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# Redesign Determination of Plat Raw Material Supplier with Analytic Hierarchy Process (AHP) Approach: A Case Study

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**Abstract**. PT. XYZ is a company in the newspaper industry. The selection of suppliers so far is only based on the price offered and the promised delivery speed. The price offered by the supplier is also influenced by the exchange rate of the rupiah against the dollar resulting in price fluctuations in the purchase price of raw materials. Even though the price of raw materials has increased, newspaper prices have remained the same, and to avoid this problem, the company has supplied raw materials from many suppliers. The company has made good cooperation with several suppliers, but does not yet have the right supplier selection method and can be applied with a good planning process. Therefore, companies need to select suppliers with the right methods so that raw material orders are optimally fulfilled and get the best suppliers who can work together in the long run. In this study, the determination of the best suppliers is carried out on the raw material of the plate as well as important criteria in the selection of these suppliers. Data collection is done using interviews, questionnaires, and literature studies. Based on the results of data collection, among others, the purchase price, delivery time, maximum number of orders, the level of disability, and the distance of the supplier with the company. Data processing uses one of the MCDM (Multi Decision Making Criteria) methods, namely AHP (Analytic Hierarchy Process). With the results of supplier one being designated as the best supplier. This can be known with the highest final value in the final AHP calculation, with a value of 3.95643, and the criteria most considered in determining suppliers is the bid price.

## 1. Introduction

Logistics system is part of the process of the supply chain (supply chain) that serves to plan, execute, control effectively, efficient procurement, management, storage of goods, services and information ranging from the starting point (point of origin) to the point of consumption (point of consumption) with the aim of meeting the needs of the consumer. One of the things that are important to any company that is doing inventory management. One of the activities within the inventory management is conducting the procurement of raw materials that are included in the activity of logistics systems. Raw materials imported from some suppliers so that the supplier be one external party that is important to the existence and sustainability of a manufacturing company. Inventory management has an impact on all fronts, primarily financial, operational, and marketing [1]. Concerning inventory, there is a different goal in a

variety of fields. On the part of Finance wants the level of inventories are low, while in operational marketing and want a high level of supplies so that consumers ' needs can be met. When the supplies could not be sufficient demand exists, the company will suffer losses. To keep the supply of raw material remains optimal, schedule the purchase of raw materials and a good relationship with the supplier to note. Valid supplier selection can help companies achieve the desired production outcomes. The company generally have different requirements in the selection of suppliers. So, companies need to do a periodic evaluation to ensure that raw materials and procurement by the standards set by the company.

PT. XYZ is a company engaged in the printing industry that produces newspapers, magazines and is CATEGORIZED in Surakarta. The complete results of the company's products are distributed to Central Java so that product quality and timeliness are becoming essential criteria that should always be maintained. This company has multiple suppliers as significant suppliers of raw materials for its production of the product to be. Supplier, which is owned by the company among other suppliers, suppliers of paper, and ink suppliers plat.

The selection of suppliers of raw materials is one of the activities in the supply chain management in pt. XYZ. The event is a strategic activity, due to the role of the supplier in determining the success of the company. If the raw materials provided by the supplier of poor quality, then this will affect the quality of the resulting product. When the supplier could not provide raw materials according to the needs of the company, then the production schedule will also be disrupted. So the selection of the supplier is essential to note. The selection of suppliers for this only based on the price offered and the speed of delivery is promised. The price offered by the suppliers and also influenced by the exchange rate of the rupiah against the dollar, which price fluctuations on the purchase price of raw materials. Although the price of raw materials prices increased, the newspaper remains the same, and to avoid the issue, PT. XYZ was supplying raw material plate from many suppliers. If companies still use many suppliers at once could cause problems among other things too hard in the setting of a schedule entered the warehouse, control of the supplier, as well as setting the payment orders of raw materials [1]. When the supplier is chosen, any common issues such as quality, quantity, and delivery time is not as promised when booking, so that interferes with the operations of the production process. Although PT. XYZ has conducted good cooperation with some suppliers, but does not yet have a proper supplier selection method and can be applied with a good planning process. Therefore, companies need to make a selection of suppliers with the right method for raw materials orders fulfilled optimally and get the best supplier who can work together in the long term. This research was conducted on the determination of the best supplier is done on a plate of raw materials as well as the essential criteria in the selection of the supplier.

## 2. Literature Review

AHP is a decision-making method that is developed to prioritize several alternatives when several criteria must be considered and allow decision-makers to construct complex problems into a hierarchy. However, the AHP method has weaknesses in the inability to accommodate the disguise or uncertainty (vagueness), and the inaccuracy of respondents in making choices [2]. In this study, the AHP method is used for decision making in developing a redesign for determining suppliers of plate raw materials.

AHP is one of the most popular MCDM tools for formulating and analyzing decisions, especially in operation management [3]. The AHP method is applied in a great variety of areas, including planning, selection of the best alternative, resource allocation, and conflict resolution, thus being the most applied method. This method is aimed at establishing priorities or weights to be attributed to different criteria and alternatives, which features a decision and, as a consequence, enables the choice of the most suitable alternative [4]. This model should be an instrument to easily and quickly state the purchasing situation, which is often hidden by ordinary production management and the customers' delivery time [5].

According to [6], to compare the Business process management and the analytic hierarchy process as the tools of process performance assessment. Conclusions are Business process management is helpful in process performance assessment because it offers a conceptual foundation. The analytic hierarchy process is a complement that makes the intuitions based on business process management rigorous.

According to [7], the study aims to identify and evaluate the barriers faced by Electrical and electronics (E&E) manufacturing companies in Malaysia in implementing material efficiency strategies. Conclusions are the identified barriers that are categorized into internal and external barriers. From the empirical analysis, a total of nine barriers that influence the implementation of material efficiency were shortlisted.

Therefore, from the two case studies in this paper, we found confidence in using the AHP method in answering goals and finding solutions in this study.

## 3. Methodology

The methods used in this research include the study of literature, data collection, and then analyze the data regarding the determination of the supplier.

a) Literature Study

Literature studies were done by a literature review regarding the problems which occurred in the procurement cycle with a method of Analytical Hierarchy Process (AHP).

b) Data collection

Data in the study obtained from interviews, questionnaires, and observation. Interview conducted by Assistant General Manager. Then a detailed questionnaire distributed to respondents during the three parts of the production, logistics, and procurement.

c) Data analysis the data analysis used IE using the method of the Analytical Hierarchy Process (AHP).

In the method of AHP, three principles must be observed, i.e., [8]:

1. Principles of drafting hierarchy
2. The principle of determining priority
3. The principle of logical consistency

The steps in the performance analysis with the AHP method: first do a recap of the calculation of the questionnaire from the three respondents. Then make a multiple comparison chart of each criterion and the supplier. After that, the table using aggregating WGCM (Weighted Geometric Mean Complex). Next, do the normalization, eigenvector performs calculations, test the consistency of the data by searching for the value of the CR, and the selection of suppliers and criteria based on the eigenvalue.

## 4. Result and Discussion

The criteria used to determine the best supplier is obtained based on the study of literature and previous research. The criteria consist of the purchase price, delivery time, the addition error or reduction of the amount of the booking, the level of disability, and the distance with supplier companies. A detailed questionnaire distributed to respondents during the three parts of the production, logistics, and procurement.

**Table 1**. The Data Information Of The Respondents

| No | Name | Parts | Weight |
|----|------|-------|--------|
| 1 | Respondents 1 | Production | 33.33% |
| 2 | Respondent 2 | Procurement | 33.33% |
| 3 | Respondent 3 | Logistic | 33.33% |

*4.1 Pairwise Comparison Between Supplier and Delivery Criteria*

For each of the criteria and alternatives, the pairwise comparison that compares each element with other elements. At each level of the hierarchy in pairs so that the obtained values the importance of the element.
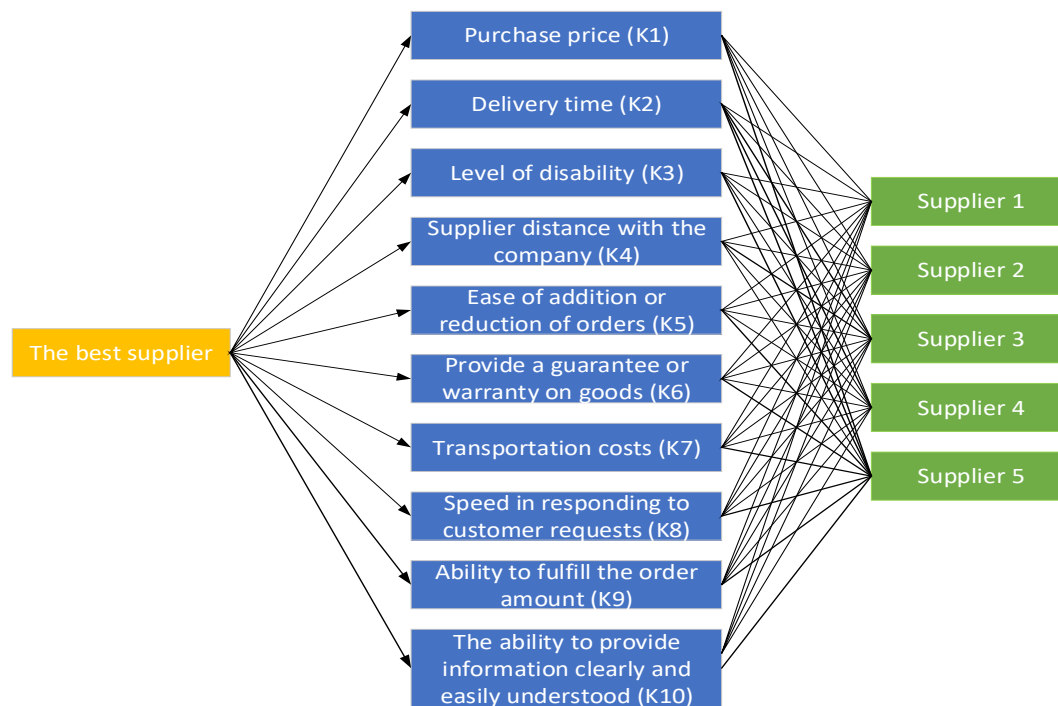
**Figure 1.** The Structure of The Hierarchy Of The Selection Criteria For Supplier

The criteria used to determine the best supplier are obtain based on literature studies and previous research. Criteria consist of price purchase, delivery time, defect rate, supplier distance from the company, and the ease of adding or reducing the number of orders, giving a guarantee or warranty on goods, transportation costs, speed in terms of responding to customer requests, the ability to fulfill the number of orders, the ability to provide information clearly and easily understood.

From the results of a questionnaire and interviews conducted on the part of the production, logistics, and procurement is done recapitulation as in table 3 for the criteria and table 5 for the supplier.

**Table 2.** Supplier Selection Criteria

| Criteria | Information |
|----------|-------------|
| K1 | Price of bid |
| K2 | Delivery time |
| K3 | Rate of Disability |
| K4 | Supplier distance with companies |
| K5 | Ease of adding or decrease in the number of orders |
| K6 | Guarantee or warranty against goods |
| K7 | Transportation cost |
| K8 | Speed in response to customer requests |
| K9 | Fulfillment abilities to the number of orders |
| K10 | The ability to provide information clearly and easily understood |

**Table 3.** WGMC (*Weighted Geometric Mean Complex*) Criteria

| Criteria | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | K9 | K10 |
|----------|------|------|------|------|------|------|------|------|------|------|
| K1 | 1,000 | 2,333 | 1,667 | 1,667 | 1,667 | 1,000 | 2,333 | 1,000 | 1,667 | 3,000 |
| K2 | 0,429 | 1,000 | 1,000 | 1,000 | 1,667 | 1,667 | 1,000 | 1,667 | 1,667 | 1,000 |
| K3 | 0,004 | 1,000 | 1,000 | 3,000 | 1,667 | 2,333 | 1,667 | 2,333 | 1,667 | 1,667 |
| K4 | 0,004 | 1,000 | 0,333 | 1,000 | 1,667 | 1,000 | 2,333 | 2,333 | 1,667 | 1,000 |
| K5 | 0,004 | 0,004 | 0,004 | 0,004 | 1,000 | 2,333 | 1,000 | 1,000 | 1,000 | 1,667 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| K6 | 1,000 | 0,004 | 0,429 | 1,000 | 0,429 | 1,000 | 1,667 | 3,000 | 1,000 | 1,000 |
| K7 | 0,429 | 0,007 | 0,004 | 0,429 | 1,000 | 0,004 | 1,000 | 1,000 | 1,667 | 2,333 |
| K8 | 1,000 | 0,004 | 0,429 | 0,429 | 1,000 | 0,333 | 1,000 | 1,000 | 1,667 | 1,000 |
| K9 | 0,004 | 0,004 | 0,004 | 0,004 | 1,000 | 1,000 | 0,004 | 0,004 | 1,000 | 2,333 |
| K10 | 0,333 | 1,000 | 0,004 | 1,000 | 0,004 | 1,000 | 0,429 | 1,000 | 0,429 | 1,000 |
| **Total** | **6,590** | **8,740** | **7,257** | **10,724** | **11,695** | **12,267** | **13,029** | **14,933** | **13,429** | **16,000** |

**Table 4.** Supplier Code

| Code | Supplier |
|---|---|
| S01 | Supplier Plat 1 |
| S02 | Supplier Plat 2 |
| S03 | Supplier Plat 3 |
| S04 | Supplier Plat 4 |
| S05 | Supplier Plat 5 |

**Table 5.** WGMC between Suppliers on any criteria

| Supplier Code | S01 | S02 | S03 | S04 | S05 |
|---|---|---|---|---|---|
| S01 | 1 | 3 | 1.6667 | 2.3333 | 1 |
| S02 | 0.333333 | 1 | 3 | 1.6667 | 2.3333 |
| S03 | 0.6 | 0.33 | 1 | 3 | 1.667 |
| S04 | 0.428571 | 0.6 | 0.33 | 1 | 2.3333 |
| S05 | 1 | 0.428571 | 0.2727 | 0.428571 | 1 |

*4.2 Normalization Of Multiple Matrices*

The normalization of the result obtained from the Division of each value in the column to the-i and j lines with total value columns to-i. The column number of the summation of results obtained from each line j, while the vector of weights derived from the average value of normalizing each line to a-j, as shown in tables 6 and 7.

*4.3 Calculation Of The Eigen Vector*

Eigen Vector calculation is performed by multiplying the vector with the initial matrix of weights. Eigen Vector calculation the following criteria.

$$
\begin{vmatrix} 1 & \dots & \dots & \dots & 3 \\ 0.4285 & \dots & \dots & \dots & \dots \\ 0.6 & \dots & \dots & \dots & \dots \\ \dots\dots & \dots & \dots & \dots & \dots \\ 3 & 1 & \dots & \dots & 1 \end{vmatrix} \times \begin{pmatrix} 0.15855 \\ \dots \\ \dots \\ \dots \\ 0.0668 \end{pmatrix} = \begin{pmatrix} 1,655 \\ \dots \\ \dots \\ \dots \\ 1,136 \end{pmatrix}
$$

Based on the calculation of the above matrix, Eigen Vector values obtained at each such criteria in table 8.

**Table 6.** Eigen Value Criteria

| Criteria | Eigen Value |
|---|---|
| **K1** | 1.655 |
| **K2** | 1.135 |
| **K3** | 1.589 |
| **K4** | 1.150 |
| **K5** | 0.964 |
| **K6** | 1.024 |
| **K7** | 0.785 |
| **K8** | 0.799 |
| **K9** | 0.821 |

| **K10** | 1.136 |
|---|---|

Eigenvalue calculations based on the results, take the top 5 criteria based on the eigenvalue. The percentage of the respective percentage of the criteria described in the Pareto diagram below.
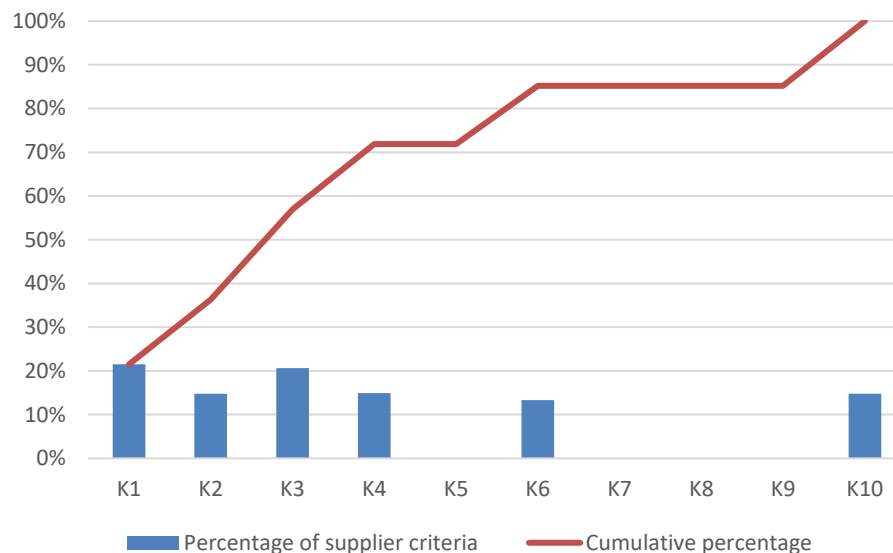


**Figure 2.** Pareto Supplier Selection Criteria

The following is a calculation of the Eigen Value for suppliers.

$$
\begin{vmatrix}
1 & 3 & 1.67 & 2.33 & 1 \\
0.333 & 1 & 3 & 1.67 & 2.33 \\
0.6 & 0.333 & 1 & 3 & 3.67 \\
0.42857 & 0.6 & 0.33 & 1 & 2.33 \\
1 & 0.42 & 0.27 & 0.428 & 1
\end{vmatrix}
\times
\begin{pmatrix}
0.29925 \\
0.23749 \\
0.22217 \\
0.12739 \\
0.1137
\end{pmatrix}
=
\begin{pmatrix}
3.95643 \\
1.48135 \\
1.27995 \\
0.7507 \\
0.6336
\end{pmatrix}
$$

**Table 7.** Eigen Value Supplier

| Supplier | Eigen Value |
|---|---|
| S01 | 3.95643 |
| S02 | 1.48135 |
| S03 | 1.27995 |
| S04 | 0.73749 |
| S05 | 0.62992 |

Table 6 explains the normalization of comparisons twos between criteria. Normalization is obtained from the results of the division each value in the i-the column and j-row with the total value in the i column. The following is a normalization table for the recapitulation of questionnaire data.

**Table 8.** Multiple Matrix normalization between Criteria

| Criteria | K1 | K2 | K3 | K4 | K5 | K6 | K7 | K8 | K9 | K10 | Total | Weight Vector |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K1 | 0,152 | 0,267 | 0,230 | 0,155 | 0,143 | 0,082 | 0,179 | 0,067 | 0,124 | 1,302 | 1,585 | 0,159 |
| K2 | 0,065 | 0,114 | 0,138 | 0,093 | 0,143 | 0,136 | 0,077 | 0,112 | 0,124 | 0,434 | 1,064 | 0,106 |
| K3 | 0,091 | 0,114 | 0,138 | 0,280 | 0,143 | 0,190 | 0,128 | 0,156 | 0,124 | 0,104 | 1,468 | 0,147 |
| K4 | 0,091 | 0,114 | 0,046 | 0,093 | 0,143 | 0,082 | 0,179 | 0,156 | 0,124 | 0,434 | 1,091 | 0,109 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K5 | 0,091 | 0,069 | 0,083 | 0,056 | 0,086 | 0,190 | 0,077 | 0,067 | 0,074 | 0,104 | 0,896 | 0,090 |
| K6 | 0,152 | 0,069 | 0,059 | 0,093 | 0,037 | 0,082 | 0,128 | 0,201 | 0,074 | 0,434 | 0,957 | 0,096 |
| K7 | 0,065 | 0,001 | 0,083 | 0,040 | 0,086 | 0,049 | 0,077 | 0,067 | 0,124 | 0,146 | 0,737 | 0,074 |
| K8 | 0,152 | 0,069 | 0,059 | 0,040 | 0,086 | 0,027 | 0,077 | 0,067 | 0,124 | 0,434 | 0,762 | 0,076 |
| K9 | 0,091 | 0,069 | 0,083 | 0,056 | 0,086 | 0,082 | 0,046 | 0,402 | 0,074 | 0,146 | 0,772 | 0,077 |
| K10 | 0,051 | 0,114 | 0,083 | 0,093 | 0,051 | 0,082 | 0,033 | 0,067 | 0,032 | 0,434 | 0,668 | 0,067 |

**Tabel 9.** Multiple Matrix normalization between Suppliers

| Supplier | S01 | S02 | S03 | S04 | S05 | Jumlah | Weight Vector |
|---|---|---|---|---|---|---|---|
| **S01** | 0,297 | 0,560 | 1,845 | 0,277 | 0,097 | 1,496 | 2,078 |
| **S02** | 0,099 | 0,187 | 0,478 | 0,198 | 0,226 | 1,187 | 1,649 |
| **S03** | 0,178 | 0,062 | 0,159 | 0,356 | 0,355 | 1,111 | 1,543 |
| **S04** | 0,127 | 0,112 | 0,053 | 0,119 | 0,226 | 0,637 | 0,885 |
| **S05** | 0,297 | 0,080 | 0,043 | 0,051 | 0,097 | 0,568 | 0,790 |

*4.4 Test the Consistency of The Data*

The next step, namely, to calculate the Consistency Index (CI) based on the current Eigen Value and Weighting Vector. The steps are as follows:

- Scoring $\lambda$

$$\lambda = \frac{\sum EV}{VB} \dots\dots\dots(1)$$

- Determine the Consistency Index (CI)

$$CI = \frac{(\lambda - n)}{(n-1)} \dots\dots\dots(2)$$

- Determine CR

$$CR = \frac{CI}{RI} \dots\dots\dots(3)$$

The results of the calculation will be the value obtained by CI CR. Data is said to be consistent if the value CR≤0,1.

**Tabel 10.** The results of the calculation of the $\lambda$ on the criteria

| EV | VB | EV/VB | λ |
|---|---|---|---|
| 1.65546 | 0.158547 | 10.44141 | 11.27111 |
| 1.135223 | 0.106384 | 10.67099 | |
| 1.588768 | 0.146818 | 10.82135 | |
| 1.149782 | 0.109062 | 10.54243 | |
| 0.963762 | 0.089639 | 10.75157 | |
| 1.023914 | 0.095664 | 10.70324 | |
| 0.784969 | 0.073655 | 10.6547 | |
| 0.798912 | 0.076241 | 10.47873 | |
| 0.820786 | 0.077187 | 10.63366 | |
| 1.136317 | 0.066802 | 17.01029 | |
| Total | | 112.7111 | |

Based on table 10, CR values obtained on Supplier of 0.0974, which means that the value of CR ≤ 0.1 then the consistent assessment.

*4.5 Determination of Supplier and Criteria*

Determination of supplier based on the eigenvalue. The selected supplier is a supplier to the value of the highest eigenvalue. Likewise, with the criteria considered in determining supplier eigenvalue derived from the value of the highest. The selected supplier is a supplier of 1 with the highest value i.e., and the eigenvalue amounted to 3.956. Table 11 below explains the selected suppliers

**Table 11.** Supplier Selected

| Supplier | Eigen Value |
|----------|-------------|
| S01 | 3.95643 |
| S02 | 1.48135 |
| S03 | 1.27995 |
| S04 | 0.73749 |
| S05 | 0.62992 |

Criteria to consider in determining the best supplier is the first criteria, namely price bidding, with eigenvalues of 1.655. Next up is the level of disability, the distance with supplier companies, the ability to provide information in a clear and easy to understand, and delivery time can be seen in table 12.

**Table 12.** The criteria taken into consideration

| Criteria | Eigen Value |
|----------|-------------|
| K 1 | 1.165 |
| K 2 | 1.135 |
| K 3 | 1.589 |
| K 4 | 1.150 |
| K 5 | 0.964 |
| K 6 | 1.024 |
| K 7 | 0.785 |
| K 8 | 0.799 |
| K 9 | 0.821 |
| K 10 | 1.136 |

*4.6 Analysis and Interpretation of Result*
- Analysis of the Criteria Hierarchy Structure

The hierarchical structure is a hierarchical model to show criteria that influence supplier determination. Based on a hierarchical structure, the criteria used in determining suppliers are price purchase, delivery time, defect rate, supplier distance from the company, the ease of adding or reducing the number of orders, giving a guarantee or warranty on goods, transportation costs, speed in terms of responding customer demand, the ability to fulfill the number of orders, the ability to provide information clearly and easily understood. Criteria were obtained from literature studies and previous research.
- Analysis of the Questionnaire Recapitulation

The questionnaire was given to 3 respondents each from the production, procurement, and logistics. Based on the calculation of the eigenvalue, priority selection criteria are obtained suppliers based on the highest to the lowest eigenvalue. Criteria consider the bid price, the level of disability, and the supplier's distance to the company.
- Supplier Determination Analysis

The suppliers used in the research of plate suppliers are because of the plate components have high price fluctuations. Based on the results of the eigenvalue calculation, The selected supplier is supplier 1, with the largest eigenvalue, which is equal to 3.9564. Then the next supplier is supplier 2 with an eigenvalue of 1.4813, and the last is supplier 3 with an eigenvalue of 1.27995. Then the last supplier 4 and 5.

**5. Conclusion**

The supplier selection method has been carried out using an analytical hierarchy process (AHP) approach. Based on processing and data analysis that has been done in the previous section, then the conclusions that can be drawn are set the supplier one as the best. It can know with the highest end of

the value in the calculation of the end of the AHP, the value of 3.95643, and the most criteria considered in determining supplier is the bid price. Suggestions for further research need to be considered or take into account the costs in selecting suppliers such as optimization on
storage costs with several suppliers that have been ranked.

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