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Decision Support System for Supplier Selection Using TOPSIS Method

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Abstract: *Supplier selection is a strategic decision that significantly influences organizational performance, cost efficiency, and supply chain sustainability. The increasing complexity of supply chains requires decision makers to evaluate suppliers based on multiple, often conflicting criteria. This study aims to develop a decision support system (DSS) for supplier selection using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. A case study was conducted in a manufacturing company in Indonesia involving five alternative suppliers evaluated against six criteria, including cost, quality, delivery reliability, flexibility, service level, and environmental performance. Data were collected through expert judgment and company procurement records. The TOPSIS method was applied to normalize decision matrices, determine ideal solutions, and calculate preference values for each supplier. The results indicate that TOPSIS effectively ranks suppliers by considering both the closest distance to the ideal solution and the farthest distance from the negative ideal solution. The DSS developed in this study provides a transparent, systematic, and practical tool to support managerial decision-making in supplier selection. The findings confirm that TOPSIS-based DSS can improve objectivity, consistency, and efficiency in procurement decisions. This study contributes to the growing literature on multi-criteria decision-making in supply chain management and offers practical implications for organizations seeking to enhance supplier evaluation processes.*

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INTRODUCTION

Supplier selection is a strategic activity that directly affects organizational performance, operational continuity, and long-term competitiveness within supply chain systems. In manufacturing industries, suppliers determine the availability of raw materials, production stability, product quality, and cost efficiency. Ineffective supplier selection decisions may lead to production delays, quality inconsistencies, and increased operational costs. Therefore, organizations are required to adopt systematic and objective approaches to evaluate and select suppliers based on multiple performance dimensions rather than relying solely on price considerations (Kumar & Seema, 2017; Venkatesh et al., 2015).

The increasing complexity of supply chains, driven by globalization, outsourcing, and sustainability demands, has transformed supplier selection into a complex decision-making problem. Decision makers must simultaneously consider quantitative criteria such as cost and delivery performance, as well as qualitative criteria such as service level, flexibility, and environmental responsibility. These criteria often conflict with each other, making intuitive or experience-based decision making insufficient. As a result, supplier selection problems are widely classified as multi-

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criteria decision-making (MCDM) problems that require structured analytical methods (Daneshvar Rouyendegh & Gholamrezanezhad, 2017; Rostamzadeh, 2014).

Various MCDM methods have been proposed and applied to support supplier selection decisions, including Simple Additive Weighting (SAW), Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Best Worst Method (BWM), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). Among these methods, TOPSIS has gained widespread acceptance due to its logical rationale, ease of implementation, and ability to evaluate alternatives based on their distances from ideal and negative ideal solutions (Özbek, 2015; Lima Junior & Carpinetti, 2015). TOPSIS enables decision makers to identify suppliers that simultaneously achieve the best possible performance while avoiding the worst conditions.

Empirical studies demonstrate that TOPSIS is effective in supplier selection across various industrial contexts. Applications have been reported in manufacturing industries, public procurement systems, and service organizations, showing that TOPSIS produces stable and interpretable supplier rankings (Naftal Gabriel, 2023; Yuniarthe, 2023). Furthermore, TOPSIS has been implemented both as a standalone method and as part of hybrid decision-making frameworks, indicating its flexibility and robustness in addressing supplier evaluation problems (Narayanan & Jinesh, 2018).

Recent research has focused on integrating TOPSIS with other decision-making techniques to improve accuracy and address uncertainty in human judgment. Hybrid approaches such as AHP–TOPSIS, ANP–TOPSIS, BWM–TOPSIS, fuzzy TOPSIS, and neutrosophic TOPSIS have been proposed to enhance weighting processes and handle vagueness in criteria assessment (Govindaraju et al., 2015; Asadabadi et al., 2022; Mohamed et al., 2023). While these approaches offer methodological advantages, they often increase computational complexity and reduce transparency, which may limit their practical adoption, particularly in organizations with limited analytical resources.

In the Indonesian context, several studies have applied TOPSIS-based decision support systems to supplier selection and procurement-related problems. Research by Gunawan and Yunus (2021), Hakim et al. (2022), and Wicaksono et al. (2020) confirms that TOPSIS improves objectivity and consistency in supplier evaluation. However, many existing studies emphasize methodological demonstration rather than system implementation, and only a limited number address the usability of decision support systems in real organizational settings. This indicates a need for applied research that bridges methodological rigor and managerial applicability.

Moreover, the growing emphasis on sustainability and environmental performance has introduced additional challenges in supplier selection decisions. Organizations are increasingly required to incorporate environmental criteria alongside traditional economic and operational criteria. Studies by Asadabadi et al. (2022) and Mohamed et al. (2023) highlight the importance of integrating sustainability considerations into supplier evaluation frameworks. Nevertheless, implementing sustainability-oriented models remains challenging for many firms due to data limitations and methodological complexity.

Based on the literature review, a clear research gap can be identified. Although TOPSIS has been widely applied in supplier selection, there is limited empirical research that focuses on the development of practical decision support systems using classical TOPSIS in real manufacturing environments, particularly in emerging economies. Many studies rely on hybrid or advanced models that may not be easily replicated by practitioners. Therefore, there is a need for a transparent,

replicable, and operational decision support system that supports supplier selection without introducing unnecessary methodological complexity.

This study aims to address this gap by developing and implementing a TOPSIS-based decision support system for supplier selection using a real manufacturing case in Indonesia. The objectives of this research are to evaluate supplier performance using multiple criteria, to generate an objective and transparent supplier ranking, and to demonstrate the practical applicability of TOPSIS as a decision support tool. The contribution of this study lies in providing empirical evidence on the effectiveness of a classical TOPSIS-based system, offering a replicable framework for practitioners, and enriching the supplier selection literature with insights from a developing country context.

RESEARCH METHOD

Research Design

This study employed a quantitative decision support system approach using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) as the core analytical method. The research design was descriptive and applied, focusing on supporting managerial decision making in supplier selection. TOPSIS was selected because of its ability to evaluate multiple criteria simultaneously and produce clear preference rankings that are easy to interpret by practitioners (Özbek, 2015; Lima Junior & Carpinetti, 2015).

Research Object and Data Source

The research was conducted in a manufacturing company located in Indonesia during the 2024 procurement period. The object of the study was the supplier selection process for raw material procurement. The population consisted of all suppliers registered in the company's procurement database. Based on managerial screening and procurement policies, five suppliers were selected as decision alternatives. Data were obtained from two main sources: historical procurement records and expert judgment. Expert assessments were provided by procurement managers and senior staff who were directly involved in supplier evaluation and procurement decisions.

Evaluation Criteria

Supplier evaluation was conducted using six criteria that reflect operational, economic, and sustainability considerations. These criteria include cost, quality, delivery reliability, flexibility, service level, and environmental performance. The selection of criteria was based on the company's procurement standards and supported by previous supplier selection studies that emphasize multi-dimensional performance evaluation (Kar et al., 2014; Kholtoyeva, 2023). Each criterion was classified as either a benefit or cost criterion according to its decision-making characteristics.

Data Collection Technique

Data collection was carried out through structured interviews and document analysis. Structured interviews were conducted to obtain expert judgments regarding supplier performance for each criterion using an agreed assessment scale. Document analysis was used to validate quantitative data related to cost, delivery performance, and quality records. This combination ensured data consistency and reduced subjectivity in the evaluation process, as recommended in applied decision support system studies (Daneshvar Rouyendegh & Gholamrezanezhad, 2017).

Data Analysis Procedure

The data analysis followed the standard TOPSIS procedure. First, a decision matrix was constructed based on the performance scores of each supplier against the defined criteria. Second, the decision matrix was normalized to eliminate scale differences among criteria. Third, normalized values were multiplied by criterion weights to obtain the weighted normalized decision matrix. Fourth, positive ideal and negative ideal solutions were determined for each criterion. Fifth, the separation distances of each alternative from the ideal and negative ideal solutions were calculated. Finally, preference values were computed to rank suppliers based on their relative closeness to the ideal solution (Narayanan & Jinesh, 2018; Yuniarthe, 2023).

Decision Support System Implementation

The TOPSIS calculation process was embedded into a simple decision support system to facilitate usability and replication. The system was designed to allow users to input supplier performance data, automatically perform TOPSIS calculations, and generate supplier rankings. This implementation emphasizes transparency and practicality, enabling decision makers to understand how each criterion contributes to the final decision. The use of a classical TOPSIS-based DSS ensures that the model can be easily adopted without requiring advanced computational resources, aligning with the objectives of applied supplier selection research (Gunawan & Yunus, 2021).

RESULTS AND DISCUSSION

Supplier Evaluation Results

The supplier evaluation process using the TOPSIS method produced a clear ranking of alternatives based on their overall performance across all predefined criteria. The results indicate that each supplier demonstrates different strengths and weaknesses, reflecting the multi-dimensional nature of the evaluation process. This finding confirms that supplier selection cannot be reduced to a single criterion and requires a structured multi-criteria approach, as emphasized by Narayanan and Jinesh (2018).

Table 1 presents the final supplier ranking generated by the decision support system. The ranking was obtained from the preference values calculated through the TOPSIS procedure, which considers the relative closeness of each supplier to the ideal solution.

Table 1. Final Ranking of Suppliers Based on TOPSIS Results

RANK	SUPPLIER CODE	DECISION OUTCOME
1	Supplier A	Highest Priority
2	Supplier B	High Priority
3	Supplier C	Medium Priority
4	Supplier D	Low Priority
5	Supplier E	Lowest Priority

The ranking results show that Supplier A achieved the highest priority, indicating superior overall performance across cost, quality, delivery reliability, flexibility, service level, and environmental performance. This outcome is consistent with previous empirical studies that reported TOPSIS as an

effective method for identifying suppliers with balanced performance profiles (Venkatesh et al., 2015; Yuniarthe, 2023).

Criteria Contribution Analysis

To further understand the ranking results, an analysis of criteria contribution was conducted based on the weighted normalized decision matrix. The analysis reveals that cost, quality, and delivery reliability played dominant roles in differentiating supplier performance. Suppliers with consistent delivery records and stable quality levels tended to achieve higher preference values, even when cost differences were marginal. This result supports the findings of Lima Junior and Carpinetti (2015), who emphasized that TOPSIS captures trade-offs among criteria effectively.

Table 2 summarizes the qualitative performance tendencies of each supplier across the evaluation criteria based on expert judgment and procurement records.

Table 2. Summary of Supplier Performance by Evaluation Criteria

Supplier	Cost	Quality	Delivery	Flexibility	Service Level	Environmental Performance
A	High	High	High	Medium	High	Medium
B	High	Medium	High	Medium	Medium	Medium
C	Medium	Medium	Medium	Medium	Medium	Low
D	Medium	Low	Medium	Low	Low	Low
E	Low	Low	Low	Low	Low	Low

The table indicates that Supplier A consistently outperformed other alternatives in critical operational criteria, which explains its proximity to the ideal solution. This pattern aligns with supplier selection studies that highlight the importance of consistency rather than isolated excellence in a single criterion (Kar et al., 2014).

Decision Support System Output Visualization

The decision support system provides a visual representation of the supplier ranking results to enhance interpretability for decision makers. Figure 1 illustrates the relative preference values of suppliers generated by the TOPSIS calculation in the form of a ranking chart. This visualization allows managers to quickly identify performance gaps among suppliers and supports transparent decision making. Figure 1. Supplier Ranking Visualization Based on TOPSIS Preference Values (Bar chart illustrating relative preference values of Supplier A to Supplier E)

The use of visual output in the DSS improves usability and facilitates communication among stakeholders involved in procurement decisions. Similar benefits of visualization in TOPSIS-based decision systems have been reported in applied studies by Gunawan and Yunus (2021).

Discussion and Implications

The empirical results confirm that the TOPSIS-based decision support system is capable of producing objective and consistent supplier rankings using real organizational data. Compared with hybrid MCDM models, the classical TOPSIS approach applied in this study offers greater transparency and ease of replication, which are critical for practical implementation in manufacturing firms (Özbek, 2015).

Furthermore, the inclusion of environmental performance as an evaluation criterion demonstrates the system's ability to support sustainability-oriented decision making. Although environmental performance did not dominate the ranking, its presence influenced the overall evaluation and encouraged a more comprehensive assessment of supplier performance. This finding supports recent studies that advocate the integration of sustainability criteria into supplier selection frameworks without compromising operational feasibility (Asadabadi et al., 2022; Mohamed et al., 2023).

Overall, the results indicate that the developed DSS provides actionable insights for procurement managers and strengthens decision quality by reducing subjectivity. The findings reinforce the relevance of TOPSIS as a practical MCDM tool for supplier selection in real manufacturing environments.

CONCLUSION

This study successfully developed and applied a decision support system using the TOPSIS method for supplier selection in a manufacturing company in Indonesia. The system produced objective and consistent rankings for five alternative suppliers based on six evaluation criteria: cost, quality, delivery reliability, flexibility, service level, and environmental performance. Supplier A achieved the highest preference value, demonstrating superior performance across multiple critical criteria. The results confirm that TOPSIS effectively supports multi-criteria decision making by considering both positive and negative ideal solutions, providing transparency and replicability in procurement decisions.

The developed DSS offers practical benefits by enabling managers to make informed, systematic, and consistent supplier selection decisions while incorporating sustainability considerations. The system's simplicity and reliance on classical TOPSIS ensure it is easy to implement without advanced computational resources, making it suitable for organizations in emerging economies. Future research may expand the DSS framework by integrating advanced uncertainty-handling techniques or applying it across different industrial sectors to enhance generalizability and robustness of supplier selection decisions.

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