Kangly	Fanindo
Price		0,117	0,622	0,118	0,260
%		11,7%	62,2%	11,8%	26,0%
	Ranking		1	3	2
Quality		0,554	0,702	0,102	0,197
%		55,4%	70,2%	10,2%	19,7%
	Ranking		1	3	2
Delivery		0,074	0,551	0,136	0,313
%		7,4%	55,1%	13,6%	31,3%
	Ranking		1	3	2
Service		0,144	0,669	0,113	0,219
%		14,4%	66,9%	11,3%	21,9%
	Ranking		1	3	2
Profile Supplier		0,111	0,730	0,081	0,188
%		11.1%	73,0%	8,1%	18,8%
	Ranking		1	3	2
Total Alternative weight			0,680	0,106	0,215
Priority			1	3	2

Based on the table above, the calculation results for weights/priorities on criteria and alternatives are carried out by multiplying the weight of each criterion by the weight of each alternative and then calculating the amount, then the total weight of alternatives is obtained.

5 Conclusion

Based on the results of research and discussion using the Analytical Hierarchy Process (AHP) method, PT Patlite Indonesia has several weight criteria in supplier selection, namely: first quality criteria with a weight of 0.554, second service criteria with a weight of 0.144, third price criteria with a weight of 0.117, fourth supplier profile criteria with a weight of 0.111 and fifth, the delivery criteria with a weight of 0.074. For the order of priority of the best methanol suppliers based on total weight, namely: Aik Moh supplier with a total weight of 0.680, Fanindo supplier with a total weight of 0.215, Kangly supplier with a total weight of 0.106.

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