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COMPARISON OF SAW, AHP, AND TOPSIS METHODS IN IMPROVING THE QUALITY OF SUPPLIER SELECTION RESULTS AT PT. Selamat Sempurna Tbk

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Abstract

Suppliers are a crucial element in the supply chain with a significant impact on the continuity of production processes. PT. Selamat Sempurna Tbk., located in Tangerang, is an automotive component industry that collaborates with several packaging suppliers (Duplek). However, the supplier selection process is still subjective, and a decision-making method has not yet been established. The diverse standards set by suppliers make the selection process less effective. In line with this issue, PT. Selamat Sempurna Tbk. requires decision-making methods, namely SAW, AHP, and TOPSIS. Through interviews with relevant stakeholders, supplier selection criteria are identified, weighted, and assigned levels of importance. The criteria include product quality, delivery capability, warranty, ISO certification ownership status, price, and minimum order quantity. The calculation process involves comparing the three methods. Based on the research findings, the SAW method selected PT. PHI (0.958), while the AHP method (0.256) and the TOPSIS method (0.891) selected PT. PGU. The final evaluation results of the three methods indicate differences in values and rankings, as each method employs different approaches in evaluating supplier selection criteria. Among the three methods, it can be concluded that the SAW method is easier to understand but pays less attention to the interrelationships between criteria. The AHP method places greater emphasis on pairwise weighting processes, whereas the TOPSIS method provides clearer results by comparing distances to ideal solutions, but it requires precise comparative data for accurate results.

Keywords: SAW, AHP, TOPSIS, Supplier Selection

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A. Introduction

According to Nugraha and Nursholihah (2020), every individual plays a role as a decision-maker, and decision-making occurs almost constantly in daily life. The decisions made by individuals have a significant impact on the quality of the outcomes achieved, particularly in producing high-quality products. The optimization of product quality is influenced by various factors, such as the smoothness of the production process and the improvement of product quality itself. One of the factors that supports the smooth running of the production process is the supplier or raw material provider. Suppliers can be individuals or companies that supply raw materials to other parties, whether individuals or companies, to be processed into specific goods or services (Shabira dan Sutrisno, 2022).

As a crucial part of the supply chain, suppliers have a significant impact on the continuity of a company's production process. The substantial influence of suppliers drives business actors to make decisions with a high level of objectivity. However, the diversity of standards and quality offered by suppliers often presents challenges for decision-makers in selecting the most suitable supplier. In many companies, the supplier selection process is still conducted subjectively, which can potentially lead to suboptimal decisions. Therefore, a more structured and objective method is needed to assist in this decision-making process. The method utilized is expected to provide accurate calculations and facilitate supplier evaluation, ensuring that the decisions made are more targeted and effective (Hapid et al., 2020).

Suppliers are an integral part of the development of logistics management concepts and functions. This element encompasses various activities related to the flow of goods, such as procurement, inventory control, transportation, storage, and distribution, all of which take place within a single company. In a horizontal context, there are five key players in the supply chain: suppliers, manufacturers, distributors, retailers, and customers. Vertically, the supply chain involves roles such as buyers, transporters, warehouse operators, sellers, and others. This concept highlights the comprehensive integration of various supply chain elements to ensure the smoothness and efficiency of a company's operations (Hapid et al., 2020).

From the explanation above, it can be concluded that suppliers are a vital key element for the continuity of a company. Their role contributes significantly to the operational sustainability of the business. Given the diverse need for raw materials, companies often choose to collaborate with more than one supplier. However, this practice also carries the potential for conflict. Therefore, companies must adopt a selective approach in choosing suppliers to establish strategic partnerships. Selecting the right suppliers and fostering effective collaboration are crucial steps to ensure the quality

of raw materials and services, thereby supporting smooth production processes and the long-term sustainability of the business.

In the business world, companies can achieve both direct and indirect benefits through optimal supplier selection. These benefits can be realized by establishing a hierarchy of priorities or considering various factors that influence the process of selecting the best supplier for the company's progress. Choosing the right supplier can also minimize the risk of errors in decision-making related to suppliers (Maullana *et al*., 2021).

The selection of suppliers, whether existing or new ones, has the potential to result in errors that could lead to significant losses for the company. Therefore, the supplier selection process becomes a critical aspect of the company's purchasing activities. Purchasing activities play a strategic role as they involve components, raw materials, and inventory that form a substantial part of the company's final products. Making the right decision in choosing suppliers is essential to minimize risks and ensure smooth operations and quality within the company's supply chain (Fachrizal *et al*., 2022).

The smooth operation of a company's supply chain can be achieved through collaboration with reliable suppliers who provide raw materials to be processed into products for customers. The quality of materials obtained from suppliers significantly impacts the final product's quality. High-quality materials from suppliers result in superior products, while low-quality materials can lead to unsatisfactory products, financial losses, and production delays. Each supplier has its own strengths and weaknesses. However, finding and selecting the best supplier among the available options often poses a significant challenge for companies. (Maullana *et al*., 2021).

The same issue is faced by PT. Selamat Sempurna Tbk., which continues to encounter difficulties in selecting the right supplier. This challenge arises from the absence of decision reports or evaluations of the best suppliers. Supplier selection is still conducted subjectively, without a clear decision-making method or a structured supplier report, making it difficult for the company to identify available suppliers that were not selected. Consequently, stakeholders face challenges in determining the most suitable supplier.

Based on the above description, this study will discuss efforts to improve the quality of supplier selection by comparing several decision-making methods, namely Simple Additive Weighting (SAW), Analytical Hierarchy Process (AHP), and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). Each of these methods has its own advantages that can assist and simplify the decision-making process.

The SAW method has the advantage of being able to make more accurate and precise assessments using both qualitative and quantitative data. This is based on the criteria values and preference weights that have been predetermined. In addition, SAW

can select the best alternative from a set of available alternatives due to the ranking process after assigning weights to each attribute. The results of the SAW calculation are easy to explain and understand because of its direct and simple process. (Qiyamulllailiy *et al*., 2020).

The advantage of the AHP method, according to (Bhagawati, 2022) lies in its ability to use a clear hierarchical structure by breaking down the decision problem into a hierarchy consisting of objectives, criteria, sub-criteria, and alternatives. AHP allows the use of both qualitative and quantitative data, providing flexibility in assessing various different criteria (Chen, 2020). This method also helps to check the logical consistency of the users' assessments of the criteria, thus improving the reliability of the decision results. Additionally, AHP can involve multiple stakeholders in the decision-making process, enabling broader and more inclusive participation. In the context of multi-criteria decision-making, this method is highly effective for solving problems that involve many criteria and require a comprehensive evaluation. (Menon dan Ravi, 2022).

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B. Method

The initial stage of the research begins with observations on the supplier selection process to understand how suppliers are chosen and what factors are considered in the selection. Afterward, the researcher prepares a list of questions that will form the basis for the research objectives. These questions cover aspects that need to be understood or improved in the supplier selection process. Next, supplier identification is carried out by determining the criteria used to evaluate suppliers and assigning weights to each criterion according to its level of importance. Suppliers are then classified based on the criteria and weights that have been established through interviews with relevant stakeholders to gather more information about the suppliers and the criteria used. Additionally, identification of the factors influencing supplier selection is conducted through discussions with company management, particularly in the Procurement Department, to identify the best suppliers at PT. Selamat Sempurna Tbk. The next step involves applying decision-making methods such as SAW, AHP, and TOPSIS. Based on the analysis and discussions carried out in the previous stages, the company can then determine the best supplier based on the evaluation that has been identified and discussed.

C. Finding and Discussion

1. Analysis Using the SAW Method

The following is the data collected from observations for data processing using the SAW method.

a. Supplier Criteria Based on Price Competitiveness

Price information was obtained from the purchase data available in the Procurement Department. Due to other considerations, written information related to price quotations cannot be disclosed for the research document or final project. The results of the observations on the price competitiveness criteria are shown in Table 1.

Table 1 Supplier Criteria Based on Price Competitiveness

No	Supplier Name	Price Competitiveness
1	PT. Panca Garda Ultima	≥ Rp. 3.000,00
2	PT. Tiga Cahaya Cemerlang	≤ Rp. 2.000,00
3	PT. Tristan Alur Jayadi	≤ Rp. 2.000,00
4	PT. Wesko Abadi Prima	< Rp. 3.000,00
5	PT. Prima Honeycomb International	< Rp. 3.000,00

b. Supplier Criteria Based on Quality (Product Deviations)

The product deviation data is obtained from the Quality Assurance (QA) department in the form of a document titled "Request for Corrective Action to Supplier," also known as the PTKKS document, which is sent to the supplier through the Procurement Department (Buyer). PTKKS is issued based on deviations or non-conformities found during the production process or upon initial arrival of the goods. Each supplier who receives PTKKS must be able to provide an analysis of the cause, preventive actions, and corrective actions that will be taken moving forward. The observation results for the quality criteria (product deviations) are shown in Table 2.

Table 2 Supplier Criteria Based on Quality (Product Deviations)

No	Supplier Name	Quality Criteria (Product Deviations)
1	PT. Panca Garda Ultima	1 deviations
2	PT. Tiga Cahaya Cemerlang	3 deviations
3	PT. Tristan Alur Jayadi	14 deviations
4	PT. Wesko Abadi Prima	4 deviations
5	PT. Prima Honeycomb International	13 deviations

c. Supplier Capability Based on Delivery Performance

The information related to the delivery timeliness criterion was obtained from the "Questionnaire for New Suppliers." For suppliers who have been working with PT. Selamat Sempurna Tbk for a longer period, and where the mentioned document has been destroyed in accordance with retention periods, this information was reassessed

by contacting the suppliers through a Google Form application. The ability to deliver on time significantly impacts the production process, so suppliers must deliver goods according to their capacity. The observation results for the delivery timeliness criterion are shown in Table 3.

Table 3 Supplier Criteria Based on Delivery Capability

No	Supplier Name	Delivery Capability
1	PT. Panca Garda Ultima	<30 days
2	PT. Tiga Cahaya Cemerlang	<30 days
3	PT. Tristan Alur Jayadi	<30 days
4	PT. Wesko Abadi Prima	<30 days
5	PT. Prima Honeycomb International	<30 days

d. Supplier Criteria Based on Product Warranty

Similar to the delivery timeliness criterion, information regarding the product warranty criterion was also obtained from the "Questionnaire for New Suppliers." For suppliers who have been in collaboration with PT. Selamat Sempurna Tbk for a longer period, and where the aforementioned document has been destroyed in accordance with the retention policy, the information was re-collected from suppliers through a Google Form application. The results of the observations on the product warranty criterion are shown in Table 4.

Table 4 Supplier Criteria Based on Product Warranty

No	Supplier Name	Product Warranty
1	PT. Panca Garda Ultima	<1 year
2	PT. Tiga Cahaya Cemerlang	<1 year
3	PT. Tristan Alur Jayadi	<1 year
4	PT. Wesko Abadi Prima	<1 year
5	PT. Prima Honeycomb International	<1 year

e. Supplier Criteria Based on Minimum Order Quantity (MOQ)

Information regarding the MOQ criterion was collected by conducting interviews with suppliers through a Google Form application. The results of the observations on the MOQ criterion are presented in Table 5.

Table 5 Supplier Criteria Based on Minimum Order Quantity (MOQ)

No	Supplier Name	MOQ
1	PT. Panca Garda Ultima	Yes, 500 pcs
2	PT. Tiga Cahaya Cemerlang	Yes, 2,000 pcs
3	PT. Tristan Alur Jayadi	Yes, 500 pcs
4	PT. Wesko Abadi Prima	Yes, 500 pcs
5	PT. Prima Honeycomb International	Yes, 1,000 pcs

f. Supplier Criteria Based on ISO Certification Ownership

Data or information regarding ISO certification ownership (quality management system) by suppliers can be found in the "Approved Supplier List". Suppliers with a quality management system certification (at least ISO 9001) are generally prioritized because they provide a guarantee of quality, have well-established production process workflows, and include supporting documents prior to production up to the delivery of goods to customers. The results of observations on the ISO certification ownership criterion are shown in Table 6.

Table 6 Supplier Criteria Based on ISO Certification Ownership

No	Supplier Name	ISO Status
1	PT. Panca Garda Ultima	Not Yet
2	PT. Tiga Cahaya Cemerlang	In Process
3	PT. Tristan Alur Jayadi	Not Yet
4	PT. Wesko Abadi Prima	Not Yet
5	PT. Prima Honeycomb International	Certified

Table 7 Data Analysis Results

Criteria	Price	Quality (Defects)	Delivery Capability	Product Warranty	MOQ	ISO Status
PGU	≥Rp.3,000	1	< 30 days	< 1 year	Yes, 500 pcs	Not Yet
TCC	≤Rp.2,000	3	< 30 days	< 1 year	Yes, 2,000 pcs	In Process
TAJ	≤Rp.2,000	14	< 30 days	< 1 year	Yes, 500 pcs	Not Yet
WAP	<Rp.3,000	4	< 30 days	< 1 year	Yes, 500 pcs	Not Yet
PHI	<Rp.3,000	13	< 30 days	< 1 year	Yes, 1,000 pcs	Certified

The general calculation process for decision-making is applied to the selection of packaging (duplex) suppliers. In this study, each supplier is evaluated based on predetermined criteria. Data processing using the Simple Additive Weighting (SAW) method requires specific criteria and weight assignments to perform the calculations, ultimately determining the best alternative or supplier.

PT. Selamat Sempurna Tbk. aims to select the best supplier for packaging (duplex) products. To achieve this, six (6) criteria and five (5) supplier alternatives were used as the basis for this study:

C1 = Product Quality (Product Defects):

The level of product defects determines quality, with fewer defects indicating better quality.

C2 = On-Time Delivery:

Suppliers with delivery times of less than 30 days are preferred.

C3 = Product Warranty:

A longer warranty period reflects better service and quality assurance.

C4 = ISO Certification Status:

Possession of ISO certification (at least ISO 9001) reflects a commitment to quality management systems.

C5 = Competitive Pricing:

Lower prices are prioritized to maintain cost efficiency.

C6 = Minimum Order Quantity (MOQ):

Lower MOQ values demonstrate greater flexibility in meeting customer needs.

Supplier Alternatives:

1. A1 = PT. Panca Garda Ultima
2. A2 = PT. Tiga Cahaya Cemerlang
3. A3 = PT. Tristan Alur Jayadi
4. A4 = PT. Wesko Abadi Prima
5. A5 = PT. Prima Honeycomb International

The supplier selection diagram for duplex packaging can be seen in Figure 1.

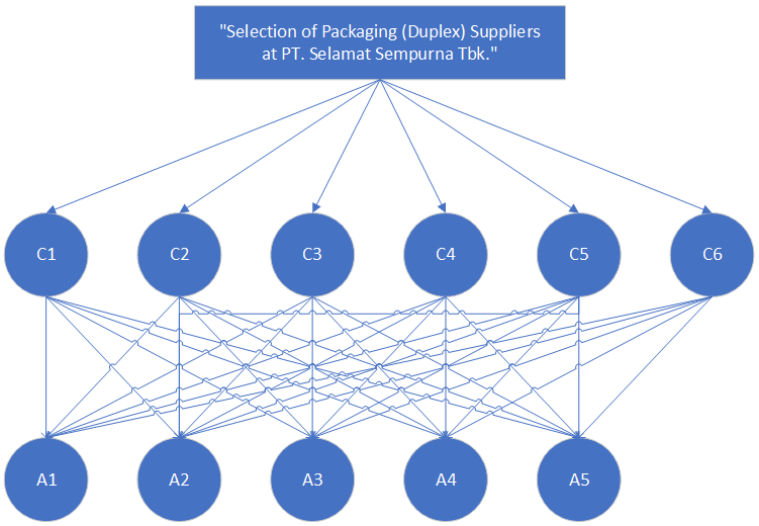

Figure 1. Supplier Selection Diagram for Duplex Packaging (Procurement, 2023)

Below is the table listing the names of suppliers along with the evaluation scores obtained from the Procurement Department, as shown in Table 8.

Table 8 Supplier Evaluation Results for Packaging (Duplex)

No	Supplier Name	Criterion Value					
		C1	C2	C3	C4	C5	C6
1	PT. Panca Garda Ultima	C	B	K	K	K	C
2	PT. Tiga Cahaya Cemerlang	K	B	K	C	B	K
3	PT. Tristan Alur Jayadi	K	B	K	K	B	C
4	PT. Wesko Abadi Prima	K	B	K	K	C	C
5	PT. Prima Honeycomb International	K	B	K	B	C	K

Here is the table where the evaluation values of each supplier are converted into the interest table based on the previously determined criteria. The results are shown in Table 9.

Table 9 Supplier Evaluation Results Based on Importance Level

No	Supplier Name	Nilai Kriteria					
		C1	C2	C3	C4	C5	C6
1	PT. Panca Garda Ultima	7	8	6	6	6	7
2	PT. Tiga Cahaya Cemerlang	6	8	6	7	8	6
3	PT. Tristan Alur Jayadi	6	8	6	6	8	7
4	PT. Wesko Abadi Prima	6	8	6	6	7	7
5	PT. Prima Honeycomb International	6	8	6	8	7	6

Table 10 Compatibility Rating

Alternative	Criterion Values					
	C1	C2	C3	C4	C5	C6
A1	7	8	6	6	6	7
A2	6	8	6	7	8	6
A3	6	8	6	6	8	7
A4	6	8	6	6	7	7
A5	6	8	6	8	7	6

Next, the normalization values for each alternative are calculated using Equation 1, based on the criteria previously defined:

Benefit Criteria

C3 = Product Warranty

C4 = ISO Certification Ownership Status

Cost Criteria

C1 = Quality / Product Deviation

C2 = Delivery Capability

C5 = Price Competitiveness

C6 = MOQ

Next, we proceed to the normalization calculation step. If the criteria factor is a benefit, the formula used is:

Rij = (Xij / max {Xij}), which will be applied to columns C3 and C4. On the other hand, if the criteria factor is a cost, the formula used is: Rij = (max {Xij} / Xij), which will be applied to columns C1, C2, C5, and C6.

Normalization Data:

1. Product Quality / Deviation Criteria

The product quality criterion falls under the cost category, as the smallest value in this attribute represents the best value. From column C1, the minimum value is "6".

$$r_{11} = \frac{\text{Min } (7;6;6;6;6)}{7} = \frac{6}{7} = 0.86$$

$$r_{21} = \frac{\text{Min } (7;6;6;6;6)}{6} = \frac{6}{6} = 1$$

$$r_{31} = \frac{\text{Min } (7;6;6;6;6)}{6} = \frac{6}{6} = 1$$

$$r_{41} = \frac{\text{Min } (7;6;6;6;6)}{6} = \frac{6}{6} = 1$$

$$r_{51} = \frac{\text{Min } (7;6;6;6;6)}{6} = \frac{6}{6} = 1$$

2. Delivery Capability Criteria

The delivery capability criterion falls under the cost category, as the smallest value in this attribute represents the best value. From column C2, the minimum value is "8".

$$r_{12} = \frac{\text{Min } (8;8;8;8;8)}{8} = \frac{8}{8} = 1$$

$$r_{22} = \frac{\text{Min } (8;8;8;8;8)}{8} = \frac{8}{8} = 1$$

$$r_{32} = \frac{\text{Min } (8;8;8;8;8)}{8} = \frac{8}{8} = 1$$

$$r_{42} = \frac{\text{Min } (8;8;8;8;8)}{8} = \frac{8}{8} = 1$$

$$r_{52} = \frac{\text{Min } (8;8;8;8;8)}{8} = \frac{8}{8} = 1$$

3. Product Warranty Criteria

The product warranty criterion falls under the benefit category, as the largest value in this attribute represents the best value. From column C3, the maximum value is "6"

$$r_{13} = \frac{6}{\text{Max } (6;6;6;6;6)} = \frac{6}{6} = 1$$

$$r_{23} = \frac{6}{\text{Max } (6;6;6;6;6)} = \frac{6}{6} = 1$$

$$r_{33} = \frac{6}{\text{Max } (6;6;6;6;6)} = \frac{6}{6} = 1$$

$$r_{43} = \frac{6}{\text{Max } (6;6;6;6;6)} = \frac{6}{6} = 1$$

$$r_{53} = \frac{6}{\text{Max } (6;6;6;6;6)} = \frac{6}{6} = 1$$

4. ISO Certification Ownership Status Criteria

The ISO certification ownership status criterion falls under the benefit category, as the largest value in this attribute represents the best value. From column C4, the maximum value is "8".

$$r_{14} = \frac{6}{\text{Max } (6;7;6;6;8)} = \frac{6}{8} = 0{,}75$$

$$r_{24} = \frac{7}{\text{Max}\,(6;7;6;6;8)} = \frac{7}{8} = 0{,}88$$

$$r_{34} = \frac{6}{\text{Max}\,(6;7;6;6;8)} = \frac{6}{8} = 0{,}75$$

$$r_{44} = \frac{6}{\text{Max}\,(6;7;6;6;8)} = \frac{6}{8} = 0{,}75$$

$$r_{54} = \frac{8}{\text{Max}\,(6;7;6;6;8)} = \frac{8}{8} = 1$$

5. Price Competitiveness Criteria

The price competitiveness criterion falls under the cost category, as the smallest value in this attribute represents the best value. From column C5, the minimum value is "6".

$$r_{15} = \frac{\text{Min}\,(6;8;8;7;7)}{6} = \frac{6}{6} = 1$$

$$r_{25} = \frac{\text{Min}\,(6;8;8;7;7)}{8} = \frac{6}{8} = 0{,}75$$

$$r_{35} = \frac{\text{Min}\,(6;8;8;7;7)}{8} = \frac{6}{8} = 0{,}75$$

$$r_{45} = \frac{\text{Min}\,(6;8;8;7;7)}{7} = \frac{6}{7} = 0{,}86$$

$$r_{55} = \frac{\text{Min}\,(6;8;8;7;7)}{7} = \frac{6}{7} = 0{,}86$$

6. MOQ Criteria

The MOQ criterion falls under the cost category, as the smallest value in this attribute represents the best value. From column C6, the minimum value is "6".

$$r\_(16) = (\text{Min}\,(7;6;7;7;6))/7 = 6/7 = 0{,}86$$

$$r\_(26) = (\text{Min}\,(7;6;7;7;6))/6 = 6/6 = 1$$

$$r\_(36) = (\text{Min}\,(7;6;7;7;6))/7 = 6/7 = 0{,}86$$

$$r\_(46) = (\text{Min}\,(7;6;7;7;6))/7 = 6/7 = 0{,}86$$

$$r\_(56) = (\text{Min}\,(7;6;7;7;6))/6 = 6/6 = 1$$

Next, the normalization results are presented in the normalization matrix, which is as follows:

$$R = \begin{bmatrix} 0{,}86 & 1 & 1 & 0{,}75 & 1 & 0{,}86 \\ 1 & 1 & 1 & 0{,}88 & 0{,}75 & 1 \\ 1 & 1 & 1 & 0{,}75 & 0{,}75 & 0{,}86 \\ 1 & 1 & 1 & 0{,}75 & 0{,}86 & 0{,}86 \\ 1 & 1 & 1 & 1 & 0{,}86 & 1 \end{bmatrix}$$

The final step is to calculate the final preference value (Vi) according to equation (2), which is obtained from the sum of the product of the row elements of the normalized matrix (R) with the preference weights (W). The weights used are as shown in Table 11.

Table 10 Calculation of Alternative Values Using Criteria Weights

Alternatives (V)	Calculation
V1	= (0,2 x 0,86) + (0,2 x 1) + (0,1 x 1) + (0,1 x 0,75) + (0,3 x 1) + (0,1x 0,86) = 0,172 + 0,2 + 0,1 + 0,075 + 0,3 + 0,086 = 0,933
V2	= (0,2 x 1) + (0,2 x 1) + (0,1 x 1) + (0,1 x 0,88) + (0,3 x 0,75) + (0,1x 1) = 0,2 + 0,2 + 0,1 + 0,088 + 0,225 + 0,1 = 0,913
V3	= (0,2 x 1) + (0,2 x 1) + (0,1 x 1) + (0,1 x 0,75) + (0,3 x 0,75) + (0,1x 0,86) = 0,2 + 0,2 + 0,1 + 0,075 + 0,225 + 0,086 = 0,886
V4	= (0,2 x 1) + (0,2 x 1) + (0,1 x 1) + (0,1 x 0,75) + (0,3 x 0,86) + (0,1x 0,86) = 0,2 + 0,2 + 0,1 + 0,075 + 0,258 + 0,086 = 0,919
V5	= (0,2 x 1) + (0,2 x 1) + (0,1 x 1) + (0,1 x 1) + (0,3 x 0,86) + (0,1x 1) = 0,2 + 0,2 + 0,1 + 0,1 + 0,258 + 0,1 = 0,958

The comparison of values is performed, and the results of the calculations can be tabulated in Table 11.

Table 11 Ranking Results

No	Alternative	Final Result	Ranking
1	PT. Panca Garda Ultima	0,933	2
2	PT. Tiga Cahaya Cemerlang	0,913	4
3	PT. Tristan Alur Jayadi	0,886	5
4	PT. Wesko Abadi Prima	0,919	3
5	PT. Prima Honeycomb International	0,958	1

Below is the table sorted by the best ranking, as shown in Table 12.

Table 12 Ranking Results

No	Alternative	Final Result	Ranking
1	PT. Prima Honeycomb International (PHI)	0,958	1
2	PT. Panca Garda Ultima (PGU)	0,933	2
3	PT. Wesko Abadi Prima (WAP)	0,919	3
4	PT. Tiga Cahaya Cemerlang (TCC)	0,913	4
5	PT. Tristan Alur Jayadi (TAJ)	0,886	5

From the ranking results, it can be concluded that the highest final score represents the selected alternative, and the best duplex packaging supplier using the SAW method

at PT. Selamat Sempurna Tbk. is PT. Prima Honeycomb International with a final score of 0.958.

2. Data Processing Using the AHP Method

The following is a summary of the research results from each criterion and alternative, as presented in Table 13.

Table 13 Research Results of Criteria and Alternatives

Criteria / Alternative	Price (Rp)	Product Quality	Delivery Capability (days)	Product Warranty (Years)	ISO Certificate Ownership Status	MOQ (Units)
PHI	Rp. 2.767	13	29	1	Yes	1.000
TCC	Rp. 1.950	3	29	1	In Process	2.000
TAJ	Rp. 1.782	14	29	1	No	500
WAP	Rp. 2.297	4	29	1	No	500
PGU	Rp. 3.000	1	29	1	No	500

Table 14 Pairwise Comparison Matrix of Price Criteria

Alternative	PHI	TCC	TAJ	WAP	PGU
PHI	1,00	0,70	0,64	0,83	1,08
TCC	1,42	1,00	0,91	1,18	1,54
TAJ	1,55	1,09	1,00	1,29	1,68
WAP	1,20	0,85	0,78	1,00	1,31
PGU	0,92	0,65	0,59	0,77	1,00
summary	6,10	4,30	3,93	5,06	6,61

From the calculation results above, the next step is to divide each value in the column by the total of the respective column to obtain the normalized matrix. Then, sum the values from each row and divide by the total of each column to get the average value. The summation results are shown in Table 15.

Table 15 Normalization and Average of Pairwise Comparison for Quality Criteria

Alternative	PHI	TCC	TAJ	WAP	PGU	Rata-rata (Σ)
PHI	0,04	0,04	0,04	0,04	0,04	0,04
TCC	0,19	0,19	0,19	0,19	0,19	0,19
TAJ	0,04	0,04	0,04	0,04	0,04	0,04
WAP	0,14	0,14	0,14	0,14	0,14	0,14
PGU	0,58	0,58	0,58	0,58	0,58	0,58

Table 16 Pairwise Comparison Matrix for Delivery Capability Criteria

Alternative	PHI	TCC	TAJ	WAP	PGU
PHI	1,00	1,00	1,00	1,00	1,00
TCC	1,00	1,00	1,00	1,00	1,00

TAJ	1,00	1,00	1,00	1,00	1,00
WAP	1,00	1,00	1,00	1,00	1,00
PGU	1,00	1,00	1,00	1,00	1,00
summary	5,00	5,00	5,00	5,00	5,00

From the calculation results above, the next step is to divide each value in the column by the total of the respective column to obtain the normalized matrix. Then, sum the values from each row and divide by the total of each column to get the average value. The summation results are shown in Table 17.

Table 17 Normalization and Average of Pairwise Comparison for Delivery Capability Criteria

Alternative	PHI	TCC	TAJ	WAP	PGU	Rata-rata (Σ)
PHI	0,20	0,20	0,20	0,20	0,20	0,20
TCC	0,20	0,20	0,20	0,20	0,20	0,20
TAJ	0,20	0,20	0,20	0,20	0,20	0,20
WAP	0,20	0,20	0,20	0,20	0,20	0,20
PGU	0,20	0,20	0,20	0,20	0,20	0,20

Table 18 Pairwise Comparison Matrix for Product Warranty Criteria

Alternative	PHI	TCC	TAJ	WAP	PHI
PHI	1,00	1,00	1,00	1,00	1,00
TCC	1,00	1,00	1,00	1,00	1,00
TAJ	1,00	1,00	1,00	1,00	1,00
WAP	1,00	1,00	1,00	1,00	1,00
PGU	1,00	1,00	1,00	1,00	1,00
Total	5,00	5,00	5,00	5,00	5,00

From the results of the calculations above, the next step is to divide each value in the column by the total of the corresponding column to obtain the normalized matrix. Then, sum the values from each row and divide them by the total of each column to get the average value. The summation results are presented in Table 19.

Table 19 Normalization and Average of Pairwise Comparison for MOQ Criteria

Alternative	PHI	TCC	TAJ	WAP	PHI	Rata-rata (Σ)
PHI	0,13	0,13	0,13	0,13	0,13	0,13
TCC	0,07	0,07	0,07	0,07	0,07	0,07
TAJ	0,27	0,27	0,27	0,27	0,27	0,27
WAP	0,27	0,27	0,27	0,27	0,27	0,27
PGU	0,27	0,27	0,27	0,27	0,27	0,27

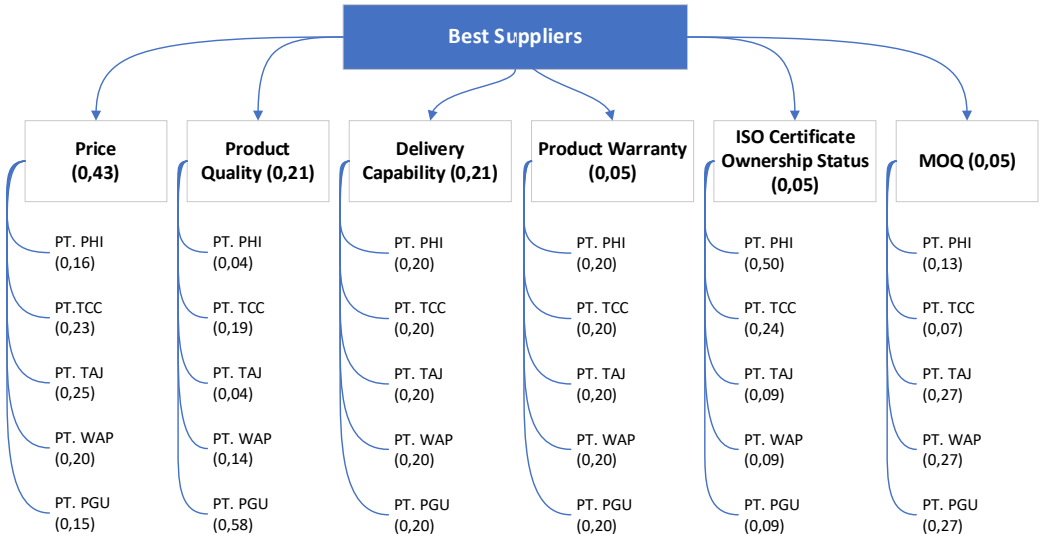

Figure 2 Hierarchical Structure of Alternative Acquisition and Criteria

Table 20 Average Calculation of Criteria

Price	Quality	Delivery Capability	Warranty	ISO Certification Ownership	MOQ
0,43	0,21	0,21	0,05	0,05	0,05

The last step is to perform the ranking calculation for each alternative as shown in the calculation below

PHI	=	(0,16 x 0,43) + (0,04 x 0,21) + (0,20 x 0,21) + (0,20 x 0,05) + (0,50 x 0,05) + (0,13 x 0,05)
	=	0,163
TCC	=	(0,23 x 0,43) + (0,19 x 0,21) + (0,20 x 0,21) + (0,20 x 0,05) + (0,24 x 0,05) + (0,07 x 0,05)
	=	0,208
TAJ	=	(0,25 x 0,43) + (0,04 x 0,21) + (0,20 x 0,21) + (0,20 x 0,05) + (0,09 x 0,05) + (0,27 x 0,05)
	=	0,188
WAP	=	(0,20 x 0,43) + (0,14 x 0,21) + (0,20 x 0,21) + (0,20 x 0,05) + (0,09 x 0,05) + (0,27 x 0,05)
	=	0,185
PGU	=	(0,15 x 0,43) + (0,58 x 0,21) + (0,20 x 0,21) + (0,20 x 0,05) + (0,09 x 0,05) + (0,27 x 0,05)
	=	0,256

From the comparison of values conducted, the results of the calculation can be tabulated in Table 21

Table 21 Ranking Results

No	Alternative	Final Result	Ranking
1	PT. Prima Honeycomb International (PHI)	0,163	5
2	PT. Tiga Cahaya Cemerlang (TCC)	0,208	3
3	PT. Tristan Alur Jayadi (TAJ)	0,188	2
4	PT. Wesko Abadi Prima (WAP)	0,185	4
5	PT. Panca Garda Ultima (PGU)	0,256	1

Based on the ranking results, it can be concluded that the alternative with the highest final score is the selected one, and the best packaging (duplex) supplier using the AHP method at PT. Selamat Sempurna Tbk. is PT. Panca Garda Ultima with a final score of 0.256

3. Medium Data Processing Using the TOPSIS Method

The next calculation uses the TOPSIS method, where the first step is to determine the performance ratings for each alternative based on each criterion. As explained earlier, there are 6 (six) criteria and 5 (five) supplier alternatives that are the subject of this study, as shown in Table 22

Table 22 Data Results from Analysis

Criterion	Quality (C1)	Delivery Capability (C2)	Product Warranty (C3)	ISO Status (C4)	Price (C5)	MOQ (C6)
PGU (A1)	1	< 30 days	< 1 year	No	≥Rp.3.000	Ya,500
TCC (A2)	3	< 30 days	< 1 year	In Process	≤Rp.2.000	Ya,2.000
TAJ (A3)	14	< 30 days	< 1 year	No	≤Rp.2.000	Ya,500
WAP (A4)	4	< 30 days	< 1 year	No	<Rp.3.000	Ya,500
PHI (A5)	13	< 30 days	< 1 year	Available	<Rp.3.000	Ya,1.000

Table 23 Supplier Data Conversion

Alternative / Criterion	C1	C2	C3	C4	C5	C6
A1	7	8	6	6	6	7
A2	6	8	6	7	8	6
A3	6	8	6	6	6	7
A4	6	8	6	6	6	7
A5	6	8	6	8	8	6

Table 25 TOPSIS Method Normalization

No	Criterion	Variable	Value
1	Product Quality	Important	7
2	Delivery Capability	Important	7

3	Product Warranty	Quite Important	6
4	ISO Certificate Ownership Status	Quite Important	6
5	Price Competitiveness	Very Important	8
6	MOQ	Quite Important	6

Table 26 Ranking Results

No	Alternative	Vi	Final Result	Ranking
1	PT. Panca Garda Ultima (PGU)	A_1	0,891	1
2	PT. Tiga Cahaya Cemerlang (TCC)	A_2	0,092	3
3	PT. Tristan Alur Jayadi (TAJ)	A_3	0,031	4
4	PT. Wesko Abadi Prima (WAP)	A_4	0,031	5
5	PT. Prima Honeycomb International (PHI)	A_5	0,109	2

Table 27 Ranking Results

No	Alternative	Vi	Final Result	Ranking
1	PT. Panca Garda Ultima (PGU)	A_1	0,891	1
2	PT. Prima Honeycomb International (PHI)	A_5	0,109	2
3	PT. Tiga Cahaya Cemerlang (TCC)	A_2	0,092	3
4	PT. Tristan Alur Jayadi (TAJ)	A_3	0,031	4
5	PT. Wesko Abadi Prima (WAP)	A_4	0,031	5

Based on the ranking results, it can be concluded that the alternative with the highest final value is the chosen one, and the best duplex packaging supplier using the TOPSIS method at PT. Selamat Sempurna Tbk. is PT. Panca Garda Ultima, with a final value of 0.891.

4. Final Results of Decision-Making Method Comparison

The following is the final result of the comparison of decision-making methods, as shown in Table 28.

Table 28 Final Results of Decision-Making Method Comparison

No	Alternative	Metode		
		SAW	AHP	TOPSIS
1	PT. Panca Garda Ultima	0,933	0,256	0,891
2	PT. Tiga Cahaya Cemerlang	0,913	0,208	0,092
3	PT. Tristan Alur Jayadi	0,886	0,188	0,031
4	PT. Wesko Abadi Prima	0,919	0,185	0,031
5	PT. Prima Honeycomb International	0,958	0,163	0,109

Based on the final assessment results using the three methods above, it shows that the supplier evaluation results have differences in values and rankings. Nevertheless, these methods have good data accuracy, indicating that each method has a different approach in evaluating the supplier selection criteria.

From these three methods, the following strengths and weaknesses can be concluded:

1. The SAW method is easy to understand and apply but does not give much attention to the relationships between criteria.
2. The AHP method considers the relationships between criteria and analyzes them through pairwise weighting according to the comparison scale. However, determining the comparison scale can be challenging because an incorrect scale can affect the final result.
3. The TOPSIS method provides clearer results as it compares the distance to the ideal solution (both negative and positive). However, inaccurate comparison data can lead to unreliable results.

To overcome these issues, criteria determination can be done by seeking suggestions from relevant teams directly involved, such as the buyers, not just the decision-makers (Department Heads).

D. Conclusion

Based on the measurements and analysis that have been conducted, several conclusions can be drawn:

1. The types of criteria obtained in the supplier selection process for duplex packaging at PT. Selamat Sempurna Tbk. include: a. Product Quality. b. Delivery Capability. c. Product Warranty. d. Supplier ISO Certificate Ownership Status. e. Price Competitiveness. f. Minimum Order Quantity (MOQ).
2. The results of this study provide the calculation of 3 (three) alternative decision-making methods in selecting the best supplier using the following methods: a. SAW Method: PT. Prima Honeycomb International with a final value of 0.958. b. AHP Method: PT. Panca Garda Ultima with a final value of 0.256. c. TOPSIS Method: PT. Panca Garda Ultima with a final value of 0.891.
3. Based on the analysis results using these three methods, one method selects PT. Prima Honeycomb International, while two methods select PT. Panca Garda Ultima. Therefore, PT. Panca Garda Ultima is the chosen supplier to become the best duplex packaging supplier because two methods provide the same result or decision.

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