Technema: Journal of Intelligent Engineering and Computing
Vol 1 No 3 September 2026, Hal 258-272
ISSN: 3163-6020 (Print) ISSN: 3163-5997 (Electronic)
Open Access: https://sovereignresearch.org/technema

Proposal for Selecting a Supplier of PE Polyester Raw Materials at Camo Fashion Using the ISM and ANP Methods

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Article Info :
Received:
02-08-2026
Revised:
23-08-2026
Accepted:
04-09-2026

Abstract

Camo Fashion is a manufacturing company producing camouflage-patterned apparel that relies on PE Polyester fabric as its primary raw material and currently collaborates with five suppliers. Supplier selection was previously based mainly on price and quality, resulting in several procurement problems, including delayed raw-material deliveries and inconsistencies in fabric specifications, particularly material weight. This study aimed to propose an appropriate PE Polyester supplier by integrating Interpretive Structural Modeling (ISM) and Analytical Network Process (ANP) within a multi-criteria decision-making framework. Empirical data were collected through interviews and pairwise-comparison questionnaires involving three respondents directly responsible for procurement and production activities. ISM and MICMAC analyses were applied to identify influential subcriteria and their structural relationships, while ANP was used to determine criterion and subcriterion priorities and rank five supplier alternatives. The results identified four key criteria: quality, price, warranty, and delivery, with quality receiving the highest priority weight of 0.487. Five key subcriteria were retained, with quality conformance to specifications ranking first at 0.178. Supplier E achieved the highest overall priority weight of 0.118, followed by Suppliers C, D, A, and B. Supplier E was recommended as the primary supplier because of its stronger performance in material quality, defect control, and delivery reliability, despite its relatively higher purchasing price.

Keywords: *Analytical Network Process, Interpretive Structural Modeling, Multi-Criteria Decision Making, PE Polyester, Supplier Selection.*

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INTRODUCTION

Competition among companies has become increasingly intense as market demands continue to emphasize product quality, competitive pricing, delivery reliability, and service performance, making effective resource and supply chain management essential to manufacturing competitiveness. The availability of high-quality raw materials plays a critical role throughout the production process because inconsistencies in material characteristics can directly affect production efficiency, product quality, and the ability of companies to satisfy customer requirements. Within supply chain management, suppliers do not merely function as providers of goods or services but also constitute strategic partners that support the continuity of production and logistics activities (Haming & Nurnajamuddin, 2017). Recent developments in supplier selection research increasingly position supplier selection as a *Multi-Criteria Decision Making* (MCDM) problem because companies must simultaneously consider quality, price, capacity, delivery, flexibility, and sustainability-related criteria (Chakraborty et al., 2026). Selecting an appropriate supplier can reduce purchasing costs while strengthening competitiveness because supplier performance directly influences input quality, supply continuity, and operational expenditure (Halim & Amalia, 2021). This condition makes supplier selection more than an administrative procurement activity, as it represents a strategic decision that can influence a firm's ability to respond to changing market requirements and maintain operational performance.

Many companies still select suppliers based on personal perceptions, previous experience, or interpersonal relationships rather than systematic and measurable evaluation, potentially resulting in decisions that fail to capture the complexity of supplier performance (Hasibuan et al., 2019). MCDM approaches have consequently gained importance because they provide structured mechanisms for evaluating several alternatives according to multiple criteria with different levels of importance. In textile and apparel industries, supplier selection becomes particularly complex because material quality, price, delivery performance, order fulfillment capability, flexibility, and warranty policies may simultaneously affect supply chain performance (Paul et al., 2022). Research on supplier selection in the clothing and textile sector indicates that hybrid decision-making approaches can provide more comprehensive evaluations by integrating economic, operational, and sustainability considerations rather than relying on a single performance dimension (Lahdhiri et al., 2024). A supplier offering the lowest price may not necessarily represent the most appropriate alternative when lower purchasing costs are accompanied by inconsistent material quality or unreliable delivery. The complexity increases when supplier selection criteria are interdependent, because decision models assuming complete independence among criteria may produce priorities that do not accurately represent actual operational conditions. Recent research on supplier selection criteria similarly emphasizes the importance of understanding relationships among criteria because supplier priorities can influence and be influenced by broader company performance (Topdemir & Akman, 2026).

Camo Fashion is a manufacturing company specializing in apparel products for hunting activities, including camouflage shirts, buffs, bags, and hats, and utilizes advanced sublimation printing technology to produce high-quality camouflage patterns. The company primarily uses PE Polyester fabric because its durability, strength, lightweight characteristics, and ability to absorb sublimation ink make it suitable for outdoor apparel products. Camo Fashion produces approximately 8,000–10,000 camouflage shirts per month and requires approximately 40–50 rolls of PE Polyester raw material each month, with one roll capable of producing approximately 200 camouflage shirt products. To fulfill its raw material requirements, Camo Fashion currently collaborates with five suppliers, namely suppliers A, B, C, D, and E, each of which presents different advantages and limitations regarding quality, price, availability, delivery, and warranty policies. Research on clothing-material supplier selection has demonstrated that identifying the structural relationships among criteria is important before determining supplier priorities, particularly when supplier performance depends on interconnected decision factors (Alawiyah & Prassetiyo, 2022). A related study in a convection company also demonstrated that the integration of Interpretive Structural Modeling (ISM) and Analytical Network Process (ANP) can structure supplier selection criteria and determine supplier priorities while accounting for relationships among decision factors (Alicia & Prassetiyo, 2023).

Each supplier collaborating with Camo Fashion has distinct characteristics that influence the company's procurement decisions. Supplier A provides consistent raw material quality, particularly in terms of fabric weight and texture, which meet company standards, but requires full payment without a down-payment option and offers a relatively higher price than several other suppliers. Supplier B provides abundant raw material availability and convenient pre-order arrangements, enabling the company to increase orders more easily, but its fabric texture frequently fails to meet the company's requirements. Supplier C provides favorable warranty claim policies for defective materials and offers a relatively low price, although its delivery time requires a minimum of three days after ordering. Supplier D provides favorable warranty claims and a relatively low price, but the supplied material is less satisfactory in terms of fabric weight and texture, making it inconsistent with company standards. Supplier E provides consistent material quality, timely delivery, and the capacity to fulfill the required order quantity, but its relatively high price can reduce company profitability. These trade-offs are consistent with recent findings that supplier selection in textile industries requires decision models capable of simultaneously considering operational and sustainability-related interdependencies rather than relying exclusively on independent criteria (Sithi et al., 2025).

Among the five suppliers, supplier D has become the primary choice of Camo Fashion, while the other suppliers function as supporting sources for procurement because the company currently bases its supplier selection mainly on two criteria, namely quality and price. Supplier D offers the lowest price at IDR 950,000 per roll, compared with IDR 1,000,000 from supplier A, IDR 980,000 from supplier B, IDR 975,000 from supplier C, and IDR 1,200,000 from supplier E, making price a decisive factor in the current supplier selection practice. However, selecting suppliers based only on price and quality has generated several operational problems, particularly delays in raw material delivery that can interrupt production and discrepancies in the weight of PE Polyester materials that may compromise final product quality. ANP-based supplier selection research demonstrates that supplier evaluation should extend beyond conventional criteria because interrelationships among criteria can alter their relative weights and ultimately influence supplier priorities (Bakhtiar et al., 2021). Integrated structural and decision-making approaches have also been applied to identify relationships among procurement factors before supplier priorities are established, particularly when supplier selection involves multiple interacting variables (Tham et al., 2020). Research in the textile industry further demonstrates that integrating DEMATEL and ANP can identify causal relationships while determining supplier priorities according to the dependency structure among evaluation criteria (Utama et al., 2021). The increasing incorporation of sustainability considerations into supplier selection also reinforces the need for comprehensive decision frameworks that evaluate suppliers beyond purchasing cost alone (Shariff et al., 2024). These conditions indicate that Camo Fashion requires a supplier selection framework capable of identifying influential criteria and their interdependencies before determining the supplier that most appropriately supports its operational requirements.

The supplier selection problem at Camo Fashion is particularly important because the company's requirement of 40–50 rolls of raw material per month means that recurring supply delays, material inconsistencies, or procurement inefficiencies can have substantial effects on production continuity and operational performance. Selecting suppliers solely according to price and quality cannot adequately explain which criteria are most influential, how the criteria interact, or how these relationships affect the final ranking of supplier alternatives. This study positions ISM as a structural approach for identifying the relationships, influence levels, and hierarchy among supplier-selection subcriteria, while ANP is employed to determine the relative priorities of criteria and supplier alternatives by incorporating interdependence and feedback within the decision network. The proposed ISM–ANP framework is intended not only to identify the supplier with the highest overall priority but also to explain the structural factors underlying the decision and the relationships that determine supplier performance. The research therefore occupies a specific position within the supplier-selection literature by applying an integrated ISM–ANP framework to PE Polyester raw material supplier selection in an apparel manufacturing company, where price, material quality, delivery reliability, availability, order fulfillment capacity, and warranty policies present interconnected decision considerations. The objective of this study is to identify the structural relationships among supplier-selection criteria and subcriteria using ISM and determine the priority of PE Polyester raw material suppliers using ANP according to the operational requirements of Camo Fashion. Theoretically, the study contributes to the development of MCDM applications in supplier selection by integrating structural modeling with network-based prioritization, while methodologically it provides a systematic and transparent decision framework for supplier evaluation under interconnected criteria in an apparel manufacturing context.

RESEARCH METHODS

This study is an empirical decision-making study conducted at Camo Fashion to develop a supplier-selection proposal for PE Polyester raw materials based on the company's operational requirements. The research architecture consists of four sequential stages: data collection and respondent identification, criteria and subcriteria development, ISM-based structural modeling, and ANP-based supplier prioritization. Respondents are selected purposively from personnel who are directly involved in raw-material procurement, understand the quality and services provided by each supplier, and have practical experience in PE Polyester procurement. Supplier-selection criteria and subcriteria are identified through interviews and discussions with relevant company personnel, supported by established supplier-selection criteria and previous research on textile and apparel supply chains (Chakraborty et al., 2026). Two types of questionnaires are prepared, namely a relationship questionnaire to identify the influence among subcriteria and a pairwise-comparison questionnaire to determine the relative importance of criteria, subcriteria, and supplier alternatives. The ISM procedure comprises the construction of the Structural Self-Interaction Matrix (SSIM), conversion into the Reachability Matrix (RM), formation of the canonical matrix, development of the hierarchical ISM model, and classification of variables using MICMAC, consistent with the use of ISM for structuring interdependent factors in apparel-industry problems (Ranjan et al., 2024). The resulting ISM structure is subsequently translated into an ANP network model, in which interdependencies and feedback relationships among the selected criteria and subcriteria are incorporated before supplier alternatives A, B, C, D, and E are evaluated.

Data processing and validation are performed by examining the logical consistency of the relationships identified through ISM and the reliability of the pairwise-comparison judgments used in ANP. For ISM, responses from the relationship questionnaire are aggregated to construct the SSIM, transformed into a binary reachability matrix, and iteratively partitioned to establish the hierarchical structure of the decision variables. The MICMAC analysis then classifies the subcriteria according to their driving power and dependence power, providing a technical basis for determining which variables should be emphasized in the subsequent ANP network (Tham et al., 2020). For ANP, pairwise-comparison matrices are constructed for the criteria, subcriteria, and supplier alternatives using the Saaty fundamental scale, followed by normalization and calculation of priority vectors. The consistency of each comparison matrix is evaluated using the Consistency Ratio (CR), with judgments considered acceptable when $CR \leq 0.10$, while inconsistent matrices are reviewed and reassessed before the priority calculation is finalized. The resulting ANP priorities are synthesized to obtain the overall weight and ranking of the five PE Polyester suppliers, following the network-based supplier-evaluation logic demonstrated in textile procurement research (Utama et al., 2021). The final evaluation metric is the overall ANP priority score, complemented by the ISM hierarchy, MICMAC driving-dependence classification, and consistency results, so that the recommended supplier is determined not only from its numerical ranking but also from the structural importance and interdependence of the criteria influencing the procurement decision.

RESULTS AND DISCUSSION

Determination of Supplier Selection Criteria and Subcriteria

The determination of supplier selection criteria and subcriteria was conducted to establish the decision attributes required by Camo Fashion in evaluating suppliers of PE Polyester raw materials. The identification process combined literature-based criteria with the operational requirements obtained through discussions with company personnel directly involved in raw-material procurement. Six main criteria were initially identified, namely price, quality, delivery, warranty and claim policy, service, and flexibility, reflecting the multidimensional nature of supplier performance in textile and apparel supply chains. Previous research indicates that supplier selection in textile industries requires consideration of multiple operational attributes because purchasing cost alone cannot adequately represent supplier capability and supply-chain performance (Chakraborty et al., 2026). The criteria were subsequently refined into eleven subcriteria to provide more specific measures for comparing supplier alternatives. The resulting structure is presented in Table 1, which shows the criteria, symbols, subcriteria, attributes, and definitions, used in the decision model.

Table 2. Physical and Mechanical Properties Test Results of Untreated Soil

Criteria	Symbol	Subcriteria	Symbol	Attribute	Definition
Price	**K1**	Payment Method	**SK1**		Payment method that provides a *down payment* (DP) option
		Offered Price	**SK2**	*Cost*	Compatibility between the price offered and the quality provided by the supplier
		Discount	**SK3**	*Benefit*	Price reduction offered by the supplier for a certain quantity
Quality	**K2**	Quality Conformance to Specifications	**SK4**	*Benefit*	Supplier's ability to consistently provide raw materials according to the required specifications
		Raw Material Defect Rate	**SK5**	*Cost*	Degree of minimization of defects in raw materials supplied by the supplier
Delivery	**K3**	Delivery Timeliness	**SK6**	*Benefit*	Supplier's ability to deliver raw materials on time
		Accuracy of Quantity and Type	**SK7**	*Benefit*	Supplier's ability to provide the required quantity and

		of Raw Materials Delivered			type of raw materials accurately
Warranty and Claim Policy	**K4**	Warranty for Damaged or Non-Conforming Raw Materials	**SK8**	*Benefit*	Provision of warranty coverage for raw materials that are damaged or do not meet specifications
Service	**K5**	Responsiveness	**SK9**	*Benefit*	Speed and responsiveness of the supplier in addressing customer needs and complaints
Flexibility	**K6**	Ease of Changing Order Quantity	**SK10**	*Benefit*	Supplier's readiness to accommodate increases or decreases in raw-material requirements
		Ease of Changing Delivery Time	**SK11**	*Benefit*	Supplier's readiness to accommodate changes in delivery schedules or requests for accelerated delivery
Price	**K1**	Payment Method	**SK1**		Payment method that provides a *down payment* (DP) option
		Offered Price	**SK2**	*Cost*	Compatibility between the price offered and the quality provided by the supplier

As shown in Table 1, the proposed framework distinguishes between criteria representing economic considerations and those representing operational supplier capabilities, allowing the evaluation to capture different dimensions of procurement performance. The Price criterion (K1) consists of payment method, offered price, and discount, where the offered price is treated as a cost attribute while discount represents a benefit attribute. This distinction is important because a low nominal purchasing price may provide an economic advantage, whereas flexible payment arrangements can affect the company's working-capital requirements and procurement flexibility. ANP-based supplier evaluation has demonstrated the relevance of incorporating interconnected economic and operational considerations when supplier alternatives cannot be differentiated adequately through a single purchasing attribute (Bakhtiar et al., 2021). At the company level, these attributes are particularly relevant because Camo Fashion currently compares suppliers partly according to differences in price per roll, while payment arrangements and quantity-based discounts may influence the effective procurement burden. The inclusion of these three subcriteria therefore broadens the interpretation of price from a simple numerical comparison toward a more comprehensive assessment of purchasing conditions.

The Quality criterion (K2) comprises quality conformance to specifications (SK4) and raw material defect rate (SK5), both of which directly relate to the technical suitability of PE Polyester for Camo Fashion's production process. Quality conformance evaluates the supplier's ability to consistently provide material characteristics required by the company, whereas the defect-rate indicator focuses on the frequency or magnitude of material deficiencies received during procurement. The separation of these two attributes is analytically important because a supplier may provide materials that generally conform to specifications while still generating a relatively high incidence of defective units. Research on apparel supplier selection confirms that material quality constitutes a critical decision dimension because inconsistencies in textile inputs can propagate into production and final-product performance (Ara et al., 2025). In the Camo Fashion context, this distinction is particularly relevant to fabric weight, texture, composition, and suitability for sublimation printing. The resulting criteria structure therefore permits the ANP model to distinguish between a supplier's general ability to meet specifications and its ability to minimize defective raw materials.

The Delivery criterion (K3) consists of delivery timeliness (SK6) and accuracy of the quantity and type of raw materials delivered (SK7), reflecting the relationship between supplier reliability and production continuity. Timely delivery is required to prevent interruptions in manufacturing schedules, whereas accuracy in quantity and material type ensures that the received input corresponds to the company's planned production requirements. Supplier selection studies in textile supply chains have similarly treated delivery-related performance as an important component of supplier evaluation because delays and quantity discrepancies can generate operational inefficiencies beyond the direct purchasing cost (Paul et al., 2022). The Warranty and Claim Policy criterion (K4) is represented by SK8, which evaluates the supplier's ability to provide warranty support when materials are damaged or fail to meet agreed specifications. This criterion functions as a risk-mitigation mechanism because an effective claim policy can reduce the operational consequences associated with defective incoming materials. The incorporation of warranty performance is consistent with supplier-performance evaluation approaches that recognize post-delivery support as part of the broader supplier relationship rather than treating procurement as a transaction ending at material delivery (Ekawati et al., 2018).

The Service criterion (K5) is represented by responsiveness (SK9), while the Flexibility criterion (K6) consists of the ease of changing order quantities (SK10) and delivery times (SK11). These criteria capture supplier capabilities that become particularly important when production requirements fluctuate and the company must modify procurement plans within a limited time. Responsiveness reflects the supplier's ability to react to requests and complaints, whereas flexibility reflects its capacity to accommodate changes in quantity and delivery schedules. Studies applying ANP to supplier performance evaluation indicate that service-related attributes can interact with other procurement criteria because supplier responsiveness may affect the company's ability to manage quality issues, delivery adjustments, and changes in demand (Ekawati et al., 2018). The distinction between service and flexibility also prevents these concepts from being treated as interchangeable, since a supplier may respond quickly to communication but remain unable to adjust production or delivery arrangements. This differentiation provides a more precise foundation for the subsequent ISM analysis because the relationships among these attributes can be evaluated according to their respective influence and dependence.

The final criteria structure contains six criteria and eleven subcriteria, providing a sufficiently detailed representation of the procurement conditions encountered by Camo Fashion while retaining a manageable number of decision variables for subsequent ISM and ANP processing. The structure also reflects the shift from the company's previous emphasis on price and quality toward a multidimensional supplier evaluation framework that incorporates delivery, warranty, service, and flexibility. Such multidimensionality is consistent with contemporary supplier-selection research, which increasingly integrates economic, operational, and sustainability-related considerations to obtain supplier priorities that are more representative of actual supply-chain requirements (Afrillia, 2026). The criteria and subcriteria identified in Table 1 subsequently serve as the basis for constructing the relationship questionnaire and pairwise-comparison questionnaire used in the ISM and ANP stages. Their inclusion does not imply that every attribute has identical importance, since the subsequent ISM–MICMAC analysis determines the structural influence and dependence of each subcriterion before ANP prioritization. The resulting framework establishes the empirical foundation for identifying which procurement factors should receive greater managerial attention when selecting a PE Polyester supplier for Camo Fashion.

ISM Hierarchical Model and MICMAC Analysis

The ISM analysis was conducted to identify the structural relationships among the eleven supplier-selection subcriteria and to determine the relative position of each factor within the decision hierarchy. The transformation of the SSIM into the Reachability Matrix and subsequently into the canonical matrix produced a hierarchical structure consisting of six levels, indicating that the subcriteria do not operate as independent decision variables. The resulting hierarchy places the factors with the strongest driving influence at the upper levels and the factors that are more dependent on other variables at the lower levels, providing a structural representation of how supplier-selection conditions are connected. This approach is consistent with the application of ISM in apparel-related decision problems, where structural relationships among operational factors need to be identified before prioritization is performed (Ranjan et al., 2024). The hierarchical arrangement obtained for Camo Fashion is presented in Figure 1, while the interpretation of each level provides the basis for identifying the factors that should receive greater attention in subsequent ANP analysis.

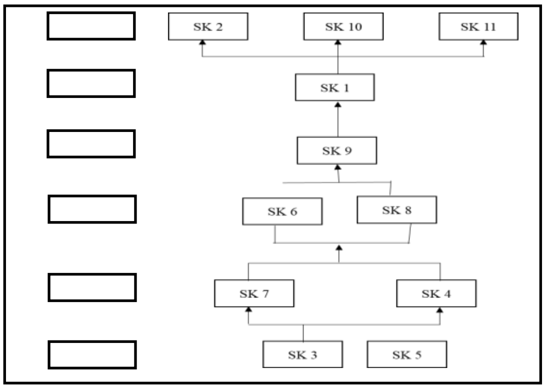

Figure 1. ISM Model

Table 3. Table 2. Recapitulation of Driving Power and Dependence Values

Level	Subcriteria	Symbol
Level 6	Offered Price	SK3
	Raw Material Defect Rate	SK5
Level 5	Quality Conformance to Specifications	SK4
	Accuracy of Quantity and Type of Raw Materials Delivered	SK7
Level 4	Delivery Timeliness	SK6
	Warranty for Damaged or Non-Conforming Raw Materials	SK8
Level 3	Responsiveness	SK9
Level 2	Payment Method	SK1
Level 1	Discount	SK2
	Ease of Changing Order Quantity	SK10
	Ease of Changing Delivery Time	SK11

The hierarchy in Figure 1 indicates that Offered Price (SK3) and Raw Material Defect Rate (SK5) occupy Level 6, representing factors positioned at the upper end of the ISM structure and associated with substantial structural influence within the model. Quality Conformance to Specifications (SK4) and Accuracy of Quantity and Type of Raw Materials Delivered (SK7) are positioned at Level 5, suggesting that these variables are structurally connected to the factors above them and contribute to the formation of supplier performance outcomes. Delivery Timeliness (SK6) and Warranty for Damaged or Non-Conforming Raw Materials (SK8) are located at Level 4, followed by Responsiveness (SK9) at Level 3. Payment Method (SK1) occupies Level 2, whereas Discount (SK2), Ease of Changing Order Quantity (SK10), and Ease of Changing Delivery Time (SK11) are located at Level 1, indicating that these factors are positioned relatively lower in the established hierarchy. The structure demonstrates that supplier selection at Camo Fashion extends beyond direct price comparison because material quality, delivery reliability, and defect prevention are embedded within an interconnected decision system. A similar logic has been reported in integrated ISM-based supplier selection, where hierarchical modeling is used to reveal the structural dependence among criteria before supplier alternatives are prioritized (Alawiyah & Prassetiyo, 2022).

The hierarchical structure becomes more informative when interpreted through the MICMAC classification because the position of a variable within ISM does not independently indicate whether it functions as a driving or dependent factor. MICMAC evaluates each subcriterion according to its driving power and dependence, allowing the variables to be classified into autonomous, linkage, dependent, and independent factors. The calculated values for the eleven subcriteria are presented in Table 2, with an average driving-power and dependence value of 4.455 serving as the midpoint for classification. The distribution indicates substantial variation in the structural roles of the variables, particularly between factors such as SK3 and SK5, which have driving power values of 7, and SK2, SK10, and SK11, which have driving power values of only 2. This differentiation is important because a factor with high driving power can influence several other variables even when its direct numerical importance in conventional supplier evaluation appears limited. The use of driving and dependence dimensions provides a more rigorous basis for identifying the variables that should be carried forward into the ANP model (Tham et al., 2020).

Table 3. Recapitulation of Driving Power and Dependence

Subcriteria	Driving Power	Dependence
SK1	3	1
SK2	2	2
SK3	7	3
SK4	6	2
SK5	7	3
SK6	5	3
SK7	6	7
SK8	5	4
SK9	4	8
SK10	2	8
SK11	2	8
Average	**4.455**	**4.455**

The MICMAC results shown in Table 3 divide the eleven subcriteria into four structural categories, namely independent factors, dependent factors, autonomous factors, and linkage factors. The independent group consists of Offered Price (SK3), Quality Conformance to Specifications (SK4), Raw Material Defect Rate (SK5), Delivery Timeliness (SK6), and Warranty for Damaged or Non-Conforming Raw Materials (SK8), all of which have driving power above the average while maintaining dependence below the average. The dependent group comprises Responsiveness (SK9), Ease of Changing Order Quantity (SK10), and Ease of Changing Delivery Time (SK11), which exhibit comparatively low driving power but high dependence on other variables. Payment Method (SK1) and Discount (SK2) are categorized as autonomous factors because their driving power and dependence values remain below the average, whereas Accuracy of Quantity and Type of Raw Materials Delivered (SK7) is classified as a linkage factor because both its driving power and dependence are high. The classification is analytically relevant because linkage variables can transmit effects throughout the system while simultaneously being affected by other factors, making them potentially unstable under changes in the decision structure. Such structural differentiation is particularly useful in supplier selection because it prevents all criteria from being treated as having equivalent causal importance (Kurniawan & Prassetiyo, 2024).

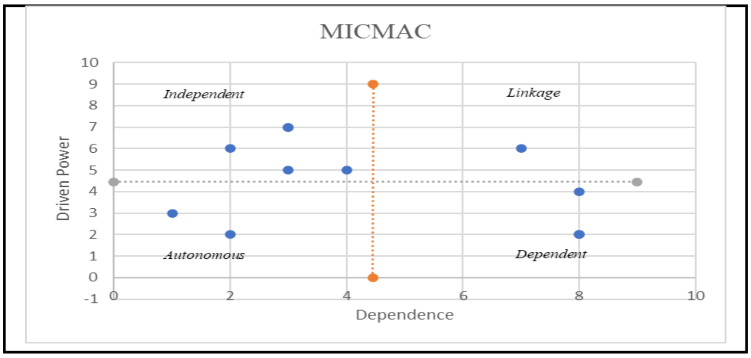

Figure 2. MICMAC Graph

The MICMAC graph in Figure 2 confirms that the independent factors constitute the principal structural drivers in the supplier-selection system at Camo Fashion. Offered Price (SK3), Quality Conformance to Specifications (SK4), Raw Material Defect Rate (SK5), Delivery Timeliness (SK6), and Warranty for Damaged or Non-Conforming Raw Materials (SK8) are therefore selected as the key subcriteria for the subsequent ANP stage because they possess relatively strong driving power and limited dependence. The prominence of quality-related factors is particularly meaningful for Camo Fashion because PE Polyester is the primary material used in sublimation-based apparel production, making conformity and defect prevention directly relevant to the continuity and quality of production. The linkage position of SK7 also deserves managerial attention because inaccurate quantity or material type can both influence other procurement outcomes and be affected by supplier performance conditions, although its high dependence makes it less suitable as an independent input for the subsequent prioritization structure. Recent textile supplier-selection research similarly demonstrates that supplier evaluation benefits from identifying influential factors before assigning final priorities because the relative importance of criteria can change when interdependencies are considered (Shariff et al., 2024). The MICMAC classification therefore narrows the decision structure from eleven subcriteria to five key structural drivers, providing a more focused empirical basis for ANP weighting.

The combination of the ISM hierarchy and MICMAC classification provides a more informative interpretation of supplier-selection conditions than a direct ranking of criteria because it distinguishes structural influence from numerical preference. The results indicate that Camo Fashion's supplier-selection problem is driven primarily by the offered price, conformity to specifications, defect rate, delivery timeliness, and warranty capability, while responsiveness and flexibility are more strongly positioned as dependent outcomes within the system. This finding is consistent with the broader development of supplier-selection models in textile supply chains, where multiple operational criteria interact and require structured decision approaches rather than isolated assessment (Iwarani et al., 2025). The identified independent factors are subsequently used as the principal inputs for ANP, where their relative importance and supplier-specific performance can be quantified through pairwise comparisons. The ISM–MICMAC stage therefore functions as a filtering mechanism that reduces unnecessary complexity while retaining the factors with the greatest structural relevance to the procurement decision. The resulting structure establishes the analytical foundation for determining whether the supplier currently prioritized by Camo Fashion remains the most appropriate alternative when the identified interdependencies and performance dimensions are incorporated into the ANP evaluation.

ANP Weighting and Priority Ranking of Criteria and Subcriteria

The ANP stage was conducted after the ISM–MICMAC analysis to quantify the relative importance of the criteria and subcriteria identified as structurally relevant to PE Polyester supplier selection at Camo Fashion. Pairwise comparison judgments were obtained from three respondents who were directly involved in the company's raw-material procurement activities and were subsequently processed using Super Decisions. The resulting criterion weights indicate that Quality obtained the highest priority with a weight of 0.487, followed by Price with 0.273, Warranty and Claim Policy with 0.106, and Delivery with 0.133. The dominance of quality indicates that supplier capability to consistently provide materials meeting the required specifications is more consequential to the procurement decision than the direct economic advantage associated with purchasing price. This finding is consistent with research on textile supplier selection showing that material quality remains a central determinant because variations in raw-material characteristics can propagate into production performance and final product quality (Ara et al., 2025). The complete criterion weighting and ranking are presented in Table 4.

Table 4. Criteria Ranking Results

Criteria	Weight	Ranking
Price	0.273	2
Quality	0.487	1
Delivery	0.133	4
Warranty and Claim Policy	0.106	3

Consistency Ratio (CR)	0.01272

The results in Table 4 demonstrate that Quality (K2) has a substantially higher weight than Price (K1), indicating that the decision-makers place greater importance on material conformity than on minimizing procurement expenditure. The weight of 0.487 assigned to quality means that almost half of the relative importance represented in the criterion-level comparison is associated with the supplier's ability to provide appropriate material quality. Price remains the second-ranked criterion with a weight of 0.273, confirming that cost efficiency continues to influence supplier selection but does not override the technical requirements of PE Polyester materials. Delivery and Warranty and Claim Policy receive lower weights of 0.133 and 0.106, respectively, although their inclusion demonstrates that supplier reliability and post-delivery risk management remain relevant to the decision. ANP is particularly appropriate for this condition because it permits decision-makers to evaluate criteria within a network structure in which relationships among supplier-performance attributes can affect final priorities (Bakhtiar et al., 2021). The criterion-level Consistency Ratio of 0.01272, which is substantially below the maximum acceptable value of 0.10, indicates that the pairwise judgments used to generate these priorities are sufficiently consistent.

The subcriteria analysis further clarifies the specific attributes responsible for the dominance of the main criteria in the supplier-selection model. Among the five key subcriteria retained from the ISM–MICMAC analysis, Quality Conformance to Specifications (SK4) achieved the highest weight at 0.178, followed by Offered Price (SK3) at 0.129, Raw Material Defect Rate (SK5) at 0.114, Delivery Timeliness (SK6) at 0.0622, and Warranty (SK8) at 0.050. The ranking indicates that the company's concern with quality is not merely related to general perceptions of supplier performance but is specifically concentrated on the ability of suppliers to deliver PE Polyester materials that comply with predetermined specifications. The distinction between conformance and defect rate is important because a supplier may provide generally suitable material while still generating defective batches that create additional inspection, replacement, or production costs. This finding corresponds with supplier-performance research in which quality-related indicators form a significant component of supplier evaluation and interact with other operational dimensions (Ekawati et al., 2018). The resulting weights and rankings are presented in Table 5.

Table 5. Subcriteria Ranking Results

Criteria	Subcriteria	Weight	Ranking
Price	Offered Price	0.129	2
Quality	Quality Conformance to Specifications	0.178	1
Quality	Raw Material Defect Rate	0.114	3
Warranty and Claim Policy	Warranty	0.050	5
Delivery	Delivery Timeliness	0.0622	4

The priority pattern in Table 5 provides an important interpretation of the company's procurement decision because Quality Conformance to Specifications (SK4) receives the highest individual subcriterion weight even though the company had previously emphasized price and quality without a formal weighting structure. Its weight of 0.178 suggests that the technical compatibility of PE Polyester with Camo Fashion's production requirements is the most influential specific attribute among the selected subcriteria. Offered Price (SK3) ranks second at 0.129, confirming that economic considerations remain important but are subordinate to material conformity. Raw Material Defect Rate (SK5) ranks third with a weight of 0.114, indicating that preventing defective materials is also a significant consideration because defects can interrupt production and affect the consistency of finished apparel. Research applying ANP to textile raw-material supplier selection similarly demonstrates that structured weighting can reveal priority patterns that are not necessarily evident from conventional supplier-selection practices (Gunawan et al., 2024). The relatively lower weights of Delivery Timeliness (0.0622) and Warranty (0.050) should not be interpreted as evidence that these factors are operationally irrelevant, because their structural position in the ISM model indicates that they remain connected to broader supplier-performance conditions.

The consistency assessment provides an important quality-control mechanism for interpreting the ANP results because pairwise comparisons are dependent on the judgments of the selected respondents. The criterion-level CR of 0.01272 is substantially below the 0.10 threshold, indicating a high degree of logical consistency in the comparative judgments. The subcriteria comparison matrices also produced consistency values below 0.10, as reported in the detailed calculation records, allowing the resulting priority weights to be retained for supplier evaluation. This consistency is particularly important in an ANP framework because inconsistent judgments can distort the priority vector and subsequently affect the ranking of supplier alternatives. Recent supplier-selection studies have emphasized the importance of combining structured weighting procedures with consistency or validation mechanisms to improve the robustness of multi-criteria decision results (Afrillia, 2026). The consistency assessment therefore supports the use of the calculated criterion and subcriterion weights as the basis for comparing the five PE Polyester supplier alternatives.

The ANP results reveal a substantive difference between the company's existing supplier-selection practice and the priorities generated through systematic multi-criteria analysis. Supplier D had previously been favored primarily because it offered the lowest price at IDR 950,000 per roll while being considered sufficiently compliant with the company's quality requirements, whereas the ANP model assigns greater importance to quality conformance than to price. This difference illustrates how a supplier that appears attractive under a limited two-criterion evaluation can lose its relative advantage when delivery reliability, defect prevention, and warranty performance are incorporated into a structured decision network. The finding is consistent with research demonstrating that integrated supplier-selection approaches can generate different priorities when multiple interdependent performance dimensions are incorporated into the evaluation process (Utama et al., 2021). The ANP weighting stage therefore provides an empirical basis for reassessing the existing supplier policy rather than simply confirming the supplier currently preferred by management. These results form the basis for the next stage of analysis, in which the five supplier alternatives are evaluated against the selected subcriteria to determine the supplier with the highest overall priority.

Supplier Ranking and Selection Based on ANP Results

The final ANP synthesis was performed to determine the relative priority of the five PE Polyester suppliers after the selected criteria and subcriteria had been incorporated into the decision network. The resulting priorities show a clear differentiation among the alternatives, with Supplier E obtaining the highest overall weight of 0.118, followed by Supplier C at 0.0973, Supplier D at 0.0924, Supplier A at 0.0913, and Supplier B at 0.0752. The ranking indicates that the supplier currently used as the main supplier by Camo Fashion, namely Supplier D, does not represent the most favorable alternative when the decision incorporates multiple operational attributes. Supplier E achieves the highest priority because its performance is comparatively strong across the attributes that received greater importance in the ANP model, particularly material quality, defect control, and delivery reliability. This result illustrates the analytical value of replacing a predominantly price-oriented supplier decision with a structured multi-criteria evaluation, since the lowest purchasing price does not necessarily produce the highest overall procurement priority. Similar evidence from textile supply-chain research indicates that supplier ranking can change substantially when quality, delivery, and other performance dimensions are evaluated simultaneously rather than through isolated cost considerations (Paul et al., 2022).

Table 6. Supplier Ranking Results

Supplier	Weight	Ranking
Supplier A	0.0913	4
Supplier B	0.0752	5
Supplier C	0.0973	2
Supplier D	0.0924	3
Supplier E	0.1180	1

The values in Table 6 indicate that Supplier E has a priority score approximately 24.5% higher than Supplier B, which occupies the lowest position, while its advantage over Supplier D is also meaningful despite the relatively close scores between the two alternatives. The relatively narrow difference between Supplier E and Supplier C or Supplier D suggests that supplier selection is not determined by a single dominant attribute, but rather by the cumulative effect of performance across several interconnected procurement requirements. Supplier C's second position indicates that its competitive advantage is sufficient to compensate for some operational limitations, whereas Supplier D's third position suggests that its low price alone cannot offset weaknesses in other important dimensions. Supplier A occupies the fourth position despite its consistent material quality because its higher price and less flexible payment arrangement reduce its overall attractiveness within the integrated decision structure. The fifth position of Supplier B is particularly informative because its strong material availability and ordering flexibility do not compensate for its inconsistent material texture and weaker conformity with the company's technical requirements. Such a ranking pattern is consistent with the principle that supplier evaluation should consider multiple and potentially conflicting performance dimensions rather than rely on a single purchasing attribute (Chakraborty et al., 2026).

The detailed supplier evaluation against the five selected subcriteria provides further evidence for the position of Supplier E within the decision network. Table 6 shows that Supplier E obtains the highest local priority for Quality Conformance to Specifications, with a value of 0.301, while Supplier C records the highest priority for Delivery Timeliness, at 0.325, and Supplier D obtains the highest priority for Offered Price, at 0.342. These results reveal an important trade-off between economic efficiency and technical-operational performance because Supplier D performs best on price, yet Supplier E achieves stronger performance on the quality dimension that carries the largest criterion weight. Supplier E also obtains a relatively high value of 0.230 for defect-rate performance, indicating that its advantage is not limited to nominal material specifications but extends to the consistency of the supplied material. The pattern demonstrates why ANP is more informative than a direct comparison of purchasing prices, particularly when supplier attributes have different strategic importance to production continuity and product conformity. Integrated ANP-based supplier-selection research in textile environments similarly emphasizes the importance of evaluating suppliers through a network of performance attributes rather than treating each criterion as an independent purchasing consideration (Shariff et al., 2024).

Table 7. Supplier Ranking Based on Selected Subcriteria

Subcriteria	Weight Value					Inconsistency
	Supplier A	Supplier B	Supplier C	Supplier D	Supplier E	
Offered Price	0.096	0.198	0.191	0.342	0.081	0.02601
Quality Conformance to Specifications	0.227	0.103	0.176	0.098	0.301	0.0249
Raw Material Defect Rate	0.227	0.103	0.176	0.091	0.230	0.02941
Warranty	0.166	0.291	0.305	0.165	0.07	0.0123
Delivery Timeliness	0.221	0.236	0.325	0.141	0.173	0.0847

Note:
Rank 1:
Rank 2:
Rank 3:
Rank 4:
Rank 5:

The supplier-level results can be interpreted through the operational characteristics observed at Camo Fashion, where PE Polyester is a critical input for sublimation printing and apparel production. Supplier E provides 100% PE material with a reported thickness of approximately 130 GSM, corresponding to the company's required quality characteristics, while its delivery performance is reported at approximately one to three days and is generally on schedule. These characteristics are particularly important because deviations in material composition, thickness, texture, or other physical properties can affect sublimation performance and subsequently influence the consistency of finished camouflage apparel. Supplier E also provides a warranty mechanism covering defective material at approximately 5%, with a replacement period of up to one week, which provides a risk-mitigation mechanism even though its warranty priority is lower than several other suppliers. The empirical pattern is consistent with research showing that quality and operational reliability remain decisive dimensions in apparel and textile supplier evaluation, especially when raw-material variability can affect downstream production performance (Sithi et al., 2025). Supplier E's first-place ranking therefore reflects a balanced performance profile rather than superiority in every individual attribute.

The comparison with Supplier D is particularly relevant because Supplier D was the company's previous primary supplier and had been selected largely because of its relatively low purchase price. Supplier D offers PE Polyester at approximately IDR 950,000 per roll, compared with IDR 1,000,000 for Supplier A, IDR 980,000 for Supplier B, IDR 975,000 for Supplier C, and approximately IDR 1,200,000 for Supplier E. Although Supplier D therefore provides the strongest price advantage, the ANP results demonstrate that its economic benefit is insufficient to compensate for weaknesses associated with material consistency and other operational considerations. This finding supports the use of structural decision-making approaches in procurement because supplier-selection criteria may exert different levels of influence and may also depend on relationships among other criteria (Topdemir & Akman, 2026). The discrepancy between the existing managerial preference and the ANP ranking represents an important managerial finding because it indicates that the procurement policy should not equate low purchase price with optimal supplier performance. A broader supplier-performance perspective is particularly relevant for manufacturing operations where the cost of material defects, production interruption, and delayed deliveries may exceed the apparent savings obtained from a lower unit price.

The final ranking also demonstrates the practical value of integrating ISM with ANP rather than applying ANP as an isolated weighting technique. The ISM analysis identified Offered Price, Quality Conformance to Specifications, Raw Material Defect Rate, Delivery Timeliness, and Warranty as the key independent factors that possess substantial driving influence within the supplier-selection structure, while the MICMAC classification helped distinguish these variables from dependent, autonomous, and linkage factors. This structural filtering reduces the possibility that the ANP model will assign excessive decision weight to variables that are primarily consequences of other supplier-performance conditions. An integrated ISM–ANP framework has similarly been applied to supplier-selection problems in apparel and textile contexts to reveal structural relationships before determining alternative priorities (Alawiyah & Prassetiyo, 2022). Research at a garment-convection company further supports the relevance of combining ISM and ANP because the approach can transform interconnected supplier criteria into a structured network for alternative evaluation (Alicia & Prassetiyo, 2023). The present results extend this logic to PE Polyester procurement by demonstrating that the supplier with the lowest price is not necessarily the supplier with the highest overall priority when technical quality and operational reliability are incorporated into the decision architecture.

CONCLUSION

The results of the supplier-selection analysis at Camo Fashion identified four key criteria that are considered critical in determining the suitability of PE Polyester raw-material suppliers, namely price, quality, delivery, and warranty. The ISM analysis further structured these criteria into five key subcriteria, consisting of offered price, quality conformance to specifications, raw-material defect rate, warranty for defective materials, and delivery timeliness. The MICMAC analysis indicated that these subcriteria have different levels of driving power and dependence, providing a structural basis for determining the variables that should receive greater attention in supplier evaluation. The ANP results established quality as the highest-priority criterion with a weight of 0.487, followed by price (0.273), warranty (0.106), and delivery (0.133). At the subcriterion level, quality conformance to specifications obtained the highest priority with a weight of 0.178, followed by offered price (0.129), raw-material defect rate (0.114), delivery timeliness (0.0622), and warranty (0.050). The supplier ranking produced by the ANP model placed Supplier E first with a weight of 0.118, followed by Supplier C (0.0973), Supplier D (0.0924), Supplier A (0.0913), and Supplier B (0.0752). These findings demonstrate that the optimal supplier is determined by the combined performance of strategically important criteria rather than by purchasing price alone.

Supplier E is therefore recommended as the principal alternative supplier for Camo Fashion because it demonstrates the strongest overall priority within the integrated ISM–ANP decision framework. Its main competitive advantage lies in its ability to provide PE Polyester materials that conform to the required specifications, maintain a relatively low defect level, and support timely delivery, which are directly relevant to production continuity and finished-product quality. Although Supplier D, which was previously used as the main supplier, offers a more competitive purchasing price, its relative performance on quality consistency and delivery reliability is less favorable when evaluated using the broader set of decision criteria. The findings indicate that the lower procurement cost offered by Supplier D does not necessarily represent the lowest overall operational risk because material nonconformity and delivery problems can generate indirect production costs and affect product quality. The proposed decision framework provides Camo Fashion with a more systematic basis for evaluating supplier alternatives by integrating structural relationships identified through ISM with quantitative priorities generated through ANP. From a methodological perspective, the integration of ISM and ANP strengthens supplier-selection analysis by combining structural identification of influential factors with comparative prioritization of supplier alternatives. The study consequently provides a decision-support framework that can be applied to improve the objectivity, consistency, and strategic alignment of PE Polyester supplier selection at Camo Fashion.

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