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Implementation of a LODECI and ALPAS Methods in Selecting Raw Material Suppliers in the Textile Industry

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ALPAS;
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Supplier Selection;
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ABSTRACT

The selection of raw material suppliers in the textile industry is a complex challenge because it involves various criteria, such as price, delivery timeliness, material quality, color consistency, and production capacity. Subjective decisions or those based on unstructured data often lead to inaccuracies, unfairness, and supply chain disruption risks. This study aims to present an objective and systematic approach by integrating the LODECI method for criteria weighting and ALPAS for alternative ranking. The LODECI method extracts criteria weights rationally from variations in supplier performance, minimizing the influence of subjectivity, while ALPAS combines the criteria weights with the performance data of alternatives to generate final scores and rank suppliers comprehensively. This study involved eleven actual suppliers as alternatives, with performance data reflecting real operational conditions. The ranking results show that alternative A8 has superior and stable performance, followed by A10 and A4, while the sensitivity analysis indicates that changes in criteria weights of ±0.05 do not cause significant shifts in rankings, confirming the model's robustness. These findings demonstrate that the integration of LODECI and ALPAS can enhance the objectivity, consistency, and accountability of supplier decision-making, supporting supply chain efficiency, product quality, and the overall competitiveness of the textile industry.

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I. Introduction

Raw material suppliers play a strategic role in the textile industry because they serve as the starting point that determines the sustainability of the entire production process, from spinning to finished products ready for the market[1], [2]. The quality of fibers, yarns, or fabrics supplied directly affects the physical and aesthetic characteristics of the final product, such as strength, comfort, color consistency, and durability, so unreliable suppliers can potentially lower the overall product quality. From a production cost perspective, the pricing structure, supply stability, and logistical efficiency offered by suppliers greatly influence a textile company's ability to control raw material costs, which are generally the largest cost component in the production structure. Dependence on suppliers with fluctuating prices or inconsistent quality can increase rework costs, material waste, and the risk of product rejection by the market. In addition, the timeliness of raw material delivery directly affects the smoothness of the production schedule and the fulfillment of customer orders, especially in the textile industry, which faces high pressure regarding lead times and rapidly changing market trends. Supply delays can cause production lines to stop, increase operational costs, and decrease customer trust. Choosing and managing the right raw material suppliers is not only an operational decision but also a strategic one that determines competitiveness, efficiency, and the long-term reputation of the textile company[3].

The selection of textile raw material suppliers is a complex issue because it involves many interrelated criteria and often has conflicting interests[4]. Material quality is the main factor as it determines the performance and competitiveness of the final product, but high quality is usually accompanied by higher costs, creating a dilemma in cost control. Color consistency is also a crucial issue, especially for companies that produce on a large scale and aim for product uniformity, as even small differences in color can lead to market rejection or the need for reproduction. On the other hand, timely delivery greatly affects the smoothness of the production schedule, but suppliers capable of ensuring on-time delivery do not necessarily have adequate production capacity to meet large or fluctuating demands. The company's own production capacity becomes a challenge, especially when market demand suddenly increases, requiring the company to assess the supplier's ability to maintain supply continuity. Additionally, compliance with environmental standards is becoming an increasingly important concern as regulatory demands and consumer awareness grow, yet suppliers that meet environmental standards often require additional costs. This situation makes the decision-making process for selecting textile raw material suppliers complex, as the company must balance various technical, economic, and sustainability criteria objectively and rationally to minimize risks and enhance supply chain performance.

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The conventional approach to selecting textile raw material suppliers still faces various limitations, especially when relying on subjective assessments and the use of a single MCDM method[5], [6]. Subjective methods that depend on expert opinions or managerial experience are prone to personal biases, inconsistencies in judgment, and differences in perception among decision-makers, making the evaluation results often difficult to replicate and less transparent. Furthermore, many studies use a single multi criteria decision making (MCDM) method independently, which in practice is very sensitive to the determination of criteria weights, as small changes in the weights can result in significantly different supplier rankings[7], [8]. This condition indicates the low robustness of single methods in dealing with supplier data variations, such as quality fluctuations, price changes, or inconsistencies in delivery performance. Single MCDM methods also tend to have certain mathematical assumptions that do not always align with the characteristics of real-world data in the textile industry, which can potentially result in less stable decisions when applied in dynamic conditions[9]–[11]. As a result, previous research findings are often limited to specific data contexts and difficult to generalize. These limitations underscore the need for an approach that is more objective, adaptive, and resilient to data variations so that the supplier selection process can produce results that are more reliable and relevant to actual operational conditions.

Logarithmic decomposition of criteria importance is an objective weighting approach that aims to capture the relative importance of decision criteria by analyzing their dispersion patterns through logarithmic transformation[12], [13]. This approach is grounded in the idea that criteria with greater variability across alternatives contain more discriminative information and therefore should receive higher importance in the decision-making process. By applying a logarithmic function, extreme values and scale differences among criteria are moderated, allowing subtle yet meaningful variations in supplier performance to be reflected more proportionally. This decomposition helps reduce dominance effects caused by outliers and improves numerical stability, especially when criteria values span wide ranges. In multi-criteria decision-making contexts, such as supplier evaluation, logarithmic decomposition provides a more balanced representation of criteria importance compared to linear or purely subjective weighting schemes[14], [15]. As a result, the derived weights tend to be more robust to data variation and less sensitive to minor fluctuations, supporting more consistent and transparent ranking outcomes that align closely with empirical data characteristics.

The Alternative Prioritization and Assessment System (ALPAS) method is a systematic framework designed to evaluate and prioritize a number of decision alternatives based on various relevant criteria in a structured and objective manner[16], [17]. This system functions as a decision-making tool by integrating alternative performance data, the importance weights of criteria, and a transparent assessment mechanism, allowing each alternative to be compared fairly and consistently. In its

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implementation, this system is capable of accommodating the complexity of problems involving multiple criteria with different characteristics, both quantitative and qualitative. The prioritization process is carried out by assessing the extent to which each alternative meets the established criteria, and then converting it into an aggregate score that reflects the level of feasibility or relative preference[18]. Through this approach, decision-makers can reduce subjectivity, increase accountability, and obtain a more rational and data-driven basis for decisions, particularly in evaluation issues such as supplier selection, creditworthiness determination, or organizational performance assessment.

The combination of LODECI and ALPAS is an integrated approach in multi-criteria decision-making that combines the advantages of objective weighting and a comprehensive alternative ranking system. LODECI is used to determine the importance level of criteria based on logarithmic decomposition of data variations, so that the resulting weights reflect empirical information and have better resilience to differences in scale as well as extreme values. Subsequently, these criteria weights become the main input in ALPAS as a system for prioritizing and evaluating alternatives, which assesses the performance of each alternative comprehensively based on its contribution to all criteria. This integration allows the evaluation process to run more consistently, as the determination of weights does not depend on the decision-maker's subjectivity, while the ranking of alternatives is carried out systematically and transparently. By combining LODECI and ALPAS, the decision outcomes tend to be more stable, rational, and representative of real data conditions, making this approach very relevant for complex problems such as selecting raw material suppliers, feasibility assessments, and performance evaluations involving multiple criteria and alternatives.

The motivation for this research is driven by the need for a decision support system model capable of handling the complexity of selecting textile raw material suppliers more objectively and in a manner relevant to real industry conditions. The LODECI method was chosen due to its ability to determine criteria weights based on logarithmic decomposition of data variations, thereby reducing dependence on subjective assessments and enhancing the stability of weights against supplier performance fluctuations. Meanwhile, ALPAS is used as a method for evaluating and prioritizing alternatives because it can comprehensively assess supplier performance while consistently considering the contribution of each criterion in an integrated manner. The combination of these two methods is expected to overcome the limitations of conventional approaches and single MCDM methods, which are sensitive to weight changes and data variations. The main contribution of this study lies in providing a decision support system model that is more objective, transparent, and easy to apply in the textile industry context, particularly to support decision-making in selecting raw material suppliers. Moreover, this study also offers a methodological contribution by expanding the application of LODECI and

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ALPAS to real industrial problems, so that the results obtained are not only theoretical but also have practical value for industry players in improving the efficiency and reliability of the supply chain.

II. Methodology

2.1. Research Framework

This research framework is designed as a conceptual reference that depicts the logical relationship between problems, methods, and research objectives in the context of selecting suppliers for textile industry raw materials[19], [20]. The framework emphasizes an objective decision-making approach by combining data-driven criteria weighting and a systematic alternative evaluation mechanism. Through this framework, the study aims to address the industry's need for a supplier evaluation model capable of handling multiple criteria with diverse characteristics while reducing the dominance of subjectivity[21]. Figure 1 is the research framework used in Selecting Raw Material Suppliers in the Textile Industry.

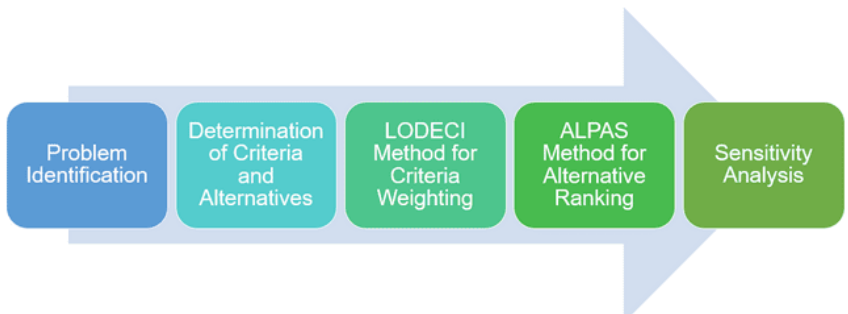

Figure 1. Research Framework

This research framework is designed to provide a systematic and logical flow in addressing the problem of selecting raw material suppliers in the textile industry. The study begins with problem identification and goal setting, followed by determining relevant criteria and supplier alternatives based on the operational conditions of the industry. Supplier performance data is then collected and processed using the LODECI method to obtain objective criteria weights based on data characteristics. Subsequently, these weights are used in the ALPAS method to evaluate and prioritize each supplier alternative comprehensively. The ranking results are analyzed using sensitivity analysis to test the stability and reliability of the decisions obtained. Through this framework, the research is expected to produce a structured and objective decision support system model to assist in making decisions for selecting raw material suppliers in the textile industry.

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2.2. Logarithmic Decomposition of Criteria Importance (LODECI) Weighting

Logarithmic Decomposition of Criteria Importance (LODECI) Weighting is an objective weighting method designed to determine the level of importance of criteria based on data variation patterns through a logarithmic decomposition approach[22], [23]. This method is based on the assumption that criteria with greater variation among alternatives have a stronger distinguishing power and, therefore, deserve to receive higher weights. Logarithmic transformation is used to balance scale differences and reduce the influence of extreme values, so that the contribution of each criterion can be represented more proportionally and stably. By directly utilizing the characteristics of the data, LODECI is able to reduce reliance on subjective assessments and improve methods. LODECI provides a basis for weighting that is more rational, resistant to data fluctuations, and relevant to real operational conditions. The LODECI weighting method is calculated using the following equation.

$$X = [x_{ij}]_{mxn} \quad (1)$$

$$d_{ij} = \begin{cases} \frac{\min_j(x_{ij})}{x_{ij}}; if\ benefit \\ \frac{x_{ij}}{\min_j(x_{ij})}; if\ cost \end{cases} \quad (2)$$

$$DV_j = \max(|d_{ij} - \overline{d_{ik}}|) \quad (3)$$

$$LDV_j = \ln(1 + \frac{DV_j}{m}) \quad (4)$$

$$w_j = \frac{LDV_j}{\sum_{j=1}^{n} LDV_j} \quad (5)$$

The stages of LODECI calculation begin by creating a decision matrix using (1), then normalization is calculated using (2). Next, the decomposition value is calculated using (4), then the logarithmic decomposition value is calculated using (5), and finally, the criteria weights are calculated using (5).

2.3. Alternative Prioritization and Assessment System (ALPAS) Method

The alternative prioritization and assessment system (ALPAS) Method is a multi-criteria decision-making method used to evaluate and prioritize alternatives based on their relative performance against a set of established criteria[24]. This method works by integrating the performance values of the alternatives with the weights of the criteria to produce an aggregate score that reflects the overall feasibility or preference of each alternative. ALPAS is designed to provide a consistent and transparent evaluation process, allowing fair comparisons between alternatives even when involving many criteria with different characteristics. In its application, this method is able to capture the contribution of each criterion to the final result without dominating

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the assessment unilaterally. The ALPAS method is calculated using the following equation.

$$b_{ij} = \begin{cases} \frac{\min_j(x_{ij})}{x_{ij}}; if\ benefit \\ \frac{x_{ij}}{\min_j(x_{ij})}; if\ cost \end{cases} \tag{6}$$

$$y_{ij} = w_j * b_{ij} \tag{7}$$

$$I_j = \begin{cases} \max(y_{ij}); if\ benefit \\ \min(y_{ij}); if\ cost \end{cases} \tag{8}$$

$$AI_j = \begin{cases} \min(y_{ij}); if\ benefit \\ \max(y_{ij}); if\ cost \end{cases} \tag{9}$$

$$S_i = \sum_{j=1}^{n} \left(\frac{(y_{ij}+1)}{(I_j+1)} - \frac{(AI_j+1)}{(y_{ij}+1)} \right) \tag{10}$$

$$P_i = \left(\alpha * \sum_{j=1}^{n}(y_{ij}+1)\right) + \left(\beta * \prod_{j=1}^{n}(y_{ij}+1)\right)^{1/n} \tag{11}$$

$$G_i = (\delta * S_i) + (\omega * P_i) \tag{12}$$

The stages of ALPAS calculation begin with creating a decision matrix using (1), then normalization is calculated using (6), next the weighted normalization is calculated using (7), then the ideal solution is calculated using (8), followed by the anti-ideal solution using (9), then the utility value is calculated using (10), next the combined power is calculated using (11), and finally the final alternative value is calculated using (12).

III. Result and Discussion

The implementation of the LODECI and ALPAS methods in selecting textile industry raw material suppliers aims to support more objective and data-driven decision-making amid the complexity of criteria that must be considered. The LODECI method is used to determine the importance weights of criteria rationally by utilizing variations in supplier performance data, thereby reducing the influence of subjectivity and enhancing assessment consistency. The resulting weights are then integrated into the ALPAS method to evaluate and prioritize suppliers based on overall performance against all relevant criteria, such as material quality, price, delivery punctuality, and environmental compliance. The implementation of LODECI and ALPAS provides an applicable solution for the textile industry in selecting the most suitable raw material suppliers to improve the efficiency and reliability of the supply chain.

3.1. Determination of Criteria and Alternatives

Determining criteria is an important stage in this study because it serves as the basis for evaluation in assessing the performance of raw material suppliers in the textile industry. The criteria are

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established to represent the main factors that influence the quality of decisions, so they must be relevant to operational needs and the characteristics of the textile industry. The selection of criteria considers technical, economic, and sustainability aspects to ensure that the evaluation conducted is comprehensive and balanced. The formulated criteria are expected to clearly and measurably reflect differences in performance among suppliers, thereby supporting the process of weighting and objective ranking. With the appropriate determination of criteria, the results of supplier evaluations become more accurate, rational, and accountable as a basis for decision-making. Table 1 presents the criteria data used in this study.

Table 1. Criteria Data

Criteria ID	Criteria Name	Criteria Type	Description
CD-1	Price	Cost	The cost offered by the supplier for raw materials, including price stability and alignment with the production budget.
CD-2	Delivery Time	Cost	The supplier's ability to deliver raw materials according to the agreed schedule.
CD-3	Material Quality	Benefit	The level of conformity of raw materials to the quality standards set by the company, including the strength, fineness, and durability of the materials.
CD-4	Color Consistency	Benefit	The supplier's ability to maintain color consistency of raw materials in each shipment and production batch.
CD-5	Production Capacity	Benefit	The supplier's ability to meet the volume of raw material demand sustainably, both under normal conditions and when demand increases.

These criteria represent a balanced combination of technical, economic, and sustainability aspects, enabling an evaluation and selection process of suppliers that is objective and relevant to the needs of the textile industry.

Determining alternatives is an important part of the decision-making process because alternatives represent choices of raw material suppliers that will be evaluated in this study. Alternatives are established based on suppliers that are actually operating and have the potential to meet the needs of the textile industry, thus having direct relevance to real conditions. Each alternative is assumed to have different performance characteristics against the predetermined criteria, in terms of quality, cost, and supply reliability. Clarity in determining alternatives greatly affects the accuracy of evaluation results, because the chosen alternatives must be able to reflect the performance variations that exist in the field. With the proper determination of alternatives, the assessment and ranking process can produce more rational and implementable supplier recommendations.

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Alternative assessment data represents the performance of each raw material supplier against all the criteria established in this study. This data is obtained from relevant sources and reflects actual operational conditions, allowing for an objective depiction of differences in supplier performance. The assessment scores are organized into a decision matrix containing both quantitative and qualitative information that has been converted into a measurable scale to be analyzed systematically. The accuracy and consistency of the alternative assessment data are crucial in determining the quality of weighting and ranking results, as this data serves as the main basis for the decision-making process. The preparation of alternative assessment data is carried out carefully so that the resulting supplier evaluations are rational, stable, and accountable, as shown in Table 2.

Table 2. Alternative Assessment Data

Alternative	CD-1	CD-2	CD-3	CD-4	CD-5
A1	320	7	9	8	7
A2	350	9	8	7	8
A3	280	12	7	7	6
A4	410	5	8	9	8
A5	300	8	9	8	9
A6	330	6	8	8	7
A7	450	11	7	6	8
A8	260	4	9	9	9
A9	380	13	8	7	7
A10	290	5	9	8	8
A11	470	10	7	8	6

3.2. LODECI Method for Criteria Weighting

LODECI Weighting is an objective weighting method used to determine the importance level of each criterion based on the distribution characteristics of alternative data. This method utilizes logarithmic decomposition to extract information from variations in criterion values, assuming that criteria with greater performance differences among alternatives provide more significant information in the decision-making process. The logarithmic approach functions to balance scale differences and reduce the influence of extreme values, resulting in weights that are more stable and proportional. By focusing on actual data, LODECI can minimize subjectivity in weight determination and enhance the consistency of evaluation results. This method provides a rational and reliable weighting foundation to support the assessment and ranking of alternatives in multi-criteria problems.

The LODECI calculation stages begin by creating a decision matrix using (1) based on the assessment data consisting of 5 criteria and 11 alternatives, with the general form of the decision matrix as follows.

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$$X=\begin{bmatrix} x_{11} & x_{21} & x_{31} & x_{41} & x_{51} \\ x_{12} & x_{22} & x_{32} & x_{42} & x_{52} \\ x_{13} & x_{23} & x_{33} & x_{43} & x_{53} \\ x_{14} & x_{24} & x_{34} & x_{44} & x_{54} \\ x_{15} & x_{25} & x_{35} & x_{45} & x_{55} \\ x_{16} & x_{26} & x_{36} & x_{46} & x_{56} \\ x_{17} & x_{27} & x_{37} & x_{47} & x_{57} \\ x_{18} & x_{28} & x_{38} & x_{48} & x_{58} \\ x_{19} & x_{29} & x_{39} & x_{49} & x_{59} \\ x_{110} & x_{210} & x_{310} & x_{410} & x_{510} \\ x_{111} & x_{211} & x_{311} & x_{411} & x_{511} \end{bmatrix}$$

The decision matrix results from the assessment data in Table 2 are as follows.

$$X=\begin{bmatrix} 320 & 7 & 9 & 8 & 7 \\ 350 & 9 & 8 & 7 & 8 \\ 280 & 12 & 7 & 7 & 6 \\ 410 & 5 & 8 & 9 & 8 \\ 300 & 8 & 9 & 8 & 9 \\ 330 & 6 & 8 & 8 & 7 \\ 450 & 11 & 7 & 6 & 8 \\ 260 & 4 & 9 & 9 & 9 \\ 380 & 13 & 8 & 7 & 7 \\ 290 & 5 & 9 & 8 & 8 \\ 470 & 10 & 7 & 8 & 6 \end{bmatrix}$$

The second stage in determining the criteria weights using LODECI is calculating the normalization values using (2), with the results of the normalization calculations as follows.

$$d_{11}=\frac{\min_j(x_{1j})}{x_{11}}=\frac{260}{320}=0.8125$$

The overall calculation of normalization values in the LODECI method is shown in Table 3.

Table 3. Calculation Results of Normalization Values Using the LODECI Method

Alternative	CD-1	CD-2	CD-3	CD-4	CD-5
A1	0.8125	0.5714	1.0000	0.8889	0.7778
A2	0.7429	0.4444	0.8889	0.7778	0.8889
A3	0.9286	0.3333	0.7778	0.7778	0.6667
A4	0.6341	0.8000	0.8889	1.0000	0.8889
A5	0.8667	0.5000	1.0000	0.8889	1.0000
A6	0.7879	0.6667	0.8889	0.8889	0.7778
A7	0.5778	0.3636	0.7778	0.6667	0.8889
A8	1.0000	1.0000	1.0000	1.0000	1.0000
A9	0.6842	0.3077	0.8889	0.7778	0.7778
A10	0.8966	0.8000	1.0000	0.8889	0.8889
A11	0.5532	0.4000	0.7778	0.8889	0.6667

The third stage in determining the criteria weights using LODECI is calculating the decomposition value using (3), the results of the decomposition value calculation are as follows.

$$\begin{aligned} DV_1 &= \max(|d_{11}-d_{1j}|) \\ &= \max(0.0412; 0.0284; 0.1573; 0.1372; 0.0954; 0.0166; 0.1935; 0.2287; 0.0871; 0.1252; 0.2181) \\ &= 0.2287 \end{aligned}$$

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The overall calculation of decomposition values in the LODECI method is shown in Table 4.

Table 4. Calculation Results of Decomposition Values Using the LODECI Method

CD-1	CD-2	CD-3	CD-4	CD-5
0.2287	0.4375	0.1212	0.1919	0.1717

The fourth stage in determining the criterion weights using LODECI is calculating the logarithmic decomposition values using (4), and the results of the logarithmic decomposition calculation are as follows.

$$LDV_1 = \ln(1+\frac{DV_1}{11}) = \ln(1+\frac{0.2287_1}{11}) = \ln(1.0208) = 0.0206$$

The overall calculation of logarithmic decomposition values in the LODECI method is shown in Table 5.

Table 5. Calculation Results of Logarithmic Decomposition Values Using the LODECI Method

CD-1	CD-2	CD-3	CD-4	CD-5
0.0206	0.0390	0.0110	0.0173	0.0155

The fifth stage in determining the criteria weights using LODECI is calculating the criteria weight values using (5), the results of the criteria weight calculation are as follows.

$$w_1 = \frac{LDV_1}{LDV_1+LDV_2+LDV_3+LDV_4+LDV_5} = \frac{0.0206}{0.0206+0.0390+0.0110+0.0173+0.0155} = 0.1991$$

The overall calculation of criteria weight values in the LODECI method is shown in Table 6.

Table 6. Calculation Results of Criteria Weight Values Using the LODECI Method

CD-1	CD-2	CD-3	CD-4	CD-5
0.1991	0.3775	0.1061	0.1674	0.1499

The weighting results using the LODECI method show that Delivery Time (CD-2) has the highest weight at 0.3775, indicating that on-time delivery is the most influential criterion in differentiating the performance of textile raw material suppliers based on the available data variations. Price (CD-1) ranks second with a weight of 0.1991, reflecting the important role of cost factors in decision-making, although its influence is still below that of delivery punctuality. Color Consistency (CD-4) has a weight of 0.1674, indicating that color consistency is also a fairly significant differentiating factor among suppliers, especially in maintaining the quality of textile products. Production Capacity (DC-5) received a weight of 0.1499, indicating that the supplier's ability to meet demand volume contributes moderately to the overall evaluation. Meanwhile, Material Quality (DC-3) has the lowest weight of 0.1061, which suggests that the variation in material quality among suppliers is relatively smaller compared to other criteria, thus its contribution in the weighting process is lower.

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3.3. ALPAS Method for Alternative Ranking

The ALPAS Method is a ranking method in multi-criteria decision making that aims to determine the priority order of alternatives based on their relative performance against all weighted criteria. This method integrates the performance values of alternatives and the weights of criteria to produce an aggregate score that represents the overall preference level for each alternative. Through a consistent evaluation mechanism, ALPAS is able to compare alternatives objectively even when involving criteria with different scales and characteristics. This approach emphasizes transparency and traceability of results, so that each ranking produced can be logically explained based on the contribution of the criteria.

The calculation steps of the ALPAS method begin with creating a decision matrix using (1) based on assessment data consisting of 5 criteria and 11 alternatives, with the general form of the ALPAS decision matrix being the same as the LODECI decision matrix. The second stage in determining the ranking of alternatives using ALPAS is calculating the normalization values using (6), with the normalization calculation results as follows.

$$b_{11} = \frac{\min_{1}(x_{1j})}{x_{11}} = \frac{260}{320} = 0.8125$$

The overall calculation of normalization values in the LODECI method is shown in Table 7.

Table 7. Calculation Results of Normalization Values Using the ALPAS Method

Alternative	CD-1	CD-2	CD-3	CD-4	CD-5
A1	0.8125	0.5714	1.0000	0.8889	0.7778
A2	0.7429	0.4444	0.8889	0.7778	0.8889
A3	0.9286	0.3333	0.7778	0.7778	0.6667
A4	0.6341	0.8000	0.8889	1.0000	0.8889
A5	0.8667	0.5000	1.0000	0.8889	1.0000
A6	0.7879	0.6667	0.8889	0.8889	0.7778
A7	0.5778	0.3636	0.7778	0.6667	0.8889
A8	1.0000	1.0000	1.0000	1.0000	1.0000
A9	0.6842	0.3077	0.8889	0.7778	0.7778
A10	0.8966	0.8000	1.0000	0.8889	0.8889
A11	0.5532	0.4000	0.7778	0.8889	0.6667

The third stage in determining the ranking of alternatives using ALPAS is to calculate the weighted normalization value using (7), with the results of the weighted normalization calculation as follows.

$$y_{11} = w_1 * b_{11} = 0.1991 * 0.8125 = 0.1618$$

The overall calculation of weighted normalization values in the LODECI method is shown in Table 8.

Table 8. Calculation Results of Weighted Normalization Values Using the ALPAS Method

Alternative	CD-1	CD-2	CD-3	CD-4	CD-5
A1	0.1618	0.2157	0.1061	0.1488	0.1166

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A2	0.1479	0.1678	0.0943	0.1302	0.1333
A3	0.1849	0.1258	0.0825	0.1302	0.0999
A4	0.1263	0.3020	0.0943	0.1674	0.1333
A5	0.1726	0.1887	0.1061	0.1488	0.1499
A6	0.1569	0.2517	0.0943	0.1488	0.1166
A7	0.1151	0.1373	0.0825	0.1116	0.1333
A8	0.1991	0.3775	0.1061	0.1674	0.1499
A9	0.1363	0.1161	0.0943	0.1302	0.1166
A10	0.1785	0.3020	0.1061	0.1488	0.1333
A11	0.1102	0.1510	0.0825	0.1488	0.0999

The fourth stage in determining the ranking of alternatives using ALPAS is to calculate the ideal solution value using (8), with the results of the ideal solution calculation as follows.

$$I_1 = \min(0.1618; 0.1479; 0.1849; 0.1263; 0.1726; 0.1569; 0.1151; 0.1991; 0.1363; 0.1785; 0.1102) = 0.1102$$

The overall calculation of ideal solution values in the ALPAS method is shown in Table 9.

Table 9. Calculation Results of Ideal Solution Values Using the ALPAS Method

CD-1	CD-2	CD-3	CD-4	CD-5
0.1102	0.1161	0.1061	0.1674	0.1499

The fifth stage in determining the ranking of alternatives using ALPAS is to calculate the anti-ideal solution value using (9), with the results of the anti-ideal solution calculation as follows.

$$AI_1 = \max(0.1618; 0.1479; 0.1849; 0.1263; 0.1726; 0.1569; 0.1151; 0.1991; 0.1363; 0.1785; 0.1102) = 0.1991$$

The overall calculation of anti-ideal solution values in the ALPAS method is shown in Table 10.

Table 10. Calculation Results of Anti-Ideal Solution Values Using the ALPAS Method

CD-1	CD-2	CD-3	CD-4	CD-5
0.1991	0.3775	0.0825	0.1116	0.0999

The sixth stage in determining the ranking of alternatives using ALPAS is calculating the utility value using (10), with the results of the utility value calculations as follows.

$$S_1 = \sum_{i=1}^{m} \left(\frac{(y_{1j}+1)}{(I_j+1)} - \frac{(AI_1+1)}{(y_{1j}+1)} \right) = -0.0058$$

The overall calculation of utility values in the ALPAS method is shown in Table 11.

Table 11. Calculation Results of Utility Values Using the ALPAS Method

Alternative	Utility Value
A1	-0.0058
A2	-0.1443
A3	-0.2397
A4	0.1212

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A5	0.0211
A6	0.0290
A7	-0.3175
A8	0.4269
A9	-0.2953
A10	0.2053
A11	-0.2940

The seventh stage in determining the ranking of alternatives using ALPAS is calculating the combined power value using (11), with the results of the combined power value calculations as follows.

$$P_1 = \left(0.5 * \sum_{i=1}^{m} (y_{1j}+1)\right) + \left(0.5 * \prod_{1=1}^{m} (y_{1j}+1)\right)^{1/5} = (2.8745) + (2.0039)^{1/5} = 4.0236$$

The overall calculation of combined power values in the ALPAS method is shown in Table 12.

Table 12. Calculation Results of Combined Power Values Using the ALPAS Method

Alternative	Combined Power Value
A1	4.0236
A2	3.9711
A3	3.9358
A4	4.0741
A5	4.0359
A6	4.0365
A7	3.9056
A8	4.1965
A9	3.9153
A10	4.1061
A11	3.9143

The eighth stage in determining the ranking of alternatives using ALPAS is calculating the final value using (12), with the results of the final value calculations as follows.

$$G_1 = (\delta * S_1) + (\omega * P_1) = (0.5 * (-0.0058)) + (0.5 * 4.0236) = 2.0089$$

The overall calculation of final values in the ALPAS method is shown in Table 13.

Table 13. Calculation Results of Final Values Using the ALPAS Method

Alternative	Final Value
A1	2.0089
A2	1.9134
A3	1.8481
A4	2.0976
A5	2.0285
A6	2.0328
A7	1.7941
A8	2.3117
A9	1.8100
A10	2.1557
A11	1.8102

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The final results of the calculation using the ALPAS method produce a final score for each alternative that represents the overall performance level based on all established criteria and weights. This final score is obtained by combining summation and multiplication components, allowing it to capture the contributions of the criteria in a balanced and comprehensive manner. Furthermore, this preference value is used as the basis for ranking the alternatives, as shown in Table 14.

Table 14. Ranking Alternative Using the ALPAS Method

Alternative	Final Value	Rank
A8	2.3117	1
A10	2.1557	2
A4	2.0976	3
A6	2.0328	4
A5	2.0285	5
A1	2.0089	6
A2	1.9134	7
A3	1.8481	8
A11	1.8102	9
A9	1.8100	10
A7	1.7941	11

The ranking results using the ALPAS method show that alternative A8 holds the first position with the highest final score of 2.3117, indicating the most superior performance compared to the other alternatives based on all evaluated criteria. The second position is held by A10 with a score of 2.1557, followed by A4 in third place with a score of 2.0976, indicating that these two alternatives have relatively strong and competitive performance. Alternatives A6 and A5 are ranked fourth and fifth with very close scores, reflecting nearly equal levels of performance. Next, A1 and A2 occupy the middle ranks, indicating fairly good performance but still below the top-priority alternatives. Meanwhile, A3, A11, A9, and A7 are at the bottom ranks, which indicates that the performance of these alternatives is relatively less optimal compared to the others. Overall, this ranking result provides a clear picture of the priority of alternatives and can serve as a rational basis for determining the best choice according to decision-making goals.

3.4. Sensitivity Analysis

Sensitivity analysis is conducted to test the stability and reliability of the decision results obtained from the method used, especially in facing changes in certain conditions or assumptions[25], [26]. In the context of supplier selection, this analysis aims to see to what extent changes in the weights of criteria or the performance values of alternatives can affect the ranking results that have been produced. By conducting a sensitivity analysis, it can be determined whether the decisions made are consistent or easily change due to small variations in input parameters[27]–[29]. This is important to ensure that the selected alternative truly has strong performance and is not just superior under certain conditions. Therefore, sensitivity analysis

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becomes an important part of strengthening the validity and confidence in the results of the decision support system that is developed[30], [31].

A scenario of weight changes with an increase and decrease of 0.05 is used in sensitivity analysis to evaluate the robustness of the ranking results against variations in criteria weights[32], [33]. This approach simulates conditions of preference changes or uncertainty in weight determination, which often occur in decision-making practice. By increasing or decreasing the weight of a criterion by 0.05 and adjusting the weights of other criteria to remain proportional, the direct impact of these changes on preference values and the ranking order of alternatives can be observed. This scenario helps identify the criteria that most significantly influence changes in decision outcomes and assess whether the best alternative remains consistent under various weight conditions[34], [35]. The scenario of changing the weight of each criterion while keeping the total weight equal to one is used to ensure the consistency and validity of sensitivity analysis in multi-criteria decision-making. In this scenario, the weight of each criterion is adjusted in a controlled manner, while the weights of the other criteria are proportionally modified so that the overall total weight remains unchanged. This approach represents real conditions where the importance level of criteria can shift without altering the overall preference structure. Through this scenario, it is possible to analyze the extent to which changes in individual weights affect preference values and the ranking order of alternatives. The results provide a clearer understanding of the model's stability and which criteria are most sensitive to weight changes. Figure 2 shows the results of the alternative ranking from the scenario of changes in criteria weights.

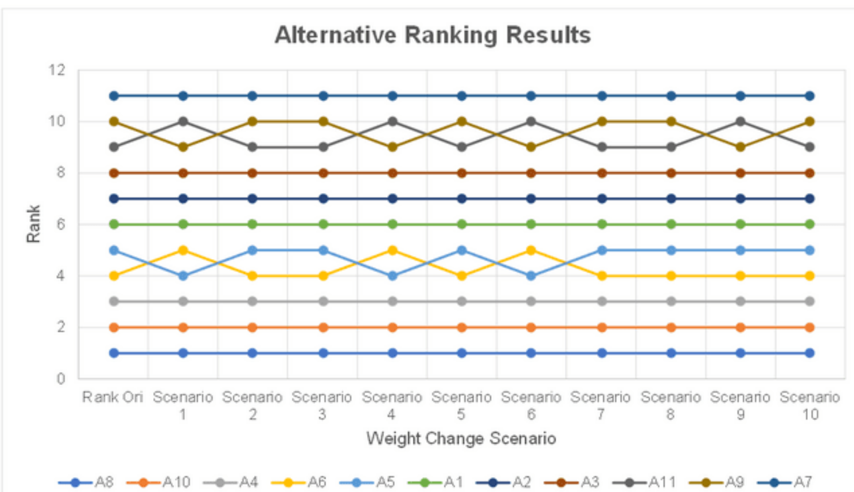

Figure 2. Alternative Ranking Results Based on Sensitivity Analysis

The results of the sensitivity analysis in the graph indicate that changes in criteria weights across various scenarios do not cause significant changes in the overall ranking structure of the alternatives. Alternative A8 consistently occupies the first rank in all scenarios,

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indicating that this alternative has the most stable and dominant performance against weight changes. Alternatives A10 and A4 also show high stability by remaining in the top-ranking group in almost all scenarios. Some mid-ranked alternatives, such as A6 and A5, experienced slight ranking fluctuations, but the changes were relatively minor and did not drastically shift their positions. Meanwhile, alternatives at the lower ranks tended to maintain their positions without significant changes. Overall, this chart indicates that the decision model used has a good level of robustness, as the ranking results remain relatively consistent despite variations in criteria weights across different scenarios.

3.5. Discussion

The implementation of the LODECI and ALPAS methods in selecting suppliers of raw materials for the textile industry demonstrates a systematic and data-driven approach to support more objective decision-making. The evaluation results show that the criteria weights determined through LODECI provide a rational overview of the factors that most influence differences in supplier performance. Assigning these objective weights reduces the dominance of subjectivity, so decisions are not solely based on individual perceptions or experiences, but on the actual performance distribution of suppliers. By integrating these criteria weights into the ALPAS method, the ranking of supplier alternatives can be determined comprehensively, reflecting overall performance across various important aspects, such as material quality, price, delivery timeliness, and compliance with environmental standards. This confirms that the combination of LODECI and ALPAS is capable of providing more reliable and relevant supplier recommendations in line with the operational conditions of the textile industry.

The determination of the criteria and alternatives used in this study serves as the main foundation of the evaluation process. The selected criteria include technical, economic, and sustainability aspects, so the evaluation reflects actual operational needs as well as the characteristics of the textile industry. For example, on-time delivery (CD-2) receives the highest weight due to significant performance differences among suppliers, indicating that the ability to supply materials on schedule is a key factor in operational success. Meanwhile, the material quality (CD-3) has relatively small variations, so its contribution to the weighting process is lower. Determining clear and relevant alternatives ensures that each supplier being evaluated can reflect real performance variations in the field, so the resulting rankings are accurate and can be directly applied in the company's strategic decisions.

The analysis of criteria weights using LODECI shows that the price criterion (CD-1) and color consistency (CD-4) also contribute significantly to supplier evaluation. Price affects economic decisions and production cost efficiency, while color consistency is closely related to the quality of the final product and customer satisfaction. With weights of 0.1991 for price and 0.1674 for color consistency, these

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two criteria become significant differentiating factors among suppliers, although not as high as delivery timeliness. Meanwhile, production capacity (CD-5) with a weight of 0.1499 emphasizes the importance of suppliers who are able to meet demand volumes consistently. The determination of this weight reflects a balance between technical and economic aspects, making the evaluation more comprehensive and accurate.

The ranking results using the ALPAS method show that alternative A8 is in the top position with a final score of 2.3117, indicating superior performance compared to other suppliers based on all established criteria. Alternatives A10 and A4 also demonstrate competitive and stable performance in the second and third positions. This suggests that some suppliers have dominant and reliable performance, while mid-ranked suppliers, such as A6 and A5, show nearly balanced performance but are slightly below the top group. Suppliers with lower scores, such as A7 and A9, indicate that they have significant weaknesses in certain criteria, so they need to be considered in the context of strategic decision-making. This analysis provides a clear picture of supplier priorities and supports decisions based on real and rational data.

The sensitivity analysis conducted reinforces the validity of the ranking results by testing the stability of decisions against changes in criteria weights. The results show that a ±0.05 change in weights does not cause significant changes in the overall ranking order. Alternative A8 remains consistently in the first position, while A10 and A4 also demonstrate high stability in the top group. Minor fluctuations occur among the middle-ranked alternatives, but they do not drastically alter their relative positions. This indicates that the decision-making model used has a high level of robustness and can be relied upon even in the face of uncertainty or changes in criteria preferences.

Overall, the integration of the LODECI and ALPAS methods provides a transparent, objective, and rational approach in selecting raw material suppliers for the textile industry. The use of real data for weighting criteria and evaluating alternatives ensures that decisions are made not only based on theory or assumptions but also on actual operational conditions. The ranking results and sensitivity analysis indicate that this model is effective in distinguishing supplier performance, supporting more accurate, efficient, and accountable decision-making. The application of this method can help the textile industry improve supply chain efficiency, product quality, and overall competitiveness.

IV. Conclusion

The implementation of the LODECI and ALPAS methods in selecting textile industry raw material suppliers aims to support more objective and data-driven decision-making amid the complexity of criteria that must be considered. The LODECI method is used to determine the importance weights of criteria rationally by utilizing variations in supplier performance data, thereby reducing the influence of subjectivity and enhancing assessment consistency. The resulting weights are then

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integrated into the ALPAS method to evaluate and prioritize suppliers based on overall performance against all relevant criteria, such as material quality, price, delivery punctuality, and environmental compliance. The implementation of LODECI and ALPAS provides an applicable solution for the textile industry in selecting the most suitable raw material suppliers to improve the efficiency and reliability of the supply chain.

The integration of the LODECI method for criteria weighting and ALPAS for alternative ranking provides an objective, rational, and data-driven approach in selecting suppliers of raw materials for the textile industry. The LODECI method successfully determines the criteria weights proportionally based on supplier performance variations, with timely delivery being the most influential factor, followed by price, color consistency, production capacity, and material quality. Furthermore, the ALPAS method is able to combine criteria weights with alternative performance data to produce a comprehensive final score, which is then used to clearly determine supplier priorities, where A8 occupies the highest position and demonstrates the most stable performance. Sensitivity analysis shows that the ranking of alternatives remains relatively consistent even with a ±0.05 change in criterion weights, with A8 still in the first position and A10 and A4 remaining in the top-ranking group, while slight fluctuations occur for mid-ranked alternatives without significantly altering the order. This confirms that the model used has a high level of robustness, allowing supplier selection decisions to remain reliable amid uncertainties or changes in criteria preferences. These findings indicate that the application of LODECI and ALPAS not only enhances the objectivity and consistency of supplier evaluations but also supports effective strategic decision-making to improve supply chain efficiency, product quality, and the overall competitiveness of the textile industry.

CRediT Authorship Contribution Statement

Pritasari Palupiningsih: Conceptualization, Methodology, Validation, Writing – Original Draft Preparation, Writing – Review & Editing. **Meilia Nur Indah Susanti:** Conceptualization, Data curation, Formal analysis, Writing – Original Draft Preparation. **Herman Bedi Agtriadi:** Investigation, Software, Writing – Original Draft Preparation.

Declaration of Competing Interest

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Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Declaration of Generative AI and AI-assisted Technologies in The Writing Process

The authors used Generative AI to improve the writing clarity of this paper. They reviewed and edited the AI-assisted content and take full responsibility for the final publication.

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