Journal of Social Research

P-ISSN:2827-9832
E-ISSN: 2828-335x
Vol. 5, No. 9, August 2026
http://ijsr.internationaljournallabs.com/index.php/ijsr

Supplier Performance Evaluation Model Using the Best-Worst Method and Analytic Network Process in Supplier Relationship Management

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Keywords:
Supplier Relationship Management; Supplier Selection; Best Worst Method; Analytic Network Process; Multi-Criteria Decision Making.

ABSTRACT

Supplier Relationship Management (SRM) is an essential component of modern supply chain management because it affects raw material availability, product quality, production continuity, and operational sustainability. The complexity of supplier evaluation requires a multi-criteria decision-making approach that accommodates interrelationships among influencing factors. This study aimed to identify supplier performance evaluation criteria, determine criterion priority weights using the Best-Worst Method (BWM), analyze interdependencies among criteria using the Analytic Network Process (ANP), and formulate an integrated BWM–ANP supplier performance evaluation model within the SRM framework at PT XYZ. This quantitative study employed surveys, observations, interviews, questionnaires, and documentation in PT XYZ's Purchasing Department from July to October 2025. Primary data were obtained from procurement experts, while secondary data were derived from internal company documents. SRM indicators were identified through a literature review and expert judgment, with data processed using Super Decisions® software. The results produced an integrated supplier performance evaluation model comprising five main criteria: quality, price, delivery accuracy, lead time, and supplier risk. The final weights showed that quality was the most dominant criterion (0.5185), followed by delivery accuracy (0.2182), price (0.1241), lead time (0.1021), and supplier risk (0.0370). The model provides a basis for supplier evaluation and clustering, supporting more objective, structured, and comprehensive supplier management decisions. The study also contributes to the development of Multi-Criteria Decision Making (MCDM)-based supplier evaluation models and offers practical implications for strengthening SRM strategies at PT XYZ.

INTRODUCTION

Supplier Relationship Management (SRM) is one of the important pillars of modern supply chain management because suppliers make significant contributions to raw material availability, product quality, production stability, and overall company competitiveness (Emon et al., 2024). Companies no longer view suppliers merely as entities that provide goods but rather as strategic partners that can influence operational efficiency and long-term business sustainability (Rahmawati & Salimi, 2022; Khulud et al., 2023). In this context, measuring and evaluating supplier performance is a crucial process to ensure that relationships established through SRM provide optimal value for companies (Arief et al., 2023; Hayati et al., 2025).

Supplier performance is assessed not only based on price and quality but also on more complex aspects, such as delivery accuracy, responsiveness, innovation capability, flexibility, technological capability, environmental sustainability, and compliance with ethical and regulatory standards (Zeng et al., 2023; Masudin et al., 2024). This complexity makes supplier assessment impossible to conduct using simple or subjective approaches. Companies require systematic, structured, measurable evaluation models capable of capturing interdependencies

among dynamic criteria. This aligns with the global trend in which Multi-Criteria Decision Making (MCDM)-based approaches have become a dominant method in modern supplier evaluation (Wu, Zou, & Barnes, 2023; Varchandi, Memari, & Jokar, 2024).

The Best-Worst Method (BWM) is one of the MCDM methods that has gained significant attention over the past decade due to its ability to simplify the criterion-weighting process while maintaining higher consistency levels compared with methods such as AHP and conventional pairwise comparisons (Alkolid et al., 2023; Arief et al., 2023). Recent studies have shown that BWM is widely adopted because it requires fewer comparisons, provides a consistency ratio, and reduces respondent bias in the decision-making process (Afrasiabi, Tavana, & Di Caprio, 2022; Aliahmadi et al., 2022). Furthermore, BWM has been extensively applied in supplier evaluation contexts, including sustainable supplier selection, raw material supplier assessment in manufacturing industries, and supplier evaluation in logistics and construction sectors (Haffar & Özceylan, 2024; Masudin et al., 2024).

Research conducted by Dixit and Paul (2025) presented a hybrid BWM approach integrated with Artificial Neural Network (ANN) for sustainable supplier selection. In their study, BWM was used to generate more consistent criterion weights for evaluating suppliers based on environmental, social, and economic aspects. These weights were subsequently incorporated into the ANN model to perform predictive analysis and evaluate supplier performance using historical data. The results demonstrated that the integration of BWM and ANN achieved higher accuracy than conventional methods such as AHP and SAW, particularly under large-scale and dynamic data conditions. The study also confirmed that the hybrid approach enabled the combination of subjective assessments (from BWM) and objective assessments (through ANN), resulting in more stable and adaptive supplier selection decisions. Although this study did not apply ANP, it demonstrated the effectiveness of BWM as a criterion-weighting method that can serve as a foundation for integration with other decision-making methods, including ANP (Nemati, 2024; Gidiagba, Okwu, & Tartibu, 2025).

Analytic Network Process (ANP) is an extension of the Analytic Hierarchy Process (AHP) that enables analysis of interdependencies among criteria and subcriteria in decision-making processes. Unlike AHP, which assumes that criteria are independent, ANP accommodates reciprocal relationships that commonly occur in supplier evaluation, such as the relationships among quality, cost, delivery performance, technology capability, and supplier risk (Kilic, 2013; Masudin et al., 2024). Various studies have demonstrated that ANP can produce more realistic evaluation models because it considers interactions among decision elements under actual conditions (Handayani et al., 2025; Hayati et al., 2025). Meanwhile, BWM is recognized as a weighting method capable of producing more consistent criterion weights with fewer comparisons than other MCDM methods. Therefore, the integration of BWM and ANP has become an increasingly applied approach in supplier evaluation because it combines consistent weighting with comprehensive analysis of relationships among criteria (Alamdari et al., 2023; Masudin et al., 2024).

Several previous studies have demonstrated the effectiveness of applying ANP combined with other decision-making methods. Masudin et al. (2024), for example, integrated ANP and TOPSIS to evaluate sustainable raw material suppliers, where ANP was used to determine criterion weights based on relationships among factors, while TOPSIS was applied for supplier ranking. Another study by Utama et al. (2022) integrated ANP with MARCOS and found that supplier quality and the ability to fulfill sustainability requirements were among the most influential factors in supplier selection. Furthermore, recent studies have shown that the BWM–ANP hybrid approach can improve the accuracy, sensitivity, and reliability of supplier evaluation models and has been applied across various industrial sectors, including manufacturing, automotive, textiles, construction, and sustainability-oriented industries (Arief

et al., 2023; Gunawan, Subechi, & Arif, 2024). These findings indicate that the integration of both methods has strong potential to support more objective and accurate decision-making.

However, several research gaps remain. Most previous studies have focused primarily on supplier selection processes without incorporating the broader concept of SRM. Other studies have emphasized sustainability or cost efficiency but have not integrated strategic dimensions such as supply chain risk, collaboration capability, digital integration, compliance, and supplier resilience within a single evaluation model (Khulud et al., 2023; Alamdari et al., 2023). In reality, the development of the global business environment, regulatory changes such as ISO 20400, the implementation of Environmental, Social, and Governance (ESG) principles, supply chain disruptions caused by pandemics and geopolitical conflicts, and digital transformation through big data analytics, the Internet of Things (IoT), artificial intelligence, and e-procurement systems have increased the complexity of supplier relationship management. These conditions require companies to adopt evaluation models that not only determine criterion priorities consistently but also capture interrelationships among influencing factors to produce more adaptive decisions in response to changes in the business environment.

At PT XYZ, supplier performance evaluation showed that, of the 257 deliveries made during the observation period, 215 deliveries (83.66%) were completed on time, while the remaining deliveries experienced delays of varying durations. In addition, from a total of 20,375 units received, 248 units were rejected, representing 1.22% of total received goods. Although the On-Time Delivery (OTD) indicator and rejection rate indicated that supplier performance was generally satisfactory, the company still required a more comprehensive evaluation model to assess various factors influencing long-term supplier relationships. Based on these conditions, this study developed a supplier performance evaluation model by integrating BWM and ANP within the SRM framework. The proposed model was expected to identify the most influential criteria, determine criterion priorities consistently, and analyze relationships among criteria to produce a more objective and accurate supplier evaluation process that supports strategic decision-making in PT XYZ's supply chain management.

METHOD

This research employed a quantitative approach with a survey design based on the positivist paradigm. The research process was conducted systematically, including planning, data collection, and analysis to address the research objectives (Cooper & Schindler, 2003). Data were collected from primary and secondary sources. Primary data were obtained through structured interviews and questionnaires distributed to respondents with expertise in supplier relationship management to identify factors influencing SRM performance and assess the importance level of each indicator. Secondary data were collected from relevant literature, including books, journals, and previous studies discussing SRM performance indicators, Best-Worst Method (BWM), Analytic Network Process (ANP), and supply chain management. Indicators identified from the literature were subsequently selected and adjusted to PT XYZ's operational characteristics, then refined through expert judgment and interview results to ensure their relevance to the company's conditions. The integration of primary and secondary data provided a comprehensive evaluation framework with indicators supported by both theoretical foundations and empirical validation, enabling academic and practical contributions to supplier relationship management.

Problem Identification

This process begins with an effort to identify various problems that generally arise in industrial practice, with the aim of finding the most relevant issues that are worthy of being the focus of research. Identification is carried out through the exploration of various problems

that often occur and potential obstacles that require more in-depth study, both in the form of classic issues that have emerged for a long time and actual problems that develop along with the dynamics of industrial operations. Through the review process, the researcher then selects problems that have high urgency and make significant contributions if further researched. In the end, this study focuses on the issue of evaluating the performance of relationship management in the supply chain between PT. XYZ and its suppliers, which are considered strategic and relevant issues to be discussed in this study.

Literature Review

Problems in the research object were analyzed through two approaches, namely literature studies and field studies. Literature review is carried out by examining various scientific sources, such as books, journals, and previous research results related to Supplier Relationship Management (SRM), Best Worst Method (BWM), Analytic Network Process (ANP), and supply chain management to obtain a theoretical foundation that supports research. Meanwhile, the field study was carried out through observation, interviews, and direct data collection at PT XYZ to obtain an overview of the company's actual condition, the process of managing relationships with suppliers, the supplier performance evaluation mechanism, and the problems faced in the procurement of raw materials. The combination of these two approaches allows researchers to gain a comprehensive understanding of research problems so that the analysis and evaluation models developed can describe the real condition of the company while being supported by a strong theoretical foundation.

Data Collection

Data collection in this study is carried out through a process of tracing information that will be used as input in the analysis stage. The data used consists of primary data and secondary data. Primary data was obtained directly from the field through observation activities, structured and semi-structured interviews, and the distribution of questionnaires to parties who have competence and relevance to the research, such as suppliers, purchasing managers, procurement staff, and other personnel who understand the procurement process and the relationship with suppliers. Through this approach, the researcher can obtain actual information that reflects the operational conditions and the relationship of the company with suppliers factually.

Meanwhile, secondary data was collected from internal company documents that were available before the study was conducted. This secondary information is used as an additional reference to strengthen the analysis and generally includes technical and administrative data, such as information about engine components, the time of the breakdown, the price of the component, the processing time per unit, the operator's labor costs, and the cost of repairs. All secondary data collected came from the company's historical records, especially PT. XYZ, and is used, among other things, for the analysis of optimal replacement time and the estimation of total operating costs. The data time range used in this study is July – October 2025.

Data Processing

The initial stage in the data processing process begins with an analysis of each supplier involved in the company's supply chain. After that, supplier grouping is carried out by the clustering method to identify common characteristics among suppliers. From the results of the group, the most dominant variables in each cluster were also determined to understand the

causes of the differences in performance between groups. Based on the results of the cluster, the researcher then formulated a supplier development strategy in accordance with the concept of Supplier Relationship Management (SRM) for each cluster.

In this stage, there are three main parts of data processing. First, processing that focuses on supplier selection, includes the identification of selection criteria, standard selection procedures, feedback mechanisms, the effectiveness of the negotiation process, and the drafting of contracts. Second, data processing related to the use of technology and information in the implementation of SRM, including the type of information system used, the level of effectiveness, and opportunities to improve the quality of the system. Third, data processing regarding supplier performance measurement, which consists of indicators of punctuality, quality, price, quantity, delivery location, product variety, and service.

Research Analysis Techniques

This study uses a modeling-based quantitative approach using the Analytic Network Process (ANP) method. The model construction process includes identifying criteria, elaborating sub-criteria, and determining alternative assessments that will be used as a reference in measuring supplier performance. The supplier selection criteria used in this study are adaptations of various previous studies in the context of the manufacturing industry, including the pesticide sector, to be relevant to the operational characteristics of PT. XYZ.

After all the data is obtained, the assessment between the criteria given by the respondents will be processed using the principles of ANP. As explained by Alfian and Fathurahman (2013), the ANP technique requires a process of checking the consistency of answers, the preparation of a paired comparison matrix, and the calculation of priority weights until the final value is obtained which is the basis for decision-making related to the attributes of managing relationships with suppliers (Alfian and Fathurahman, 2013). To ensure the accuracy and consistency of the results, the study used Super Decisions software, which is indeed designed to facilitate multicriteria decision modeling, including the ANP method.

RESULTS AND DISCUSSION

Best-worst method or BWM is a method to solve problems in multi-criteria decision-making (MCDM). In this method, a number of alternative problem solving are evaluated based on the criteria that have been set. This method was developed by Rezaei with the aim of producing a more consistent weighting criterion compared to other conventional weighting methods. BWM is carried out by determining two main criteria, namely *best criterion* and *worst criterion*, then a comparison of the level of importance between the best criteria against all other criteria (*Best-to-Others*) and a comparison of all criteria against the worst criteria (*Others-to-Worst*). Through this approach, the BWM method is able to produce more accurate priority weights with a lower level of inconsistency. BWM has the advantage that the number of comparisons is smaller than other methods, so that it is able to maintain the consistency of assessment in decision-making (Rezaei, 2015). Research conducted by Ahmadi *et al.,* (2020) related to the BWM method applied to companies can help in decision-making in supplier selection (Ahmadi et al., 2020).

The use of BWM in this study is important because the supplier performance evaluation process involves several criteria with different levels of importance. Determining criterion weights based solely on subjective judgment without a structured method risks producing

priorities that are less consistent. BWM offers a more efficient weighting approach by identifying the best and worst criteria and then comparing the importance of these two criteria against all other criteria. This approach allows decision-makers to obtain priority weights with fewer comparisons while also evaluating the consistency of expert preferences. BWM is therefore relevant as the initial stage in formulating the supplier performance evaluation model, producing a more systematic and consistent criterion priority structure before the interdependency relationships among criteria are considered through the Analytic Network Process (ANP).

In this study, the BWM method is used as an initial stage to determine the level of importance of each criterion used in performance evaluation *supplier*. The determination of the weight of the criteria is an important stage because the weight produced will affect the final results of the assessment *supplier* overall. In addition, the weighting results will also be the basis for the integration process with the *Analytic Network Process* (ANP) in the next stage. According to Dickson (1966) there are several criteria that can be used in the BWM method (Dickson, 1966), where some of the selected criteria in this study can be seen in the table below.

Table 1. Definition of research criteria

NO	CRITERIA NAME	DEFINITION	AUTHOR
1.	Quality	The supplier's ability to meet quality specifications such as materials, dimensions, design, durability, reliability, manufacturing techniques, quality systems, and continuous improvement.	(Prasad h c et al., 2016)
2.	Pricing	Including the price of goods, the price of raw materials, additional fees, taxes, and discounts.	(Prasad h c et al., 2016)
3.	Delivery accuracy	The supplier's ability to meet delivery schedules including punctuality, correct quantity, documentation, and transportation.	(Alkayid, 2025)
4.	Lead time	The time it takes for the company to order products or services to *suppliers* to receive them.	(Prasad h c et al., 2016)
5.	Risk *supplier*	Unwanted things arise beyond the *supplier*'s ability unexpectedly that affect *the supplier*'s performance.	(Dakhch & Benamar, 2024)

Source: Compiled by the researcher based on literature review from Prasad et al. (2016), Alkayid (2025), and Dakhch & Benamar (2024)

The assessment of the criteria from the *supplier* is also carried out through interviews with experts, the following expert profile table can be seen in the table below.

Table 2. Expert profile

Features	Category	Number (n=5)	Percentage (%)
Gender	Male	3	60,00
	Women	2	40,00
Departments at SCM	SCM Manager	1	20,00
	Procurement Manager	1	20,00
	Logistics Manager	1	20,00
	Warehouse Manager	1	20,00
	Purchasing Supervisor	1	20,00

Final Education	S1 Industrial Engineering	2	40,00
	S1 Logistics Management	1	20,00
	S1 Accounting	1	20,00
	S1 Operations Management	1	20,00
Long Career in SCM	1–3 years	2	40,00
	4–6 years	2	40,00
	7–9 years	1	20,00
Formal SCM Competency	Have SCM/Logistics Certification	4	80,00
	Not Have Certification	1	20,00
Informal SCM Competency	SCM Training/Workshop	5	100,00
	National/International Seminars	4	80,00
Key Areas of Expertise	Procurement & Purchasing	2	40,00
	Logistics & Distribution	1	20,00
	Inventory Management	1	20,00
	Supplier Relationship Management	1	20,00
Supplier Evaluation Experience	1–2 years	2	40,00
	3–5 years	2	40,00
	>5 years	1	20,00

Source: Researcher's survey data from PT XYZ's Supply Chain Management department (2025)

Meanwhile, in the results of the interview, the following parameters were recapitulated:

Table 3. Interview results

Yes	Criteria Name	Snippets of Expert Interviews
1	Quality	"Product quality must be consistent from every delivery. We see the suitability of material specifications, durability, and production standards." (Expert 1)
		"*A* good supplier is able to maintain product quality in the long term and has a clear quality control system." (Expert 3)
		"If there is a product mismatch, *the supplier* must quickly follow up and make improvements." (Expert 6)
		"We also consider quality certification and *the ability of suppliers* to maintain quality standards in a sustainable manner." (Expert 9)
2	Pricing	"Price is an important factor, but it must still be proportional to the quality provided." (Expert 2)
		"We consider the total cost, including shipping, taxes, and possible discounts on recurring purchases." (Expert 5)
		"*Suppliers* with stable prices are prioritized over cheap prices but change frequently." (Expert 8)
3	Precision Delivery	"The timeliness of delivery greatly determines the smooth running of the company's operational processes." (Expert 4)
		"In addition to being on time, the quantity of goods and delivery documents must also be in accordance with the order." (Expert 7)
		"*Suppliers* who are often late will affect production and distribution schedules." (Expert 9)
4	Lead Time	"The short lead time makes it easier for companies to maintain the availability of raw material stocks." (Expert 1)
		"We choose *suppliers* who have clear and consistent delivery time estimates." (Expert 5)
5	Risk *Supplier*	"Supplier risks need to be considered, especially related to distribution delays and supply instability." (Expert 2)
		"We consider *the ability of suppliers* to deal with changes in raw material prices and market conditions." (Expert 4)

Source: Researcher's interview transcripts with PT XYZ's SCM experts (2025)

Prior to the expert interviews, an initial set of eleven candidate criteria was identified through a literature review. This initial list was then discussed and validated with experts through a series of discussions and brainstorming sessions to narrow it down to the criteria most relevant to the operational characteristics of PT XYZ, the company's procurement needs, actual supplier-related issues, data availability, and expert experience in supplier management. Criteria with overlapping concepts were merged, while criteria considered less relevant to the scope of the study were excluded from further analysis. This screening process resulted in the five main criteria used in the subsequent BWM and ANP analysis.

Based on the results of interviews with experts, five main criteria were obtained in supplier selection, namely quality, price, delivery accuracy, lead time, and *supplier* risk. These criteria show that the supplier selection process is not only oriented to the cost aspect, but also considers the sustainability of the company's operations and product quality assurance.

Quality criteria are the most important aspect conveyed by experts. This shows that quality is a top priority in determining *suppliers*. Experts emphasized the importance of consistency of product quality in each shipment, suitability of material specifications, durability of products, and the application of good production standards. In addition, *suppliers* are also expected to have a clear *quality control* system and be able to take corrective actions if product non-conformities are found. Several experts also highlighted the importance of quality certification as a form of assurance that *suppliers* are able to maintain quality standards in a sustainable manner. These findings show that quality is not only viewed from the end product, but also from the supplier*'s ability* to maintain quality stability and commitment to *continuous improvement*.

Price criteria are also an important consideration in choosing a *supplier*. Based on the interview results, the price is not only seen from the nominal purchase of the product, but also includes the total costs incurred by the company, such as shipping costs, taxes, and potential discounts on routine purchases. Experts consider that competitive prices must remain proportional to the quality provided *by suppliers*. In addition, price stability is a concern because too frequent price changes can affect the company's cost planning. Thus, companies tend to choose *suppliers* who are able to provide a balance between price, quality, and cost stability in the long run.

On the criteria for delivery accuracy, experts emphasized that the timeliness of delivery greatly affects the smooth operation of the company. Delays in delivery can cause disruption to the production and distribution process. In addition to punctuality, the suitability of the number of goods and the completeness of delivery documents are also important indicators in assessing *supplier* performance. This shows that the company needs *suppliers* who have good logistics and distribution management skills so that they can meet the company's needs appropriately and consistently.

The lead time criterion is related to the length of time from the time the order was placed until the goods were received by the company. Based on the results of the interviews, a short and consistent lead time provides an advantage for the company in maintaining the availability of raw material stock. *Suppliers* with a clear estimated delivery time are considered more able to support operational efficiency and inventory planning of the company. Therefore, *lead time* is one of the important indicators in assessing the responsiveness and reliability of suppliers.

The last criterion is *supplier* risk. Experts revealed that companies need to consider various potential risks that can affect *supplier* performance, such as distribution delays, supply instability, as well as changes in raw material prices and market conditions. These risks can have a direct impact on the company's operational continuity. Therefore, *the ability* of suppliers to face uncertainty and maintain supply stability is an important factor in *making supplier* selection decisions.

Furthermore, the distribution of assessments was carried out using the BWM (*Best Worst Method*) method. The results of the distribution of the assessment of the criteria that were most chosen as the best criterion were quality, which was 5 experts (55.6%), followed by prices as many as 3 experts (33.3%), and the accuracy of delivery as many as 1 expert (11.1%).

Table 4. Distribution of best criteria

Criteria	Percentage
Quality	5 expert (55.6%)
Pricing	3 expert (33.3%)
Precision Delivery	1 expert (11.1%)
Lead Time	0
Risk *Supplier*	0

Source: Researcher's calculation based on BWM questionnaire results from PT XYZ's experts (2025)

There are no experts who choose lead time or *supplier* risk as the best criteria. These results show that the majority of respondents consider quality as the most important factor in *the supplier* performance assessment process. The high level of quality selection shows that the company prioritizes *the ability* of suppliers to provide products or services that are in accordance with the expected quality standards. In the context of a company's operations, quality plays a very important role because it directly affects the success of the production process, customer satisfaction, and company image.

With good quality, it can minimize the occurrence of product defects *(defect product)*, lowering costs due to process repetition *(rework)*, as well as reducing product return rates *(return product)*. In addition, good product quality can also increase the effectiveness of the operational process because the company does not need to carry out additional inspections or corrective actions on the products received. Therefore, quality is the main factor considered by experts in the evaluation process *supplier*. This research is in line with Rezaei's research *et al.*, 2016 which states that quality is one of the factors that has the highest level of priority in elections *supplier*. The research shows that quality has a significant influence on the success of the relationship between companies and suppliers in the long term (Rezaei et al., 2016). Other research conducted by (Ecer & Pamucar, 2020) shows that the quality aspect has a higher level of priority than other aspects in the evaluation process *supplier*.

On the other hand, in the distribution of the worst criterion, *supplier* risk was the most chosen criterion, namely by 5 experts (55.6%), then *lead time* and price were chosen by 2 experts (22.2%) each, while quality and accuracy of delivery were not chosen as the worst criteria.

Table 5. Distribution of the worst criteria *(worst)*

Criteria	Percentage
Risk *Supplier*	5 expert (55.6%)
Lead Time	2 expert (22.2%)
Pricing	2 expert (22.2%)
Quality	0
Precision Delivery	0

Source: Researcher's calculation based on BWM questionnaire results from PT XYZ's experts (2025)

These results show that *supplier* risk has a relatively lower priority level compared to other criteria. However, the low priority of supplier risk cannot mean that this factor is not important in the supplier evaluation process. Supplier risk still has an influence on the sustainability of the supply chain, but in this study, experts tend to emphasize factors that directly affect the company's operational activities.

Supplier risk is generally related to various uncertainties that can affect the company's performance, such as delays in the supply of raw materials, changes in supplier production capacity, distribution disruptions, changes in economic conditions, and supplier instability. However, because the impact does not always appear directly on the day-to-day operational process, respondents tend to consider these factors to have a lower level of priority than the quality or accuracy of delivery

The results of the final weight calculation showed that quality obtained the highest weight of 0.513 (51.3%), making it the most dominant factor in determining the decision. The next criterion is the accuracy of delivery with a weight of 0.214 (21.4%), then price of 0.144 (14.4%), lead time of 0.095 (9.5%), and *supplier* risk of 0.033 (3.3%), the results can be seen in the table below.

Table 6. Average weight of each criterion

Criteria	Weight
Price (H)	0.144
Quality (K)	0.513
Lead Time (L)	0.095
Delivery Accuracy (T)	0.214
Risk (R)	0.033

Source: Researcher's calculation using the Best-Worst Method (BWM) based on expert assessments (2025)

The priority order of criteria produced in this study shows that quality is the most dominant factor in the decision-making process related to supplier performance evaluation. The quality weight of more than 50% shows that the quality aspect is the main concern of experts. These results indicate that companies emphasize the importance of obtaining products or services with good quality rather than considering aspects of cost and process speed.

In addition to quality, the accuracy of delivery obtained the second largest weight, which was 0.214. This shows that *the supplier*'s ability to meet delivery schedules is also an important factor in the supplier evaluation process. Good delivery accuracy can maintain the continuity of the company's production process, reduce the risk of production delays, and improve the efficiency of the supply chain system.

The weighting results obtained through BWM provide information on the relative importance and priority of each criterion based on expert preferences. However, these results do not yet show how the interrelationships among criteria may affect the priority structure of the supplier evaluation model. In actual conditions, each criterion does not always stand independently; for example, lead time can be related to delivery accuracy, while supplier risk can affect supply continuity and delivery performance. Analysis was therefore continued using ANP to accommodate these interdependency relationships among criteria. In this way, BWM functions to generate consistent initial criterion priorities, while ANP refines the model by considering the interdependencies among criteria.

Next, the stage of implementing *the Analytic Network Process* (ANP) method is carried out where this method allows for interdependent relationships between criteria (*interdependence*). The initial stage of the ANP method is to compile a *pairwise comparison matrix* which is used in identifying the level of influence between criteria in research. The ANP method considers *feedback* and *interdependence* which describes real conditions in decision-making, where one criterion can affect each other and be influenced by other criteria. The *pairwise comparison matrix* table can be seen in the table below.

Table 7. *Pairwase comparison matrix*

	Pricing	**Quality**	**Lead time**	**Delivery accuracy**	**Risk**
Pricing	1,00000	0,14286	1,66667	0,55556	5,00000
Quality	7,00000	1,00000	3,00000	5,00000	9,00000
Lead time	0,60000	0,33333	1,00000	0,33333	3,00000
Delivery accuracy	1,80000	0,20000	3,00000	1,00000	9,00000
Risk	0,20000	0,14286	0,33333	0,11111	1,00000
Total	10,60000	1,81905	9,00000	7,00000	27,00000

Source: Researcher's calculation based on ANP pairwise comparison questionnaire results from PT XYZ's experts (2025)

Based on the table above, quality shows a higher comparative value such as price of 7, lead time of 3, delivery of 5, and supplier risk of 9 compared to the comparison of other criteria. This indicates that the quality of a product or service is the main priority in evaluating suppliers. In addition, the delivery accuracy criteria also show an influence on several other criteria such as risk of 9 and lead time of 3 which shows that delivery accuracy is one of the aspects in maintaining company operations.

Furthermore, it is followed by a normalization matrix (*unweighted matrix*) obtained from the division of each value in the previous matrix with the total value in each column, thus producing the proportional value or relative weight of each criterion. The goal is to eliminate the difference in scale between criteria so that they can be compared in a balanced manner. The results of the normalization matrix can be seen in the table below.

Table 8. *Unweight matrix*

	Pricing	**Quality**	***Lead time***	**Delivery accuracy**	**Risk**
Pricing	0,09434	0,07853	0,18519	0,07937	0,18519
Quality	0,66038	0,54974	0,33333	0,71429	0,33333
Lead time	0,05660	0,18325	0,11111	0,04762	0,11111
Delivery accuracy	0,16981	0,10995	0,33333	0,14286	0,33333

Risk	0,01887	0,07853	0,03704	0,01587	0,03704

Source: Researcher's calculation using ANP method based on pairwise comparison matrix (2025)

Based on the results of the normalization matrix, the comparison of quality with other criteria gave relatively larger results such as price of 0.66038; lead time of 0.33333; delivery accuracy of 0.71429, and risk of 0.33333. Where from the results of the normalization matrix, the high quality value shows the important role of the quality aspect of the product or service in evaluating *supplier performance*. This result provides an initial relationship pattern between the criteria before further weighting is carried out, namely *the weighted supermatrix*.

After normalization, the *Superweighted Matrix* is then calculated and the weight value of each criterion is obtained that has considered the dependency relationship between elements in the *Analytic Network Process* (ANP) method. The results showed that the quality had the highest weight value of 0.5185; followed by delivery accuracy of 0.2182; price of 0.1241; lead time of 0.1021; and risk of 0.0370.

Table 9. *Superweighted matrix*

	Pricing	**Quality**	***Lead time***	**Delivery accuracy**	**Risk**
Pricing	0.0943	0.0785	0.1852	0.0794	0.1852
Quality	0.6604	0.5497	0.3333	0.7143	0.3333
Lead time	0.0566	0.1832	0.1111	0.0476	0.1111
Delivery accuracy	0.1698	0.1099	0.3333	0.1429	0.3333
Risk	0.0189	0.0785	0.0370	0.0159	0.0370

Source: Researcher's calculation using ANP method processed with Super Decisions® software (2025)

The high weight of quality indicates that *the supplier*'s ability to provide products or services with consistent quality is the main consideration in the supplier evaluation process. In the context of a company's operations, good quality can support the effectiveness of the production process, reduce the possibility of defective products, and increase customer satisfaction. In addition, high quality can also increase the company's trust in *suppliers* so as to support long-term cooperation in the concept of *Supplier Relationship Management* (SRM).

Meanwhile, the accuracy of delivery obtained the second largest weight, which was 0.2182 which showed that *the supplier*'s ability to meet the delivery schedule according to the company's needs also had a considerable influence on *the assessment of supplier* performance. Good delivery accuracy can reduce the risk of production delays and maintain the sustainability of the company's supply chain.

After that, the test is carried out Based on the results of the Convergent Matrix, the final weight value of each criterion is obtained in the supplier performance assessment after going through the matrix ranking process repeatedly until it reaches a stable or convergent condition. In the convergent matrix it can be seen that each column has the same value, which indicates that it has reached equilibrium conditions so that the resulting value can be used as the final priority in the *Analytic Network Process* (ANP) method. The results showed that the quality obtained the highest weight of 0.5468; followed by delivery accuracy of 0.1636; lead time of 0.1347; price of 0.1004; and risk of 0.0544.

Table 10. Matrix convergence

	Pricing	**Quality**	***Lead time***	**Delivery accuracy**	**Risk**
Pricing	0.1004	0.1004	0.1004	0.1004	0.1004
Quality	0.5468	0.5468	0.5468	0.5468	0.5468
Lead time	0.1347	0.1347	0.1347	0.1347	0.1347
Delivery accuracy	0.1636	0.1636	0.1636	0.1636	0.1636
Risk	0.0544	0.0544	0.0544	0.0544	0.0544

Source: Researcher's calculation using ANP method after reaching convergence/equilibrium condition (2025).

The high weight of quality indicates that *the ability of suppliers* to provide products or services that are in accordance with the company's quality standards consistently is the most prioritized factor. Good product quality can increase the effectiveness of the company's operational processes, reduce the possibility of defective products, and increase customer satisfaction.

In addition, the accuracy of delivery ranks second with a weight of 0.1636, which shows that *the supplier*'s ability to meet delivery schedules according to the company's needs also has a great influence on *supplier* performance. Good delivery accuracy can support smooth operational processes and maintain the continuity of the company's supply chain.

From the results of the ANP method test, the best results are shown in the quality criteria, where these results are in line with the research conducted by Rezaei (2016) where quality is the dominant factor in the evaluation *supplier* Karen A has an influence on the effectiveness of the company's operations (Rezaei et al., 2016). Not only that, other research conducted by Ecer *and* Pamucar (2020) where respondents prioritize product quality over other aspects (Ecer & Pamucar, 2020). Research conducted by Göncü *and* Çetin (2022) the use of ANP in evaluation *supplier* Showing the results of the quality criteria to be the highest priority (Göncü & Çetin, 2022).

A comparison of the BWM and ANP results shows the added value of applying ANP in the formulated model. BWM produces information on the level of importance of each criterion based on the experts' direct preferences, whereas ANP produces final weights after the interdependency relationships among criteria have been taken into account. The changes in weight values and priority positions between the BWM and ANP results therefore indicate the influence of the relationships among criteria on the final priority structure, information that could not be obtained if the analysis stopped at BWM alone. Applying ANP after BWM thus adds value in the form of a model capable of representing the more complex conditions of supplier evaluation, in which quality, price, delivery accuracy, lead time, and supplier risk can influence one another.

Thus, the combination of BWM's method in determining priority criteria can provide a solid basis in the supplier evaluation process. The integration between the BWM and ANP methods is expected to be able to produce *a more* comprehensive, accurate, and compliant supplier performance assessment model in accordance with the principles of *Supplier Relationship Management*, so that companies can make more effective decisions in selecting and retaining *the best* suppliers.

Furthermore, by using these weights on the following 9 *suppliers* :

Table 11. List of suppliers' financial values

No.	Nama *Supplier*	Financial Value
1.	PT. A	IDR 2,250,000,000,00
2.	PT. B	IDR 1,980,000,000,00
3.	CV. C	IDR 820,000,000,00
4.	PT. D	IDR 1,540,000,000,00
5.	PT. E	IDR 1,075,000,000,00
6.	CV. F	IDR 1,350,000,000,00
7.	PT. G	IDR 1,310,000,000,00
8.	PT. H	IDR 1,280,000,000,00
9.	PT. I	IDR 2,780,000,000,00

Source: PT XYZ's internal procurement data (2025)

From the results of the questionnaire, the average assessment scale from 1-5 for each parameter and each *supplier* is as follows:

Table 12. Average rating scale *supplier*

	Pricing	Quality	*Lead time*	Delivery accuracy	Risk
PT. A	3,92	4,32	3,01	3,43	4,12
PT. B	4,01	3,53	2,31	4,22	3,84
CV. C	4,62	3,88	2,4	3,41	4,25
PT. D	3,74	4,41	3,45	4,03	3,56
PT. E	4,15	3,76	2,88	3,67	4,38
CV. F	3,58	4,58	4,11	4,45	3,91
PT. G	4,33	3,95	3,26	3,18	4,44
PT. H	2,97	4,12	2,74	4,09	3,27
PT. I	4,48	4,67	3,92	4,51	4,06

Source: Researcher's questionnaire results from PT XYZ's procurement experts (2025)

After the data, a weight assessment was carried out from each *supplier* using the weights that had been obtained from the previous ANP. From these calculations, the following assessment was obtained:

Table 13. Assessment Results of All Suppliers and Types of Categories *The Supplier*

No.	Nama *Supplier*	Nilai *Supplier*	Value Range	Category
1.	PT. A	3,95	3,41 – 4,20	*Preferred Supplier*
2.	PT. B	3,54	3,41 – 4,20	*Preferred Supplier*
3.	CV. C	3,70	3,41 – 4,20	*Preferred Supplier*
4.	PT. D	4,10	3,41 – 4,20	*Preferred Supplier*
5.	PT. E	3,70	3,41 – 4,20	*Preferred Supplier*
6.	CV. F	4,36	4,21 – 5,00	*Strategic Partner*
7.	PT. G	3,80	3,41 – 4,20	*Preferred Supplier*
8.	PT. H	3,77	3,41 – 4,20	*Preferred Supplier*
9.	PT. I	4,49	4,21 – 5,00	*Strategic Partner*

Source: Researcher's calculation based on ANP weighting and supplier performance assessment results (2025)

Based on the results of *supplier* evaluation using *the Supplier Relationship Management* (SRM) method, two categories *of suppliers* were obtained, namely *Preferred Supplier* and

Strategic Partner. The determination of the category is carried out based on the *final value of the supplier* obtained from the results of weighting all assessment criteria, including price, quality, *lead time*, delivery accuracy, and *supplier risk*.

The results of the assessment show that most *suppliers* are in the *Preferred Supplier category* with a value range of 3.41–4.20. *Suppliers* included in this category are PT. A, PT. B, CV. C, PT. D, PT. Hey, PT. G, and PT. H. *Suppliers* in this category are considered to have good performance and are able to meet the company's needs quite consistently. However, there are still several aspects that need to be improved, such as product quality stability, delivery accuracy, and lead time efficiency in order to reach the highest category.

PT. D obtained the highest score in the *Preferred Supplier* category, which was 4.10. This value shows that *the supplier* has a relatively better performance than other *suppliers* in the same category, especially in maintaining the quality and accuracy of delivery. Meanwhile, PT. B obtained the lowest score in this category, which was 3.54. This indicates that there are still several factors that need to be improved to improve the *overall performance of suppliers*.

In the *Strategic Partner category*, there are two *suppliers*, namely CV. F and PT. I with a score of 4.36 and 4.49, respectively. *Suppliers* in this category are considered to have excellent performance and are able to meet all the main criteria of the company optimally. PT. I obtained the highest score of all *the suppliers* evaluated. This shows that the *supplier* has advantages in terms of product quality, delivery consistency, *lead time*, and the ability to minimize operational risks. Therefore, *suppliers* with the *Strategic Partner category* can be prioritized for long-term cooperation because they are considered able to support the sustainability of the company's supply chain more stably and effectively.

Overall, the results of this evaluation show that the majority of *suppliers* have performed quite well, but the company still needs to conduct periodic monitoring and evaluation to ensure the improvement of the quality of cooperation and maintain the stability of the supply chain in the future.

CONCLUSION

This study successfully identified five main criteria for evaluating supplier performance at PT XYZ: quality, price, lead time, delivery accuracy, and supplier risk. These five criteria were obtained through an integrated process consisting of the identification of eleven initial criteria based on a literature review, followed by screening through expert discussion, brainstorming, and expert judgement. BWM and ANP served complementary functions in this model, where BWM generated consistent criterion priorities while ANP refined those priorities by accounting for the interdependencies among criteria; as a result, this study produced not only supplier weights or rankings but a decision-making model that PT XYZ can use to evaluate, prioritize, and determine supplier relationship management strategies. Based on the analysis using the Best-Worst Method (BWM) and Analytic Network Process (ANP), quality was identified as the highest-priority criterion with a weight of 0.5468, followed by delivery accuracy, lead time, price, and supplier risk. The evaluation of nine suppliers showed that most suppliers were categorized as Preferred Suppliers, while CV F and PT I were categorized as Strategic Partners, with PT I achieving the highest performance score of 4.49. These results demonstrated that the developed model was capable of supporting

companies in determining supplier priorities through a more objective and structured approach as a basis for decision-making and long-term supplier relationship management.

Therefore, PT XYZ is recommended to prioritize quality aspects in the supplier evaluation process while maintaining attention to delivery accuracy, price, and lead time. The company should also strengthen the implementation of Supplier Relationship Management (SRM) through effective communication, periodic performance evaluations, and the development of long-term partnerships. Future research is recommended to incorporate additional criteria and subcriteria, such as flexibility, production capacity, responsiveness, and sustainability, as well as involve a larger number of respondents or experts to produce more comprehensive findings.

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