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Thinner Raw Material Supplier Recommendation System Using a Combination of AHP and TOPSIS Methods

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Abstract: *This study examines the division of household responsibilities between husbands and wives in millennial families in Sungai Tendang Village, Kumai District, Central Kalimantan, from the perspective of Islamic family law. The study aims to analyze the forms of role division between husbands and wives, examine their compatibility with the principles of Islamic family law, and identify the obstacles faced by millennial couples in carrying out their household responsibilities. This research employed a qualitative approach using a case-study method. The participants consisted of five Muslim families selected through purposive sampling. Data were collected through observation, semi-structured interviews, and documentation, and were analyzed using data reduction, data presentation, and conclusion drawing. The findings show that millennial families tend to apply a more flexible division of roles in terms of income generation, domestic work, childcare, and household decision-making. Some couples continue to follow the traditional pattern in which the husband is primarily responsible for earning a living while the wife manages domestic affairs. Other couples divide household responsibilities through mutual cooperation and consultation, particularly when both spouses work outside the home. From the perspective of Islamic family law, flexible role division is permissible as long as it is based on mutual agreement, justice, consultation, responsibility, and the fulfillment of each spouse's rights and obligations. The main obstacles include patriarchal culture, economic pressure, social expectations, and limited communication. This study concludes that a cooperative and mutually agreed division of household responsibilities can support family harmony while remaining consistent with the principles of Islamic family law.*

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Introduction

Selecting a thinner raw material supplier is a crucial part of CV Tiga Jago's procurement process, as the raw materials used impact production efficiency. Suppliers should be assessed not only based on price, but also on material quality, delivery time, stock availability, payment systems, and service. A supplier selection process that relies solely on experience, business relationships, or the lowest price can be subjective, as each criterion isn't clearly weighted. Therefore, a quantitative approach is necessary to ensure a more objective, measurable, and accountable supplier selection process.

The main problem in this research is how to determine the weight of the criteria for selecting thinner raw material suppliers, how to determine the ranking of the best suppliers for each raw material, and how to build a web-based decision support system that can assist the supplier selection process at CV Tiga Jago. This research is limited to five suppliers, nine thinner raw materials, and six assessment criteria, namely price, quality, delivery, stock, payment, and service. The AHP method is used to determine the priority weight of each criterion, while the TOPSIS method is used to determine the ranking of the best suppliers for each raw material.

The purpose of this research is to develop a web-based Decision Support System to assist CV Tiga Jago in selecting thinner raw material suppliers objectively, systematically, and measurably. Specifically, this research aims to determine the criteria weights using the Analytical Hierarchy Process method and determine the ranking of the best suppliers for each thinner raw material using the Technique for Order Preference by Similarity to Ideal Solution method. With this system, the results of supplier selection are expected to be not only experience-based decisions, but also supported by clear calculation results.

Several previous studies have shown that the AHP and TOPSIS methods are relevant for supplier selection because they are able to process decision problems involving multiple criteria. Rivaldi et al. (2023) showed that quality is the dominant criterion in bolt supplier selection, while Zahira and Pulansari (2023) showed that AHP-TOPSIS integration can help determine supplier priorities based on criteria weights and preference values. However, previous studies have not specifically discussed the selection of thinner raw material suppliers in chemical-based manufacturing companies, have not emphasized supplier ranking based on each type of raw material, and have not all been implemented into a web-based decision support system that can be used directly by companies.

The contribution of this research lies in the application of a combination of AHP and TOPSIS in the context of web-based thinner raw material supplier selection. AHP is used to generate criteria weights based on the level of importance, while TOPSIS is used to generate supplier rankings based on the supplier's performance value for each raw material. Thus, this research is expected to add to the study of the application of the AHP-TOPSIS hybrid method in Decision Support Systems, especially in the context of raw material supplier selection in chemical-based manufacturing companies.

Literature review

1. Decision Support System

A Decision Support System (DSS) is a computer-based system used to assist the decision-making process by processing specific data, models, and methods. A DSS is used when a decision involves multiple factors, alternatives, or conditions that cannot be resolved through subjective considerations alone. This system functions to provide information, analysis, and recommendations that can assist decision-makers in selecting the most appropriate alternative. According to Khatimah and Gustalika (2024), a DSS can help process data using specific

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methods to produce more focused and objective recommendations.

2. **Multi Criteria Decision Making**

   Multi-Criteria Decision Making (MCDM) is a decision-making approach used to solve problems involving multiple criteria. In MCDM, each alternative is assessed based on several criteria with varying degrees of importance. This approach allows decision-makers to compare alternatives more systematically because each criterion can be weighted according to its level of influence on the final decision. According to Avramova et al. (2025), MCDM can be used to evaluate, weight, and rank alternatives based on specific criteria.

3. **Analytical Hierarchy Process (AHP)**

   The Analytical Hierarchy Process (AHP) is an MCDM method used to determine priority weights through pairwise comparisons between criteria. AHP helps systematically organize the importance of each criterion using a comparison matrix. In addition to generating priority weights, AHP also has a consistency test to determine whether the assessments given are still within acceptable limits. According to Petrillo et al. (2023), AHP is widely used in multi-criteria decision-making because it has a weighting mechanism and consistency check.

4. **Technique For Order Preference By Similarity To Ideal Solution (Topsis)**

   The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is an MCDM method used to rank alternatives based on their proximity to the positive ideal solution and their distance from the negative ideal solution. The best alternative in TOPSIS is the alternative that is closest to the best condition and farthest from the worst condition. The TOPSIS stages include compiling a decision matrix, normalization, weighting, determining positive and negative ideal solutions, calculating distances, and calculating preference values. According to Madanchian and Taherdoost (2023), TOPSIS is widely used because it has clear calculation stages and is able to produce a systematic ordering of alternatives.

5. **Web Based System**

   A web-based system is an application that runs through a browser and utilizes web technology to manage, process, and display data. Web-based systems are widely used because they can be accessed through devices with a browser and a compatible network. According to MDN Web Docs (2026a), the web is built using core technologies such as HTML, CSS, JavaScript, and web APIs. Furthermore, web-based systems can facilitate more centralized data management because users can access system features through web pages. Khatimah and Gustalika (2024) explain that web-based Decision Support Systems can assist the alternative selection process because data and calculation methods can be managed in a structured manner through the system.

Research Methods

This research focuses on the development of a Decision Support System to assist in the selection of thinner raw material suppliers at CV Tiga Jago. The Analytical Hierarchy Process (AHP) method is used to determine the priority weight of the criteria, while the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is used to determine the preference value and ranking of the best suppliers for each raw material. The research stages include research design, data collection, determination of criteria and alternatives, AHP-TOPSIS analysis, system design, database design, system implementation, and system testing and evaluation.

Research Design

This research uses a quantitative approach through the development of a web-based system. The quantitative approach is used because the supplier selection process is based on numerical data, criteria weights, alternative values, and preference calculations. The research stages are carried out sequentially, starting from literature study, data collection, needs analysis, criteria and alternative

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determination, criteria weight calculation using AHP, supplier ranking calculation using TOPSIS, system design, system implementation, and testing and evaluation. The research stage flow is shown in Figure 3.1.

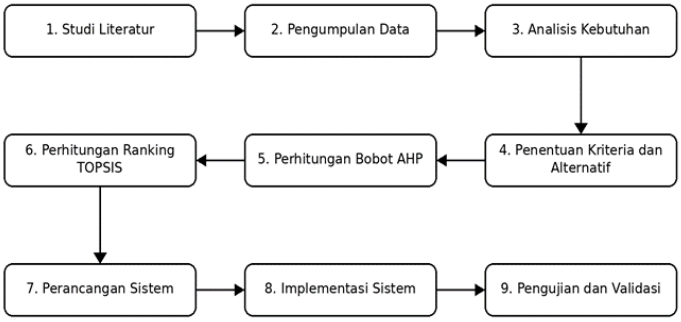

Figure 1 Research Stages

Data Collection Sources and Techniques

The object of this research is the process of selecting thinner raw material suppliers at CV Tiga Jago. The data used include supplier data, thinner raw material data, criteria data, supplier assessment data, and information regarding the ongoing supplier selection process. Data collection techniques were carried out through observation, interviews, and documentation at the company. Observations were conducted to determine the ongoing supplier selection process, interviews were used to obtain information regarding the criteria and the level of importance of the criteria, while documentation was used to obtain supplier data, raw materials, and supplier assessment values used in the calculation.

The research dataset consists of five thinner raw material suppliers, nine types of raw materials, and six assessment criteria. The suppliers analyzed are those listed as thinner raw material suppliers at CV Tiga Jago. The raw materials used include Butyl Acetate, Butyl Cellosolve, Ethyl Acetate, Methanol, MIBK, Toluene, Xylene, Acetone, and Condensate. The assessment criteria used consist of price, quality, delivery, stock, payment, and service. Price is positioned as a cost criterion, while quality, delivery, stock, payment, and service are positioned as benefit criteria.

Criteria and Alternatives

The criteria used in this study consist of C1 price, C2 quality, C3 delivery, C4 stock, C5 payment, and C6 service. The price criterion is used to assess the price level of raw materials offered by suppliers. The quality criterion is used to assess the suitability of raw material quality. The delivery criterion is used to assess the timeliness of delivery, while the stock criterion is used to assess material availability. The payment criterion is used to assess the ease of the transaction system, and service is used to assess the supplier's response and support. The alternatives used are five thinner raw material suppliers who are the objects of assessment in the supplier selection process.

Data Analysis Techniques

Data analysis was conducted through two main processes: criteria weighting using AHP and supplier ranking using TOPSIS. In the AHP process, pairwise comparison values between criteria are arranged into a comparison matrix. This matrix is normalized to obtain the priority weights for each criterion. Next, the resulting weights are tested using the Consistency Ratio (CR). The weights are declared usable if the CR value meets the consistency limit, which is no more than 0.1. This stage is carried out to ensure that the criteria weights used in the TOPSIS process have a consistent basis for calculation.

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In the TOPSIS process, supplier assessment data is organized into a decision matrix based on each supplier's score against each criterion. The decision matrix is then normalized, multiplied by the AHP weights, and used to determine the positive ideal solution and the negative ideal solution. The distance between each alternative and the positive ideal solution is then calculated. The preference value is obtained by comparing the distance to these ideal solutions. The supplier with the highest preference value becomes the most recommended alternative for each thinner raw material.

System Design

The developed system has two main actors, namely the admin and the leader. The admin plays a role in managing raw material data, supplier data, criteria data, AHP comparison values, supplier assessment values, the TOPSIS calculation process, recommendation results, and reports. The leader plays a role in viewing supplier recommendation results, preference value graphs, and calculation result reports. The system flow starts from login, master data management, AHP comparison matrix input, criteria weight calculation, supplier performance value input, TOPSIS process, supplier ranking display, preference value graphs, and printing recommendation reports. The system flow of the admin and leader is shown in Figure 2.

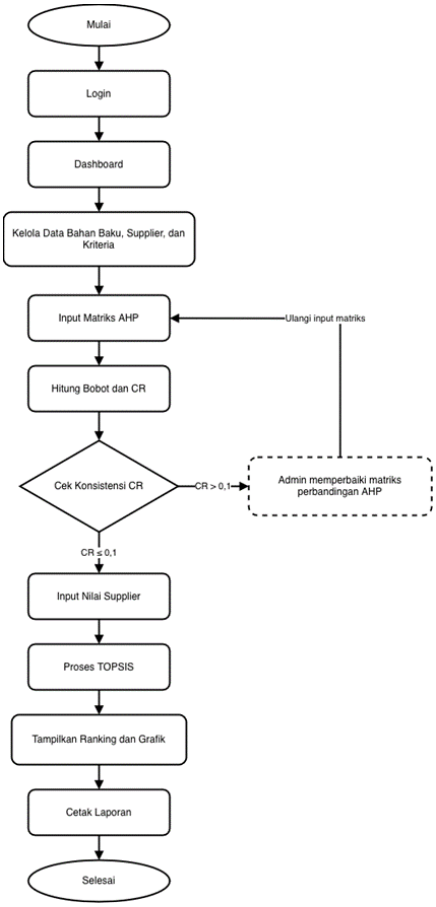

Figure 2 Admin and Leadership System Flow

Database Design and System Implementation

The database is designed to accommodate the data needed in the thinner raw material supplier selection process. The data includes user accounts, raw material data, supplier data, criteria data, assessment scales, AHP matrices, AHP weights, supplier assessments, TOPSIS results, and recommendation reports. The database structure is used to support the data input process, value

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retrieval, AHP calculations, TOPSIS calculations, ranking results storage, and report printing. The system is implemented as a web application using PHP Native as the programming language and MySQL as the database.

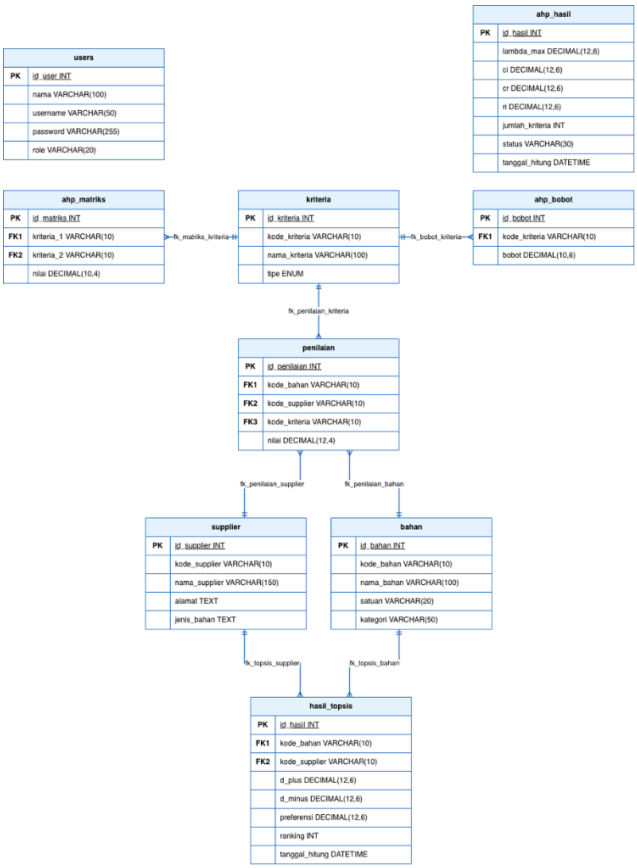

Figure 3 System Database Design

System Testing and Evaluation

System testing is conducted to ensure that the main functions of the system run according to design. Testing is conducted using Black Box Testing by checking the conformity of input and output on the login feature, dashboard, raw material management, supplier management, criteria management, AHP value management, supplier performance value input, TOPSIS process, recommendation display, preference value graph, report printing, and logout. In addition to functional testing, evaluation is also carried out through validation of calculation results by comparing the system results with manual calculations or Microsoft Excel. Validation is carried out on AHP weights, Consistency Ratio values, TOPSIS preference values, and supplier rankings. The system is declared valid if the system calculation results are the same as the comparison results or only have small differences due to rounding of numbers.

Results and Discussion

System Implementation

The Decision Support System for selecting thinner raw material suppliers is implemented in a web-based application using PHP Native and MySQL. This system has two main actors: the admin and the leader. The admin can manage raw material data, supplier data, criteria data, AHP comparison matrices, supplier performance scores, TOPSIS calculation

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results, and recommendation reports. The leader can view supplier recommendation results, preference value graphs, and calculation results reports as considerations in decision-making.

The AHP weighting results page displays the priority weighting values for each criterion, the lambda max value, the Consistency Index, the Random Index, the Consistency Ratio, the consistency status, and the criteria weighting graph. If the CR value is less than or equal to 0.10, the weighting is declared consistent and can be used in the TOPSIS process. The supplier performance score page is used to enter supplier assessment scores based on specific raw materials and six predetermined criteria. Furthermore, the best supplier recommendation page displays supplier rankings, positive ideal distances, negative ideal distances, preference values, and preference value graphs. The print results page is used to generate supplier recommendation reports based on selected raw materials.

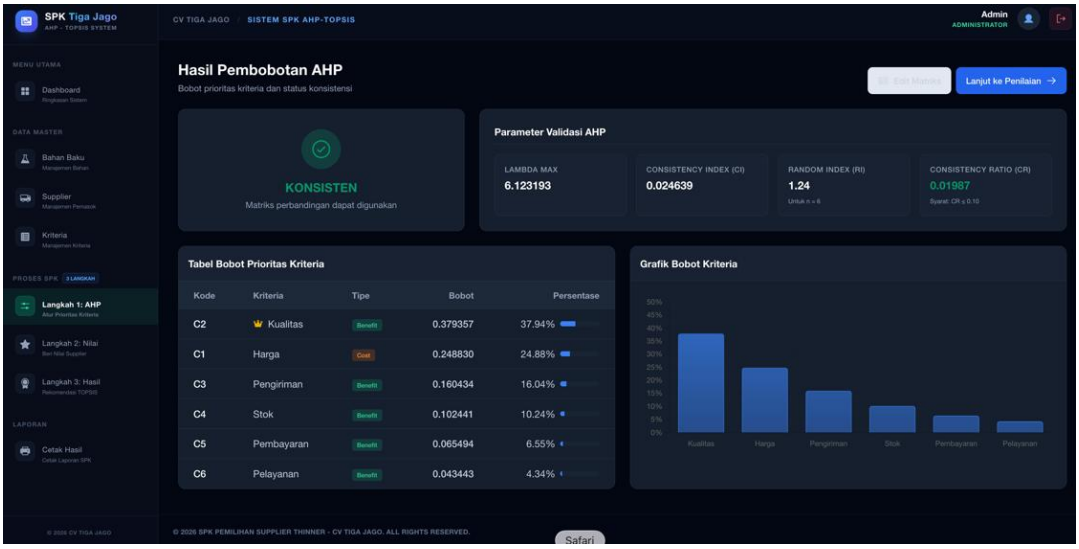

Figure 4 AHP Weighting Results Page

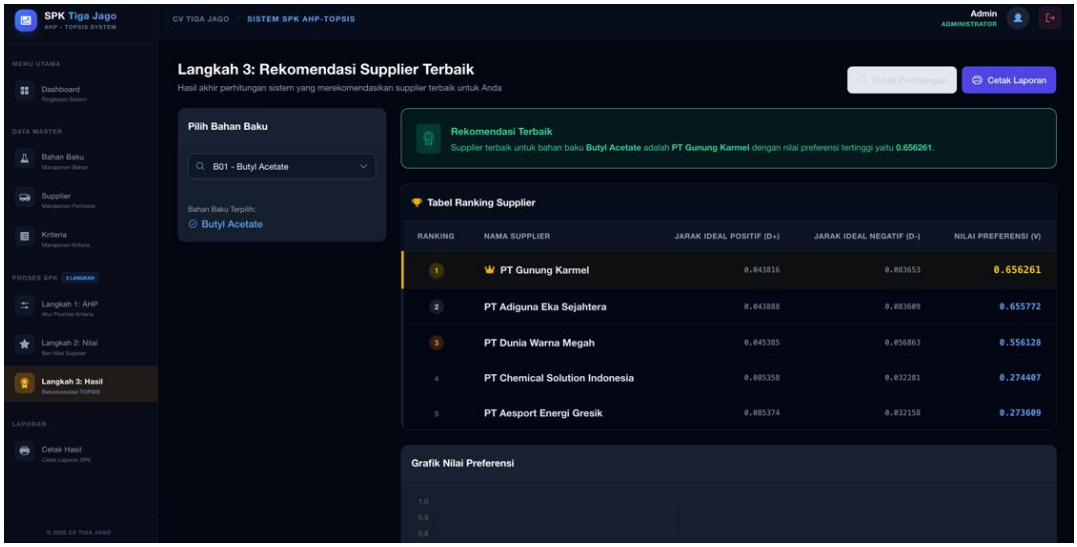

Figure 5 Best Supplier Recommendation Page

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AHP Criteria Weighting Results

The AHP calculation was performed to determine the priority weights of six criteria for selecting thinner raw material suppliers. The criteria used were price, quality, delivery, stock, payment, and service. Pairwise comparison scores between criteria were arranged based on their importance and then normalized to obtain priority weights. The results of the AHP weighting and consistency test are shown in Table 1.

Table 1 AHP Weighting and Consistency Results

Code	Criteria	Type	Weight
C1	Price	Cost	0.2488
C2	Quality	Benefits	0.3794
C3	Delivery	Benefits	0.1604
C4	Stock	Benefits	0.1024
C5	Payment	Benefits	0.0655
C6	Service	Benefits	0.0434
Amount			**1,0000**
Consistency Ratio			**0.0199**
Status			**Consistent**

Based on Table 1, the quality criterion received the highest weighting of 0.3794. This indicates that quality is the most dominant factor in selecting a thinner raw material supplier. The next criteria are price with a weighting of 0.2488, delivery of 0.1604, stock of 0.1024, payment of 0.0655, and service of 0.0434. The Consistency Ratio value of 0.0199 is below the 0.10 limit, so the results of the pairwise comparison are declared consistent and can be used as a weighting in the TOPSIS calculation.

TOPSIS Calculation Results

The TOPSIS calculation is performed to determine the best supplier ranking for each thinner raw material. The calculation process is carried out by compiling a decision matrix based on the supplier's score against each criterion, performing normalization, calculating the weighted normalization using AHP weights, determining the positive and negative ideal solutions, calculating the distance of each alternative from the ideal solution, and calculating the preference value. The supplier with the highest preference value becomes the most recommended alternative.

An example of a TOPSIS calculation is shown for Butyl Acetate raw material. The calculation results show that PT Gunung Karmel obtained the highest preference value of 0.656262, making it the best supplier for Butyl Acetate raw material. The TOPSIS ranking results for Butyl Acetate raw material are shown in Table 4.2.

Table 2 TOPSIS Calculation Results for Butyl Acetate Raw Material

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Ranking	Supplier	D+	D-	Preference Value
1	PT Gunung Karmel	0.043816	0.083653	0.656262
2	PT Adiguna Eka Sejahtera	0.043888	0.083609	0.655772
3	PT Dunia Warna Megah	0.045385	0.056863	0.556128
4	PT Chemical Solution Indonesia	0.085358	0.032281	0.274407
5	PT Aesport Energi Gresik	0.085374	0.032158	0.273609

Based on Table 2, PT Gunung Karmel is ranked first because it has the highest preference value. This preference value indicates that this alternative is closest to the positive ideal solution and relatively farthest from the negative ideal solution compared to other alternatives. Therefore, PT Gunung Karmel is the most recommended supplier for Butyl Acetate raw materials.

A summary of the best supplier results for all raw materials is shown in Table 3.

Table 3 Summary of Best Suppliers Based on TOPSIS Calculations

Code	Raw material	Best Supplier	Preference Value
B01	Butyl Acetate	PT Gunung Karmel	0.656262
B02	Butyl Cellosolve	PT Dunia Warna Megah	0.806054
B03	Ethyl Acetate	PT Chemical Solution Indonesia	0.891968
B04	Methanol	PT Gunung Karmel	0.656794
B05	MIBK	PT Dunia Warna Megah	0.805684
B06	Toluene	PT Chemical Solution Indonesia	0.891976
B07	Xylene	PT Gunung Karmel	0.656323
B08	Acetone	PT Dunia Warna Megah	0.804845
B09	Condensate	PT Aesport Energi Gresik	0.800389

Based on Table 3, the best suppliers differ across several raw material types. PT Gunung Karmel is the best supplier for Butyl Acetate, Methanol, and Xylene. PT Dunia Warna Megah is the best supplier for Butyl Cellosolve, MIBK, and Acetone. PT Chemical Solution Indonesia is the best supplier for Ethyl Acetate and Toluene. Meanwhile, PT Aesport Energi Gresik is the best supplier for Condensate. These results indicate that supplier selection needs to be based on each raw material, not just based on the overall supplier ranking.

System Verification and Testing

Verification was performed to ensure that the system's calculation results matched the manual or Microsoft Excel calculations. Verification was performed on the AHP weights, Consistency Ratio values, TOPSIS preference values, and supplier rankings. In the AHP

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calculations, the system's results showed the same values as the manual or Microsoft Excel calculations. The AHP verification results are shown in Table 4.

Table 4 Verification of Manual AHP Calculations with System Results

No	Evaluation Components	Manual/Excel	System	Difference	Status
1	Price Weight	0.2488	0.2488	0.0000	In accordance
2	Quality Weight	0.3794	0.3794	0.0000	In accordance
3	Shipping Weight	0.1604	0.1604	0.0000	In accordance
4	Stock Weight	0.1024	0.1024	0.0000	In accordance
5	Payment Weight	0.0655	0.0655	0.0000	In accordance
6	Service Weight	0.0434	0.0434	0.0000	In accordance
7	Consistency Ratio	0.0199	0.0199	0.0000	Consistent

TOPSIS verification was performed on Butyl Acetate raw material by comparing the preference and ranking values of the system results with manual or Microsoft Excel results. The TOPSIS verification results are shown in Table 5.

Table 5 Verification of Manual TOPSIS Calculations with System Results

No	Supplier	Manual/Excel Preferences	System Preferences	Difference	Manual/Excel Ranking	Ranking System	Status
1	PT Gunung Karmel	0.656262	0.656262	0.000000	1	1	In accordance
2	PT Adiguna Eka Sejahtera	0.655772	0.655772	0.000000	2	2	In accordance
3	PT Dunia Warna Megah	0.556128	0.556128	0.000000	3	3	In accordance
4	PT Chemical Solution Indonesia	0.274407	0.274407	0.000000	4	4	In accordance
5	PT Aesport Energi Gresik	0.273609	0.273609	0.000000	5	5	In accordance

Based on Tables 4 and 5, the system calculation results are the same as the manual or Microsoft Excel calculation results. This indicates that the system has implemented the AHP

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and TOPSIS stages according to the formulas used. System testing was also conducted using Black Box Testing on the login, dashboard, raw material management, supplier management, criteria management, AHP value management, supplier performance value input, TOPSIS process, recommendation display, preference value graph, report printing, and logout features. All main system functions run according to the expected results.

Discussion

The results of the study indicate that the combination of AHP and TOPSIS can be used to support the process of selecting thinner raw material suppliers more systematically. AHP is able to produce criteria weights based on the level of importance, while TOPSIS is able to produce supplier rankings based on the supplier's performance value for each raw material. The AHP weights indicate that quality is the most dominant criterion, so that supplier selection is not only based on the lowest price, but also considers raw material quality, delivery accuracy, stock availability, payment systems, and supplier service.

The Consistency Ratio value of 0.0199 indicates that the pairwise comparison results are consistent. Therefore, the criteria weights can be used in the TOPSIS process. The TOPSIS results indicate that the best supplier can differ for each raw material. This finding suggests that the thinner raw material supplier selection process is more appropriate based on the type of raw material, rather than just one general supplier ranking.

The results of this study align with those of Rivaldi et al. (2023), who demonstrated that quality is the dominant factor in supplier selection using AHP-TOPSIS. However, these results differ from those of Sabhira et al. (2024), who found that price was the most influential criterion in vegetable supplier selection. This difference indicates that the priority of criteria can change depending on the characteristics of the research object. For thinner raw materials, quality is prioritized because chemicals require quality stability and conformity to specifications.

Manual verification and black box testing demonstrated that the system implemented the formulas and core functions as designed. This system can help CV Tiga Jago obtain more objective, measurable, and documented supplier recommendations. However, the recommendations remain a decision-making tool, with the final decision remaining with company management.

Conclusion and Recommendation

Based on the research results, several conclusions were obtained as follows:

The AHP calculation produces the weight of the thinner raw material supplier selection criteria, namely quality of 0.3794, price of 0.2488, delivery of 0.1604, stock of 0.1024, payment of 0.0655, and service of 0.0434. The Consistency Ratio value of 0.0199 indicates that the results of the pairwise comparison are in the consistent category, so the criteria weight can be used in the TOPSIS calculation process.

The TOPSIS calculation is able to produce the best supplier ranking for each thinner raw material. The results show that the best supplier is not always the same for each type of raw material. PT Gunung Karmel is the best supplier for Butyl Acetate, Methanol, and Xylene. PT Dunia Warna Megah is the best supplier for Butyl Cellosolve, MIBK, and Acetone. PT Chemical Solution Indonesia is the best supplier for Ethyl Acetate and Toluene, while PT Aesport Energi Gresik is the best supplier for Condensate. These results indicate that supplier selection is more appropriate based on each raw material, rather than just based on the general supplier ranking.

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The developed web-based system can assist in the process of selecting thinner raw material suppliers in a more objective, systematic, and documented manner. The system is capable of managing raw material data, supplier data, criteria data, AHP calculations, supplier performance value input, TOPSIS calculations, recommendation displays, preference value graphs, and report printing. Based on the test results, all the system's main functions run according to the designed requirements, so the system can be used as a decision-making tool at CV Tiga Jago. The final decision remains with the company's management.

Based on the research results that have been conducted, the system can be developed by adding purchase history features and periodic supplier performance evaluations so that companies can monitor changes in supplier performance over time. In addition, future research can add other, more specific criteria, such as supplier legality, delivery capacity, supplier location distance, risk of delay, and price stability, so that the recommendation results are more complete according to the needs of thinner raw material procurement. The system can also be developed to be accessible online through a hosting server and equipped with a database backup feature. Further research is recommended to compare the AHP-TOPSIS method with other multicriteria decision-making methods, such as SAW, MOORA, WP, VIKOR, or a combination of other MCDM methods.

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