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# PVC Resin Supplier Selection with Integration of AHP and TOPSIS Methods

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**ABSTRACT**

Choosing the right suppliers is important for companies to provide raw materials for production in the long run. The sustainability of production activities is tightly controlled by suppliers in the manufacturing industry. A company in Mojokerto that manufactures PVC pipes falls under the plastic pipe industry sector. Raw materials for PVC resins must be ensured through assessments of suppliers. This study was conducted to determine which resin supplier was the best based on predetermined criteria. Variable include: price, quality, delivery, quantity accuracy, and service. To determine the order of preference for resin suppliers, this study uses AHP, which gives the individual a probability score for each criterion, and TOPSIS, which gives the user an indication of which supplier to choose when selecting a resin. As a result of data processing, suppliers are ranked based on their preferences. The preference values for each supplier are: supplier 1, which is 0.927; supplier 2, which is 0.739; supplier 3, which is 0.091; and supplier 4, which is 0.267. There are five parameters used in this study, and quality is known to have an influence of about 47% on the four suppliers. However, the delivery and service parameters only contribute 5%.



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## INTRODUCTION

As the manufacturing business has developed at an increasingly fast pace, competitiveness has become increasingly strict [1]. To survive in the competition, the company needs to conduct a supplier assessment so that the production process runs smoothly [2]. The company's suppliers play a crucial role in providing raw materials to sustain its production activities [3]. Choosing the right supplier can increase the effectiveness of the company, as well as the customers' confidence in the quality of the products it produces [4].

There are two major criteria to consider when selecting a supplier: the delivery time and the price offered [5]. Additionally, several other factors were overlooked, including tight competition between suppliers and the need to build long-term relationships [6]. The criteria of quality, accuracy, flexibility and cost are used as indicators to select suppliers for goods and services that are available [7]. Some previous studies have established criteria in selecting Supplier's raw materials. For example, Dickson lists 23 criteria in determining raw material suppliers [8], Fei lists 14 criteria [9], as well as Chang with 20 criteria [10].

The plastic pipe industry in Mojokerto entrusts four suppliers to provide raw materials for the manufacturing process. A high-quality PVC resin used as the primary raw material can significantly improve the quality and performance of the product. The company has an issue with supplier delivery timeliness. Often, suppliers do not fulfill delivery obligations on time and exceed the timeframe stated by their companies. Usually, suppliers deliver goods within two to three days of receiving them from their companies. Due to the delay caused by the inability to obtain raw materials, the production process was slowed down, causing the workers to interfere and prevent the activities that were necessary for the production process. The company's profits were reduced as a result.

Currently, the company selects suppliers based on a supplier's lowest bid price and the quantity and type of raw materials they are ordered to supply. When using raw materials in the production process, the company will be at high risk if it only considers the lowest price and the suitability of the amount. The type of material can cause damage to raw materials and cause the manufacturing process to be slowed down and prolonged if the type of material chosen is poor.

In light of these issues, the company needs a method to evaluate the choice of PVC resin suppliers so the company can meet its production requirements. Among the methods used in supplier assessment are Analytic Hierarchy Process (AHP) and TOPSIS. In using AHP, each criterion is assigned a subjective weighting for the purpose of evaluating suppliers [11]. When choosing or determining the most appropriate suppliers, priorities cannot be determined or chosen subjectively. Consequently, an integrated method of selecting resin raw material suppliers that uses the AHP method and the TOPSIS method can be used to determine which supplier will supply the right resin raw material.

More than 63% of supplier selection studies was based on multiple criteria in past studies [12]. In Pitchaiah's reasearch [13] shown that DEA is the most common technique for resolving supplier selection issues, while AHP-GP is the most widely integrated approach. Additionally, the most important criteria for selecting suppliers are not price or
cost but quality and delivery. As a result, the AHP method is ineffective for cases with many criteria and alternatives [14]. Therefore, to improve effectiveness must incorporate other techniques with the AHP method. In Akbas's research [15] supplier selection is based on fuzzy AHP with four criteria and 12 attributes that ignore many

important factors that create uncertainty in supplying products, especially risk factor considerations when selecting global suppliers. Many AHP combinations have been utilized, such as [16] AHP- PROMOTHEE are given with many preferences. Every preference should consider the compatibility between the objects studied and the preferences to be used. In Wibawa's research [17] fuzzy AHP, TOPSIS, and SMART are used to compare supplier selection methods. As a result of the fuzzy conformity index and the fuzzy rating values being difficult to calculate, fuzzy AHP creates different supplier roles. SMART is a straightforward way to analyze complex issues, making the results inconsistent. The TOPSIS calculation can deliver optimal alternative results based on positive and negative ideal solutions, allowing supplier selection to be more optimal. Still, there is no valid method for determining supplier priority weights, so other methods are needed**.**

There are gaps in a parameter based on previous research. In this study, we added parameters that fill in research gaps, and these parameters are a combination of prior studies. In this study, quantity accuracy was one of the most influential parameters for supplier selection. Quantity accuracy of raw materials that are not following the order will lead to losses for the company. The production process will be accurate since the supply chain runs according to the master requirement plan. In addition, by providing this parameter, the research pad results can be better supported in making decisions.
Furthermore, researchers had failed to handle decisions efficiently and effectively when the criteria and sub-criteria were inconsistent in an actual situation. The selection of suppliers is not conducted according to essential criteria, resulting in uncertainty in supplying raw materials. A problem with choosing suppliers using popular techniques is failing to consider the company's needs. Therefore, authors suggested using AHP and TOPSIS methods for evaluating suppliers in the plastic pipe industry in Mojokerto to fill this research gap. With a pair comparison matrix, AHP and TOPSIS combine to provide advantages based on the ability to conduct consistency analysis or measure the relative effectiveness of decision alternatives. This study suggests that companies should focus on the quality criteria of their PVC resin suppliers when selecting them. Furthermore, the company employs the AHP - TOPSIS methodology in selecting PVC resin suppliers and make other decisions

## RESEARCH METHOD

Several factors determine the best supplier alternatives with the application of multi-criterion decision methods. A combination of interviews conducted between researchers and the company and several reviews of existing literature was used to develop the criteria. The research was conducted at a plastic pipe industry company in Mojokerto, East Java. In this study, the data were collected through direct interviews with trusted sources, or the Head of Supply Chain, regarding both the production process and the level of performance of raw material suppliers. Secondly, the respondents were asked to complete questionnaires, which provide data and information about suppliers. The respondents were Production Managers, Supply Chain Managers, Human Resources Managers, Maintenance Managers, and Quality Assurance Managers.

After obtaining data from the results of interviews and the dissemination of questionnaires, the next step is data processing. Analysis of the selection of appropriate supplier criteria is an element used in the decision-making system in supplier selection. In this study, authors used an AHP and TOPSIS methods as their data processing. The


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following is the research methodology depicted in Figure 1 below.

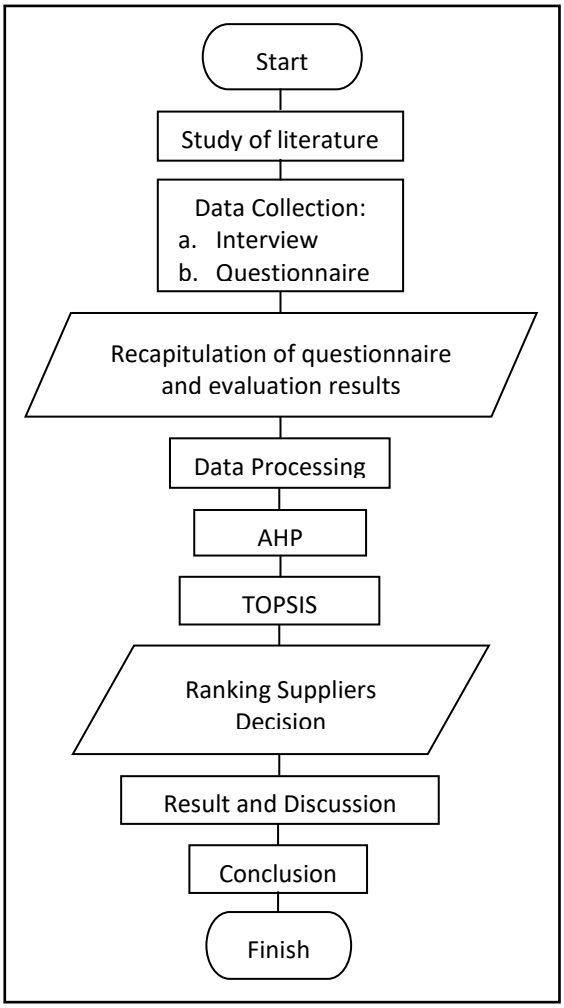


**Figure 1.** Research Methodology

***Analytical Hierarchy Process (AHP)***

The AHP method consists of determines some criteria and gives rankings on available alternatives based on those criteria [18]. Using AHP, multi-objective and multi-criteria problems can be solved by comparing the preferences of each hierarchy element [19]. In theory, the AHP method arranges the alternatives and their weights in a hierarchical arrangement and then calculates values based on subjective assessments of the level of significance of criteria variables and sub-criteria of each alternative [20].

Here are the steps for solving problems using the AHP method [21]:

a. Defining and understanding problems by creating a hierarchy of objectives, supplier criteria, supplier sub-criteria, and the existing suppliers.
b. Create a comparison matrix in pairs. In terms of comparison, it is entirely up to the person who is considered to have the best understanding of the problems and conditions in the field. The purpose of this comparison is to measure the level of interest in criteria and sub-criteria.

c. Using the normalized paired comparison matrix, multiply the vector eigenvalue to find the consistency value.
d. All three steps b, c, and d must be repeated for every component in the hierarchy.

e. Calculates the eigenvalue (λ max) by dividing the result of the sum of each line by the total amount.
f. To determine whether the data obtained is valid, consistency tests are conducted

The hierarchy consistency test has a CR value provision of < 0.1
CR value obtained from:

$$CR = \frac{CI}{RI} \quad (1)$$

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

CI = Consistency Index
λ max = Eigenvalue
n = Total matrix comparison

Through Table 1, one can observe the average value of the Random Index (RI) based on Franek's opinion [22]:

**Table 1.** Random Index Table

| N | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Random Index | 0 | 0 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 |

In cases where a CR value was not within the requirements, the results were deemed inconsistent and needed to be reviewed.

***Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)***

In 1982, Yoon together with Hwang developed a TOPSIS approach, decisions are made based on multiple criteria, allowing management to make informed decisions [23]. The TOPSIS approach makes decisions based on alternative distances between the positive and negative results of the solution [24]. As a result of TOPSIS method, all resulting parameters should be simplified or minimized. Accordingly, the ideal solutions must be both positive and negative for each of a criteria parameters as well as evaluate each alternative option. It is also necessary to identify the results of positive and negative perfect solutions [25]. The TOPSIS process Will evaluate each alternative's measurable proximity to the positive ideal as a primary factor determining its outcome [26].

Following are the algorithmic steps involved in TOPSIS [27] :

a. Create a matrix for decision-making based on the supplier criteria assessment
b. Transform each element in the decision matrix to normalize the results

$$r_{ij} = \frac{x_{ij}}{\sqrt{\Sigma_{i=1}^{m} x_{ij}^2}} \quad (3)$$

value $j = 1, 2, \dots, n$; and $i = 1, 2, 3, \dots, m$
c. Create a matrix of normalized weighted decisions. The matrix is determined by imitating a normalized decision matrix with related weights.
yij = wi x rij (4)
d. Generate a matrix with one positive and negative ideal solution, where $A^+$ shows the positive ideal solution, and $A^-$ shows the negative ideal solution.
$A^+ = (y_1^+, y_2^+, \dots, y_n^+)$
$\{(\max yij|\ j \in J), (\min yij|\ j \in J')\}$ (5)
$A^- = (y_1^-, y_2^-, \dots, y_n^-)$
$\{(\min yij|j \in J), (\max yij\ |ju \in J')\}$ (6)
with,
J = { j = 1,2,..n | j is benefit criteria}
J = { j = 1,2,..n | j is cost criteria}


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e. Calculate the distance between each value of the alternative.

$$D_i^+ = \sqrt{\Sigma_{j=i}^n (y_i^+ - y_i)^2} \quad (7)$$

$$D_i^- = \sqrt{\Sigma_{j=i}^n \left(y_{ij} - y_i^-\right)^2} \quad (8)$$

value $i = 1, 2, 3, \ldots, m$

f. Compute a value of preference for each alternative

$$Vi = \frac{D_i^-}{D_i^- + D_i^+} \quad (9)$$

Values of Vi range from 0 to 1. When compared with other Ai alternatives, the specified alternative includes the highest Vi value.

## RESULT AND DISCUSSION

In choosing the best supplier, the company needs to conduct a supplier assessment in terms of criteria and sub-criteria. Consequently, a supplier's performance will be assessed using these criteria and sub-criteria as standards. In relation to the continuity of cooperation between the company and its suppliers, assessment results can be used to make decisions. The data collected through a questionnaire were answered by five respondents. According to the questionnaire, suppliers are evaluated on price, quality, delivery, number accuracy, and service. Then from these criteria, there are ten sub-criteria. There are four alternatives, among them supplier 1, supplier 2, supplier 3, and supplier 4. These are the criteria and sub-criteria for select suppliers. Table 2 summarizes the criteria.

**Table 2.** List of Factors Used to Select Suppliers

| Criteria | Sub-criteria |
|---|---|
| **Price (P)** | Price level (P1) |
| | Discount (P2) |
| **Quality (Q)** | Suitability of goods specifications (Q1) |
| | Defect of goods(Q2) |
| **Delivery (D)** | On-time delivery (D1) |
| | Delivery quantity accuracy (D2) |
| **Quantity Accuracy (A)** | Suitability of delivery amount (A1) |
| | Suitability of packaging contents (A2) |
| **Service (S)** | Ease of complaining (S1) |
| | Speed of responding to requests (S2) |

Multiple criteria are used to identify a hierarchy of problems in hierarchical systems. The hierarchical structure starts with alternatives and solutions at the bottom level, then continues with several criteria and sub-criteria above. In a hierarchical structure, the highest position is what needs to be achieved. The first level of a hierarchical structure is the solution, followed by several levels of criteria, then sub-criteria. A top position is ultimately aimed for in a hierarchy. Figure 2 shows the hierarchy of the system we will use in this study.

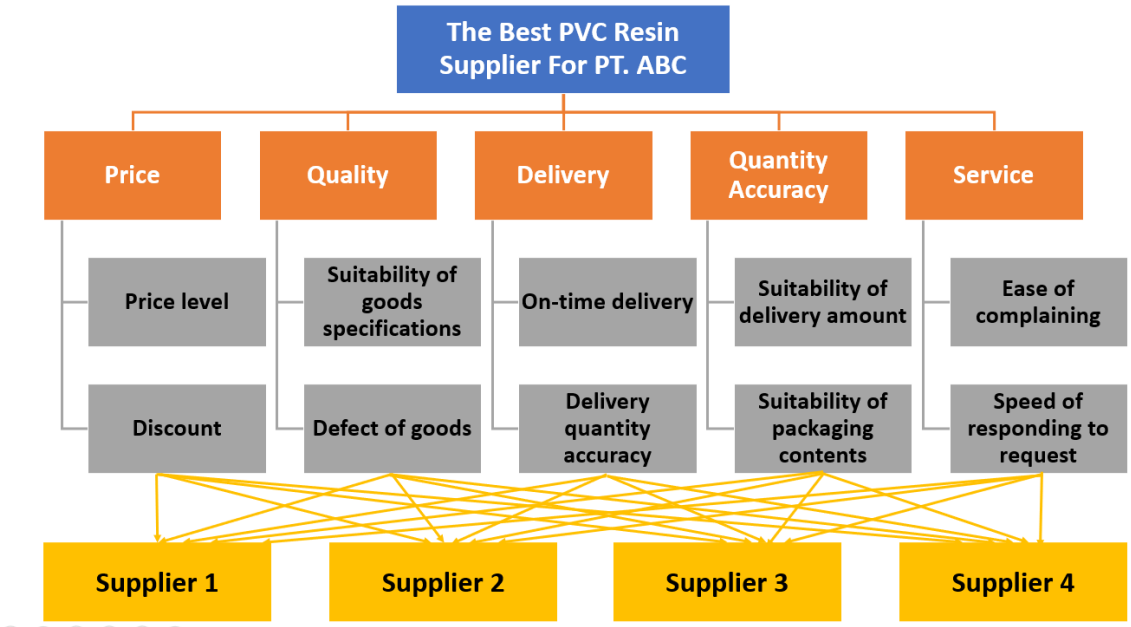


**Figure 2.** Hierarchical Structure of PVC Resin Supplier Selection

***Weight Assessment of Supplier Criteria with AHP Method***

a. The matrix of paired comparisons of criteria obtained from the recapitulation of respondent evaluations. Results of the supplier performance evaluations are incorporated into a paired comparison matrix for each criterion (table 3).

**Table 3.** Initial Matrix of Paired Comparisons Between Criteria

| Criteria | Price | Quality | Delivery | Quantity Accuracy | Service |
|---|---|---|---|---|---|
| **Price** | 1 | 0.12 | 3 | 0.14 | 4 |
| **Quality** | 8 | 1 | 8 | 2 | 6 |
| **Delivery** | 0.33 | 0.12 | 1 | 0.14 | 1 |
| **Quantity Accuracy** | 7 | 0.5 | 7 | 1 | 6 |
| **Service** | 0.25 | 0.16 | 1 | 0.16 | 1 |
| **Total** | 16.58 | 1.9 | 20 | 3.44 | 18 |

b. A normalization matrix is constructed by dividing the column elements by the column's total value. (table 4).

**Table 4.** Results of Matrix Normalization Between Criteria

| Criteria | Price | Quality | Delivery | Quantity Accuracy | Service |
|---|---|---|---|---|---|
| **Price** | 0.060 | 0.063 | 0.150 | 0.041 | 0.222 |
| **Quality** | 0.483 | 0.526 | 0.400 | 0.581 | 0.333 |
| **Delivery** | 0.020 | 0.063 | 0.050 | 0.041 | 0.056 |
| **Quantity Accuracy** | 0.422 | 0.263 | 0.350 | 0.291 | 0.333 |
| **Service** | 0.015 | 0.084 | 0.050 | 0.047 | 0.056 |
| **Total** | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

c. Calculates the consistency of the paired comparison matrix by multiplying each matrix column by every matrix row (table 5).


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**Table 5.** Eigen Vector Results Matrix Paired Criteria

| Criteria | *Eigen Vector* | Share Results |
|---|---|---|
| **Price** | 0.5482 | 5.109888 |
| **Quality** | 2.6552 | 5.713708 |
| **Delivery** | 0.2338 | 5.097015 |
| **Quantity Accuracy** | 1.9378 | 5.839057 |
| **Service** | 0.2504 | 4.981135 |

d. Calculates the value of λ max

$\lambda \text{ max} = \frac{\Sigma(\frac{Wij}{\Sigma Wj})}{n}$

λ max = (5.109888 + 5.713708 + 5.097015 + 5.839057 + 4.981135) / 5

= 5.3482

Based on the calculations above, it can be inferred that λ max is 5.3482.

e. The consistency index is calculated by calculating the value of:

$CI = \frac{\lambda \max - n}{n-1}$

$CI = \frac{5.3482 - 5}{5-1} = 0.0870$

Based on the above calculation it can be shown that CI is 0.0870. The following CI values are used to calculate consistency ratio values (CR).

f. To calculate consistency ratio (CR), divide the CI value by the randomly generated index (RI). If matrix order n = 5, then RI = 1.12.

$CR = \frac{CI}{RI}$

$CR = \frac{0.0870}{1.12} = 0.0777$

It is reported as 0.0777, simply because the CR value is within the tolerance limit (0.1), so the comparison matrix of paired criteria is considered consistent and does not need to be reevaluated. Table 6 shows the final weight values for each criteria and sub-criteria.

**Table 6.** Final Weight Value Results of Each Criterion

| Criteria | Weight Results | Sub-Criteria | Weight Results |
|---|---|---|---|
| **Price (P)** | 0.107 | Price level (P1) | 0.797 |
| | | Discount (P2) | 0.203 |
| **Quality (Q)** | 0.465 | Suitability of goods specifications (Q1) | 0.888 |
| | | Defect of goods(Q2) | 0.112 |
| **Delivery (D)** | 0.046 | On-time delivery performance (D1) | 0.351 |
| | | Quantity reliability delivery (D2) | 0.649 |
| **Quantity Accuracy (A)** | 0.332 | Suitability of delivery amount (A1) | 0.682 |
| | | Suitability of packaging contents (A2) | 0.318 |
| **Service (S)** | 0.050 | Ease of complaining (S1) | 0.273 |
| | | Speed of responding to requests (S2) | 0.727 |

***Ranking Supplier Based on TOPSIS Method***

Supplier reviews were conducted by five respondents who knew and were responsible for the procurement of PVC resin raw materials, including the Manager of Production, Manager of Supply Chain, Manager of Maintenance, Manager of Human Resource, and Manager of Quality Assurance. Steps involved in determining the supplier:

a. Create a decision matrix based on the questionnaire results to compare suppliers according to their criteria and sub-criteria. Table 7 provides an overview of potential suppliers.

**Table 7.** Supplier Alternative Comparison Matrix

| Supplier | P | | Q | | D | | A | | S | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P1 | P2 | Q1 | Q2 | D1 | D2 | A1 | A2 | S1 | S2 |
| Supplier 1 | 2 | 3 | 5 | 4 | 5 | 5 | 5 | 5 | 3 | 4 |
| Supplier 2 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 4 |
| Supplier 3 | 4 | 4 | 2 | 3 | 5 | 5 | 5 | 5 | 3 | 4 |
| Supplier 4 | 4 | 4 | 3 | 3 | 5 | 5 | 5 | 5 | 3 | 4 |

b. The matrix of decision is calculated by calculating the normalized decision using the alternative decisions m and n. Table 8 shows the results of normalizing the decision matrix.

**Table 8.** Normalized Decision Matrix

| Supplier | P | | Q | | D | | A | | S | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P1 | P2 | Q1 | Q2 | D1 | D2 | A1 | A2 | S1 | S2 |
| Supplier 1 | 0.30 | 0.42 | 0.63 | 0.52 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Supplier 2 | 0.45 | 0.42 | 0.63 | 0.65 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Supplier 3 | 0.60 | 0.57 | 0.25 | 0.39 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Supplier 4 | 0.60 | 0.57 | 0.38 | 0.39 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

c. Weighting is calculated by adjusting rows and columns in the normalized decision matrix according to the weight assigned to test results by the AHP method. Table 9 shows matrix of weighted normalized decisions.

**Table 9.** Matrix of Weighted Normalized Decision Making

| Supplier | P | | Q | | D | | A | | S | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P1 | P2 | Q1 | Q2 | D1 | D2 | A1 | A2 | S1 | S2 |
| Supplier 1 | 0.24 | 0.09 | 0.56 | 0.06 | 0.18 | 0.33 | 0.34 | 0.16 | 0.14 | 0.36 |
| Supplier 2 | 0.36 | 0.09 | 0.56 | 0.07 | 0.18 | 0.33 | 0.34 | 0.16 | 0.14 | 0.36 |
| Supplier 3 | 0.48 | 0.12 | 0.22 | 0.04 | 0.18 | 0.33 | 0.34 | 0.16 | 0.14 | 0.36 |
| Supplier 4 | 0.48 | 0.12 | 0.34 | 0.04 | 0.18 | 0.33 | 0.34 | 0.16 | 0.14 | 0.36 |

d. In order to find out a positive ($A^+$) and negative ideal solution ($A^-$), weight ratings are normalized. The following table 10 shows both solutions that are positive ideals as well as negative ideals ranked by sub-criteria.

**Table 10.** Matrix of ideal positive ($A^+$) and negative solutions ($A^-$)

| Criteria | Ideal Positive Solution ($A^+$) | Ideal Negative Solution ($A^-$) |
|---|---|---|
| P1 | 0.2376 | 0.4752 |
| P2 | 0.1148 | 0.0861 |
| Q1 | 0.5594 | 0.2238 |
| Q2 | 0.0437 | 0.0729 |
| D1 | 0.1755 | 0.1755 |


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| Criteria | Ideal Positive Solution ($A^+$) | Ideal Negative Solution ($A^-$) |
|---|---|---|
| P1 | 0.2376 | 0.4752 |
| D2 | 0.3245 | 0.3245 |
| A1 | 0.3410 | 0.3410 |
| A2 | 0.1590 | 0.1590 |
| S1 | 0.1365 | 0.1365 |
| S2 | 0.3635 | 0.3635 |

e. Calculate the distance of value from each alternative by comparing proximity relative to the positive ideal solution ($A^+$) and the negative ideal solution ($A^-$) (Table 11).

**Table 11.** Value Distances for Each Alternative

| Supplier | $D^+$ | $D^-$ |
|---|---|---|
| Supplier 1 | 0.032199 | 0.411491 |
| Supplier 2 | 0.12566 | 0.356041 |
| Supplier 3 | 0.411232 | 0.040922 |
| Supplier4 | 0.326388 | 0.119127 |

f. Assigns a value to each alternative according to its preference. A preference value refers to a value that describes the proximity distance value of an alternative to its ideal solution. The alternative (Ai) with a higher preference value is preferred.

**Table 12.** Preference Value

| Supplier | Preference |
|---|---|
| Supplier 1 | 0.9274286 |
| Supplier 2 | 0.7391329 |
| Supplier 3 | 0.0905047 |
| Supplier 4 | 0.2673912 |

Based on Table 12, the preferred supplier for this plastic pipe industry is Supplier 1. As a result, it has the highest preference result compared to the other suppliers. In detail, the results of the weighting of the criteria show that quality takes priority over price. In addition to Table 6, the weight result for quality is 0.465, the weight result for Q1 is 0.888, and the weight result for Q2 is 0.112. The results of this study support previous research by Kumar [28], which concluded that price is not one of the most influential components in supplier selection. If quality, quantity accuracy, delivery, and service do not align with the company's efficiency, there can be irreparable damage and losses. In the same way, Adam's research [29] suggests that "low price does not always indicate good quality raw materials and reliable supplier service." As an established industry, plastic pipe holds a positive reputation in the community. Therefore, quality criteria need to be carefully considered, and raw

materials purchased should conform to quality standards.

This study can utilize an integrated approach of AHP and TOPSIS to identify which suppliers and supplier selection indicators are suitable to supply long-term raw materials for the company. Based on the integration of the methods used by suppliers, the highest preference value was selected, which is supplier 1.

The interviews and questionnaires completed by top managers suggest that selecting suppliers include price, quality, delivery, quantity accuracy, and service. The authors used AHP and TOPSIS for this study to assess and identify the best suppliers in the plastic pipe industry. Criteria for evaluating suppliers are determined by the AHP model, in which the respondents decide the weighting of the criteria. At the end of the process, TOPSIS is used to rank suppliers. TOPSIS will choose a supplier with a higher preference value, and the supplier with the lowest preference value can be evaluated or replaced.

Using these studies as decision-making tools eliminates subjective judgments and help companies make objective decisions. By following this method, the PVC pipe industry will be able to find suppliers it can rely on as long-term business partners that fulfill the company's raw material requirements for PVC resin.

## CONCLUSION

Based on the results of processing the data through AHP and TOPSIS, it was concluded that Supplier 1 has the highest priority value result compared to other suppliers, which is 0.927. To establish a cooperative relationship between the company and supplier, supplier 1 will consider the criteria of quality, price, delivery, quantity accuracy, and service. Quality criteria have the most dominant influence of 47% on suppliers of PVC resin. This is the main criterion that is most prioritized in the selection process.

Further research is needed to address some of the limitations of this study. The limitations of this research leave some space for improvement and provide a good foundation for future research in selecting and evaluating sustainable suppliers. For example, additional empirical research is needed to determine the framework for the plastic pipe industry. The research can be more thorough if it considers more respondents and broader organizations in the industry, even though only a few managers from plastic pipe companies participate in the data retrieval process. In addition, further research should be conducted to add additional factors such as location, lead time, and payment method as more complex variables since the study focuses on five parameters, including price, quality, delivery, quantity accuracy, and service. Considerations must be taken when determining how many sustainability criteria are required or applied to make those final decisions from the results.

This study suggests that companies should emphasize the quality criteria provided by their PVC resin suppliers in selecting suppliers. Additionally, the company utilizes the AHP - TOPSIS methodology when selecting PVC resin suppliers and other decision-making processes.


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## NOMENCLATURE

CI = Consistency Index
λ max = eigenvalue
P = Price
P1 = Price level
P2 = Discount
Q = Quality
Q1 = Suitability of goods specifications
Q2 = Defect of goods
D = Delivery
D1 = On-time delivery
D2 = Delivery quantity accuracy
A = Quantity Accuracy
A1 = Suitability of delivery amount
A2 = Suitability of packaging contents
S = Service
S1 = Ease of complaining
S2 = Speed of responding to requests


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