



Integration of DAM Objective Weighting and TOPSIS Ranking for Strategic Business Partner Selection

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ABSTRACT

Keywords:

Strategic Business Partner Selection; DAM Weighting; TOPSIS Method; Multi-Criteria Decision Making; Sensitivity Analysis;

Selecting the right strategic business partner is important because partner performance can directly influence operational efficiency, competitiveness, sustainability, and long-term business performance. However, strategic business partner selection involves multiple criteria with different levels of importance, making subjective decision-making potentially inconsistent and biased. This study proposes an integrated Multi-Criteria Decision-Making (MCDM) approach combining Data Assessment Method (DAM) Weighting and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to support systematic and objective strategic business partner selection. DAM Weighting is employed to determine objective criterion weights based on the characteristics of the available data, while TOPSIS ranks partner alternatives according to their relative closeness to the positive ideal solution. Seven strategic business partners were evaluated using seven criteria representing cost, quality, delivery, flexibility, technology, financial stability, and collaboration. The DAM Weighting results indicate that CP1 obtained the highest weight of 0.2414, followed by CP4 (0.1537), CP6 (0.1408), CP3 (0.1384), CP5 (0.1212), CP2 (0.1105), and CP7 (0.0940). Based on TOPSIS, Partner F achieved the highest preference value of 0.8277, followed by Partner B with 0.7158 and Partner D with 0.6657, indicating that Partner F is the most preferred strategic business partner. Sensitivity analysis was conducted by modifying criterion weights to evaluate ranking stability and robustness. The results show that several alternatives maintain stable positions, while some experience ranking changes under different weighting scenarios. Overall, the DAM Weighting-TOPSIS framework provides a systematic, objective, and transparent approach for supporting strategic business partner selection and evaluating ranking robustness.

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I. Introduction

A strategic business partner plays an important role in supporting sustainability and boosting a company's competitiveness in today's increasingly dynamic and competitive business environment[1], [2]. Choosing the right strategic business partner can help a company gain the resources, expertise, technology, and market access it needs to achieve long-term strategic goals. Additionally, strategic partnerships allow companies to share risks, improve operational efficiency, and create innovations that can provide a competitive edge. However, the process of selecting a partner is not simple as it involves various criteria that often conflict with each other, like cost, quality, reputation, technological capability, flexibility, experience, and commitment to sustainability. A partner with the lowest cost doesn't necessarily have the best quality or innovation capability, while a high-quality partner might require a bigger investment. This shows that choosing a strategic business partner needs a comprehensive approach, balancing various criteria so that the chosen partner can add value and support the company's sustainability and competitiveness in the long run[3], [4].

Making decisions when choosing a strategic business partner has its limitations if it's only based on one criterion or the subjective judgment of the decision-maker[5], [6]. That approach risks overlooking other important aspects, like cost, quality, reputation, technological capability, flexibility, and commitment to sustainability. Being too subjective can also create bias because decisions are influenced by individual perceptions, experiences, and preferences. In this situation, a Decision Support System (DSS) based on Multi-Criteria Decision Making (MCDM) becomes important to help companies evaluate various partner options in a more systematic and objective way[7]-[9]. MCDM allows multiple conflicting criteria to be considered at the same time, so the selection process can result in more structured decisions that fit the company's needs. At the end of the Introduction, authors should clearly state the research objectives, scope of the study, and expected scientific contributions. The objectives should be written in a clear and specific manner, consistent with the methods employed and the results obtained[10], [11]. The Introduction should conclude by emphasizing the novelty or added value of the research, which serves as the key distinguishing factor between the present study and previous works. Using an MCDM-based DSS can also boost transparency, consistency, and the quality of decisions in picking a strategic business partner who can add value to the company.

One of the problems in multi-criteria decision making is figuring out the weight of each criterion objectively, because the importance of each criterion can vary and is often influenced by the decision maker's subjectivity. Assigning weights incorrectly can affect the evaluation results and cause the chosen alternative to not fully reflect the company's needs. The Data Assessment Method (DAM) Weighting can be used to help determine the criteria weights based on their importance in a more structured way and reduce reliance on subjective judgment[12]. After the weight of each criterion is determined, the Technique



for Order Preference by Similarity to Ideal Solution (TOPSIS) can be used to rank various alternatives based on their closeness to the positive ideal solution and distance from the negative ideal solution. This approach allows each alternative to be compared comprehensively, taking into account all the criteria that have been weighted[13]-[16]. Combining DAM Weighting and TOPSIS can result in a more systematic decision-making process in choosing the strategic business partner that best fits the company's needs and goals.

Research on business partner selection has been widely conducted using various decision-making methods, but there are still some gaps that need attention. Some studies still use subjective criteria weighting, which means the decision results can be influenced by the decision-maker's perceptions and preferences[17]. Also, the integration of certain objective weighting methods with TOPSIS in the context of selecting strategic business partners is still relatively limited. Using objective weighting can provide a more measurable basis for determining the importance of each criterion, while TOPSIS can be used to rank alternatives based on their closeness to the ideal solution. Another gap is that there's still limited research evaluating the stability or robustness of the rankings when there are changes in the criteria weights. This evaluation is important to see how changes in the level of importance of criteria can affect the position of alternatives in the ranking results.

This study aims to develop a systematic decision-making approach for determining the right strategic business partner that fits the company's needs. Specifically, the study aims to determine the weight of each criterion objectively using DAM Weighting so that the importance of each criterion can be determined based on the available data. Furthermore, the study aims to produce a ranking of strategic business partners using TOPSIS based on how close each alternative is to the ideal solution. The study also aims to develop a DAM-TOPSIS model that can be implemented as a DSS to support a more structured and objective process for selecting a strategic business partner. In addition, the study aims to evaluate the stability of the ranking results through sensitivity analysis by observing changes in the ranking of alternatives when there are changes in the criterion weights.

This study makes several contributions to the development of decision-making methods for selecting strategic business partners. The main contribution of this research is integrating DAM Weighting with TOPSIS into a single structured approach. This integration offers a more objective way to determine the importance of criteria, so that the criteria weights are not entirely dependent on the subjective judgment of decision-makers. The study also produces a DSS framework that can be used to support the evaluation and selection process of strategic business partners systematically. Additionally, the research tests the robustness of the model through an analysis of changes in criteria weights to understand the stability of the ranking results. These findings are expected to provide a more objective, transparent, and reliable approach to support decisions in selecting strategic business partners.

II. Methodology

Methodology is a systematic approach or framework used to guide the research process in achieving predetermined objectives[18]-[20]. It encompasses a series of stages, methods, techniques, and procedures used to collect, process, analyze, and interpret data in a structured manner. A well-defined methodology ensures that the research is conducted objectively, systematically, and scientifically, thereby enhancing the



validity and reliability of the findings. In quantitative research, for example, the methodology may include criteria identification, data collection, criteria weighting, selection of analytical methods, data analysis, and evaluation and interpretation of the results.

2.1. Research Stage

Research stages refer to a systematic sequence of activities carried out to guide the research process from the identification of a research problem to the achievement and interpretation of the research objectives. These stages generally include problem identification, literature review, research design, data collection, data processing and analysis, validation or evaluation of the results, and the formulation of conclusions and recommendations. A clearly structured sequence of research stages helps ensure that the research process is conducted systematically, logically, and consistently, thereby supporting the validity and reliability of the research findings. The research stages presented in Figure 1 illustrate the systematic process followed in this study, beginning with problem identification and continuing through data collection, analysis, evaluation, and the formulation of conclusions and recommendations.

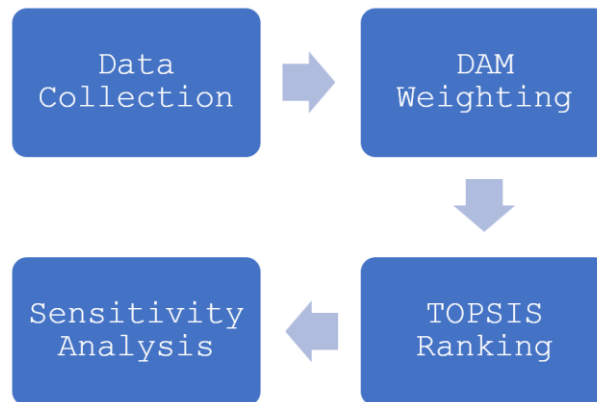


Figure 1. Research Stages

The research process consists of four main stages: Data Collection, which involves gathering the necessary data for evaluating strategic business partner alternatives; DAM Weighting, which determines the objective weights of the evaluation criteria; TOPSIS Ranking, which ranks the alternatives based on their relative closeness to the ideal solution; and Sensitivity Analysis, which evaluates the robustness and stability of the ranking results under changes in criteria weights.

2.2. Data Collection

Data collection is a systematic process of gathering relevant, accurate, and reliable information required to achieve the research objectives. This process involves identifying appropriate data sources, determining the types of data needed, and selecting suitable data collection techniques. The collected data are then organized and prepared



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for further processing and analysis using the selected research methods. Proper data collection is essential to ensure that the research findings are valid, reliable, and consistent with the research objectives.

A Strategic Business Partner Selection Dataset is a structured collection of data used to evaluate and compare potential strategic business partners based on predetermined criteria. The dataset contains relevant information about each partner alternative, including aspects such as cost, quality, delivery performance, flexibility, technological capability, financial stability, and collaboration. The data serve as the basis for assessing the suitability and performance of each potential partner and support the decision-making process in selecting the most appropriate strategic business partner. The dataset used in this study is presented in Table 1.

Table 1. Dataset

Alternative	CP1	CP2	CP3	CP4	CP5	CP6	CP7
Partner A	82	88	85	80	86	84	87
Partner B	76	91	89	85	90	88	86
Partner C	90	84	81	92	83	86	90
Partner D	79	89	87	88	91	92	89
Partner E	85	86	92	83	87	81	85
Partner F	73	93	90	86	89	91	92
Partner G	88	87	84	90	85	87	88

The dataset consists of seven potential strategic business partners (CP1-CP7) evaluated based on seven criteria: Cost, Quality, Delivery, Flexibility, Technology, Financial Stability, and Collaboration. Each criterion represents an important aspect of partner performance and suitability. Cost reflects the competitiveness of the partner's pricing, while Quality represents the ability to meet required quality standards. Delivery indicates the partner's reliability in fulfilling delivery requirements, Flexibility reflects the ability to adapt to changing business needs, and Technology represents technological capability and support. Financial Stability describes the partner's financial condition and sustainability, while Collaboration reflects the ability to establish effective and long-term cooperation. The evaluation data for CP1-CP7 based on these criteria are presented in Table 1.

2.3. DAM Weighting

This subsection describes the data sources used in the study, data collection techniques, research instruments, and data preprocessing procedures carried out prior to analysis. Authors should clearly explain how the data were obtained, organized, and prepared to ensure the reliability and validity of the subsequent analytical process.

The DAM Weighting process consists of four main stages. First, the decision matrix is constructed to represent the performance of each alternative across the selected criteria, as presented in Equation (1). Second, the decision matrix is normalized to transform the criterion values into comparable scales, as shown in Equation (2). Third, the criterion score is calculated to determine the relative contribution of each criterion based on the normalized values, as described in Equation (3). Finally, the objective weight of each criterion is



obtained by normalizing the criterion scores, ensuring that the total weights equal one, as presented in Equation (4).

$$X = [x_{ij}]_{m \times n} \quad (1)$$

$$n_{ij} = \frac{x_{ij}}{\sum_{j=1}^n x_{ij}} \quad (2)$$

$$P_j = 100 * \left| \frac{\sqrt{\sum_{i=1}^m (n_{ij})^2}}{\ln \frac{m}{\sigma_j}} \right| \quad (3)$$

$$w_j = \frac{P_j}{\sum_{k=1}^n P_k} \quad (4)$$

The main advantage of the DAM Weighting lies in its ability to determine criterion weights objectively based directly on the characteristics and information contained in the dataset, thereby reducing dependence on subjective judgments from decision-makers. This approach can account for the importance of each criterion based on data patterns, variability, and distribution, allowing the resulting weights to adapt to the characteristics of the evaluated dataset. In addition, DAM Weighting provides a systematic and transparent calculation process, can be easily integrated with various Multi-Criteria Decision-Making (MCDM) methods, and does not require predefined preferences or expert-based weighting. Therefore, DAM Weighting provides a more consistent, data-driven, and reproducible basis for determining criterion importance in decision-making processes.

2.4. TOPSIS Method

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is a widely used Multi-Criteria Decision-Making (MCDM) method designed to evaluate and rank a set of alternatives based on their performance across multiple criteria. The fundamental concept of TOPSIS is that the best alternative should have the shortest geometric distance from the Positive Ideal Solution (PIS), which represents the most desirable performance values for all criteria, and the greatest distance from the Negative Ideal Solution (NIS), which represents the least desirable performance values. By simultaneously considering these two reference solutions, TOPSIS provides a relative measure of how close each alternative is to the ideal condition. The method can accommodate both benefit and cost criteria, making it applicable to various decision-making problems with different types of evaluation attributes. The resulting relative closeness values are then used to establish the priority order of alternatives, where a higher value indicates a more preferable alternative. The main stages of TOPSIS are as follows.

TOPSIS consists of several main stages. First, a decision matrix is constructed to represent the performance values of each alternative with respect to all criteria, as calculated using (1). The values in the decision matrix are then normalized to eliminate differences in measurement scales and units across criteria using (5). The normalized values are subsequently multiplied by the corresponding criterion weights to obtain the weighted normalized matrix, as calculated using (6). Next, the Positive Ideal Solution (PIS) and Negative Ideal Solution



(NIS) are determined according to the benefit and cost characteristics of each criterion using (7). The distance of each alternative from the PIS and NIS is then calculated using (8). These distances are used to determine the relative closeness coefficient using (9) and (10), which indicates the degree of closeness of each alternative to the ideal solution. Finally, the alternatives are ranked based on the coefficient values using (11), where the alternative with the highest value is considered the best alternative.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m (x_{ij})^2}} \quad (5)$$

$$y_{ij} = r_{ij} * w_j \quad (6)$$

$$y_j^+ = \begin{cases} \max_j y_{ij}; \text{benefit} \\ \min_j y_{ij}; \text{cost} \end{cases} \quad (7)$$

$$y_j^- = \begin{cases} \min_j y_{ij}; \text{benefit} \\ \max_j y_{ij}; \text{cost} \end{cases} \quad (8)$$

$$D_i^+ = \sqrt{\sum_{i=1}^m (y_{ij} - y_j^+)^2} \quad (9)$$

$$D_i^- = \sqrt{\sum_{i=1}^m (y_{ij} - y_j^-)^2} \quad (10)$$

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (11)$$

The main advantage of TOPSIS is its ability to provide a clear, systematic, and intuitive ranking of alternatives by simultaneously considering their proximity to the positive ideal solution and distance from the negative ideal solution. TOPSIS can accommodate both benefit and cost criteria, allowing it to be applied to a wide range of multi-criteria decision-making problems with different types of evaluation attributes. The method also preserves the relative performance of alternatives through normalization and weighting, enabling criteria with different measurement units and importance levels to be evaluated within a common framework. In addition, TOPSIS has a relatively straightforward computational procedure, is easy to integrate with various objective weighting methods, and produces a quantitative closeness coefficient that facilitates the interpretation and comparison of alternatives. These characteristics make TOPSIS a flexible, transparent, and practical method for obtaining priority rankings in complex decision-making problems.

2.5. Sensitivity Analysis

Sensitivity Analysis is an analytical procedure used to examine the robustness and stability of decision-making results when changes occur in the input parameters of a model. In the context of Multi-Criteria Decision-Making (MCDM), sensitivity analysis is commonly applied by systematically modifying criterion weights, performance values, or other relevant parameters and then observing their effects



on the resulting alternative rankings. This analysis helps determine whether the obtained decision is strongly dependent on particular assumptions or remains relatively stable under different conditions.

In an MCDM framework, sensitivity analysis can be performed by increasing or decreasing the weights of selected criteria while maintaining the required weight constraints. The decision-making method is then recalculated for each scenario to obtain new preference values and rankings. The resulting rankings are compared with the original ranking to identify changes in the position of each alternative. The magnitude and direction of these changes provide an indication of how sensitive the decision results are to variations in criterion importance.

The main advantage of sensitivity analysis is its ability to provide additional evidence regarding the robustness and reliability of the obtained ranking. If alternatives maintain similar ranking positions across different scenarios, the decision results can be considered relatively stable and less sensitive to changes in the input parameters. Conversely, substantial changes in rankings indicate that the results are sensitive to particular criteria or parameter variations, suggesting that greater attention should be given to those factors in the decision-making process. Therefore, sensitivity analysis can complement the main MCDM method by providing a deeper assessment of ranking stability and supporting more reliable decision-making.

III. Result and Discussion

The integration of DAM Weighting and TOPSIS Ranking provides a robust and objective framework for Strategic Business Partner Selection. DAM Objective Weighting determines the importance of evaluation criteria based on the characteristics and information contained within the assessment data, reducing reliance on subjective judgments from decision-makers. Meanwhile, TOPSIS evaluates and ranks business partner alternatives according to their relative closeness to the Positive Ideal Solution and distance from the Negative Ideal Solution. The combination of these two methods creates a complementary framework in which DAM provides objective criterion importance, while TOPSIS translates the weighted evaluation into a clear priority ranking.

This integration is particularly relevant to strategic business partner selection because business partners are typically evaluated using multiple criteria that may have different characteristics, measurement scales, and levels of importance. By employing objective weights derived from DAM, the influence of each criterion is determined from the available data rather than being primarily dependent on expert preferences. TOPSIS then enables the overall performance of each alternative to be assessed relative to ideal reference conditions. Consequently, the framework can provide a more consistent and transparent evaluation of potential business partners while accommodating both benefit and cost criteria.

Overall, the DAM-TOPSIS integration offers a data-driven approach that combines objective criterion weighting with distance-based



alternative ranking. This combination can support more systematic, transparent, and reproducible strategic business partner selection, particularly when decision-makers need to evaluate several alternatives simultaneously across heterogeneous criteria. The resulting ranking provides a quantitative basis for identifying the most suitable business partner, while the objective weighting mechanism helps reduce subjectivity in determining criterion importance.

3.1. Determining Criteria Weights Using DAM Weighting

The DAM Weighting is used to objectively determine the weights of criteria based on the characteristics of the data associated with each criterion. This method assesses the relative importance of criteria based on the information contained in the dataset, thereby reducing dependence on subjective preferences from decision-makers. In this study, DAM Weighting is applied to generate objective criterion weights, which are subsequently used as inputs for the TOPSIS ranking process. The stages for determining criterion weights using DAM Weighting are described as follows.

The first stage involves constructing the decision matrix, which contains the performance values of all alternatives with respect to the evaluation criteria. Each value represents the performance of a particular alternative for a specific criterion. The decision matrix serves as the initial input for the DAM Weighting process, as all subsequent calculations are based on the information contained in the observed data. The complete calculation results of the decision matrix are presented in Table 1.

In the second stage, the values in the decision matrix are normalized to obtain the relative proportion of each alternative's performance for each criterion. The normalization is performed by dividing the performance value of an alternative by the total performance values of the corresponding criterion. This process transforms the original data into comparable values while maintaining the relative distribution of the data across alternatives. The complete calculation results of the normalized matrix are presented in Table 2.

Table 2. Normalization Value

Alternative	CP1	CP2	CP3	CP4	CP5	CP6	CP7
Partner A	0.1254	0.1243	0.1221	0.1163	0.1223	0.1203	0.1229
Partner B	0.1162	0.1285	0.1279	0.1235	0.1280	0.1261	0.1215
Partner C	0.1376	0.1186	0.1164	0.1337	0.1181	0.1232	0.1271
Partner D	0.1208	0.1257	0.1250	0.1279	0.1294	0.1318	0.1257
Partner E	0.1300	0.1215	0.1322	0.1206	0.1238	0.1160	0.1201
Partner F	0.1116	0.1314	0.1293	0.1250	0.1266	0.1304	0.1299
Partner G	0.1346	0.1229	0.1207	0.1308	0.1209	0.1246	0.1243

The third stage involves calculating the assessment value of each criterion based on the normalized data and its statistical characteristics. This calculation considers the magnitude of the normalized values, their dispersion, and the number of alternatives to



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determine the amount of information contributed by each criterion. The resulting assessment value represents the relative information significance of each criterion, where a higher value indicates a greater contribution to distinguishing the evaluated alternatives. The complete calculation results of the criterion assessment values are presented in Table 3.

Table 3. Assessment Value

CP1	CP2	CP3	CP4	CP5	CP6	CP7
0.0367	0.0168	0.0211	0.0234	0.0185	0.0214	0.0143

The final stage is to determine the objective weight of each criterion based on its assessment value relative to the total assessment values of all criteria. This process converts the assessment values into proportional weights, with the total weight of all criteria equal to one. The resulting weights represent the objective importance of each criterion and are subsequently used as inputs for the TOPSIS ranking process. The complete calculation results of the objective criterion weights are presented in Table 4.

Table 4. Criteria Weight

CP1	CP2	CP3	CP4	CP5	CP6	CP7
0.2414	0.1105	0.1384	0.1537	0.1212	0.1408	0.0940

The DAM Weighting method was applied to determine the objective importance of the criteria for collaboration partner selection. The resulting weights show that Cost (CP1) obtains the highest weight at 0.2414, indicating that cost is the most influential criterion in the evaluation. It is followed by Delivery (CP4) with a weight of 0.1537, Financial Stability (CP6) with 0.1408, and Quality (CP3) with 0.1384. Meanwhile, Technology (CP5) receives a weight of 0.1212, followed by Delivery (CP2) with 0.1105, while Collaboration (CP7) obtains the lowest weight at 0.0940. These results indicate that, based on the DAM Weighting approach, cost-related considerations have the greatest influence on collaboration partner evaluation, followed by delivery performance, financial stability, and quality. Conversely, the relatively lower weight assigned to collaboration suggests that this criterion contributes less to the overall differentiation among the evaluated partners.

3.2. Determining the Ranking of Alternatives using the TOPSIS Method

The ranking of alternatives using the TOPSIS method is conducted by evaluating the relative performance of each alternative based on its distance from the positive and negative ideal solutions. The method identifies the alternative that has the closest overall performance to the positive ideal solution while being relatively farther from the negative ideal solution. The resulting relative closeness values are used as the basis for ordering the alternatives from the highest to the lowest score. An alternative with a higher relative closeness value indicates better overall performance and is therefore assigned a higher rank. This process provides a systematic basis for identifying the most



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preferable alternative while considering all evaluation criteria simultaneously.

The TOPSIS method begins with the construction of a decision matrix containing the performance values of each alternative with respect to all evaluation criteria. Each row represents an alternative, while each column represents a criterion. The decision matrix is constructed directly from the observed or collected data and serves as the primary input for the TOPSIS procedure. This matrix provides the performance information required for the subsequent normalization process. The complete decision matrix is presented in Table 1.

The second stage is the normalization of the decision matrix. Normalization is performed to transform the values of different criteria into a comparable scale, particularly when the criteria have different units or measurement ranges. The normalization process follows Equation (5), which converts the original decision values into normalized values while preserving their relative performance. The resulting normalized matrix is subsequently used in the weighted normalization stage. The complete normalization results are presented in Table 5.

Table 5. Normalization Value

Alternative	CP1	CP2	CP3	CP4	CP5	CP6	CP7
Partner A	0.3539	0.3514	0.3452	0.3286	0.3458	0.3401	0.3474
Partner B	0.3280	0.3634	0.3614	0.3491	0.3619	0.3563	0.3435
Partner C	0.3884	0.3354	0.3289	0.3779	0.3338	0.3482	0.3594
Partner D	0.3409	0.3554	0.3533	0.3615	0.3659	0.3725	0.3554
Partner E	0.3668	0.3434	0.3736	0.3409	0.3498	0.3280	0.3395
Partner F	0.3150	0.3714	0.3655	0.3532	0.3579	0.3685	0.3674
Partner G	0.3797	0.3474	0.3411	0.3697	0.3418	0.3523	0.3514

The normalized values are then combined with the weights of the corresponding criteria to obtain the weighted normalized decision matrix. The weighting process incorporates the relative importance of each criterion into the evaluation of the alternatives. The calculation is performed according to Equation (6). Criteria with higher weights have a greater contribution to the overall evaluation, while criteria with lower weights have a smaller influence. The complete weighted normalized matrix is presented in Table 6.

Table 6. Weighted Normalization Value

Alternative	CP1	CP2	CP3	CP4	CP5	CP6	CP7
Partner A	0.0854	0.0388	0.0478	0.0505	0.0419	0.0479	0.0327
Partner B	0.0792	0.0401	0.0500	0.0537	0.0439	0.0502	0.0323
Partner C	0.0937	0.0371	0.0455	0.0581	0.0405	0.0490	0.0338
Partner D	0.0823	0.0393	0.0489	0.0556	0.0444	0.0524	0.0334
Partner E	0.0885	0.0379	0.0517	0.0524	0.0424	0.0462	0.0319
Partner F	0.0760	0.0410	0.0506	0.0543	0.0434	0.0519	0.0345
Partner G	0.0917	0.0384	0.0472	0.0568	0.0414	0.0496	0.0330

The fourth stage determines the positive ideal solution and the negative ideal solution based on the weighted normalized values. The positive ideal solution represents the most desirable performance for each criterion, whereas the negative ideal solution represents the least desirable performance. The determination of these ideal solutions considers whether each criterion is



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categorized as a benefit or cost criterion. The positive and negative ideal solutions are obtained according to Equations (7) and (8). The complete ideal solution results are presented in Table 5.

Table 6. Ideal Solution Value

Type	CP1	CP2	CP3	CP4	CP5	CP6	CP7
Positive	0.0760	0.0410	0.0517	0.0581	0.0449	0.0524	0.0345
Negative	0.0937	0.0371	0.0455	0.0505	0.0405	0.0462	0.0319

The next stage calculates the distance of each alternative from the positive and negative ideal solutions. The separation measures indicate how close an alternative is to the best and worst reference points. The distance from the positive ideal solution and the distance from the negative ideal solution are calculated using Equations (9) and (10). The complete calculation results are presented in Table 7.

Table 7. Distance Ideal Value

Alternative	Positive	Negative
Partner A	0.0141	0.0091
Partner B	0.0066	0.0167
Partner C	0.0200	0.0083
Partner D	0.0076	0.0152
Partner E	0.0158	0.0086
Partner F	0.0043	0.0204
Partner G	0.0172	0.0079

Subsequently, the relative closeness value of each alternative to the positive ideal solution is determined using Equation (11). A higher relative closeness value indicates that an alternative is closer to the positive ideal solution and farther from the negative ideal solution. The complete calculation results are presented in Table 8.

Table 8. Final Value

Alternative	Final Value
Partner A	0.3930
Partner B	0.7158
Partner C	0.2938
Partner D	0.6657
Partner E	0.3515
Partner F	0.8277
Partner G	0.3156

The final stage of the TOPSIS method is the ranking of alternatives based on their relative closeness values. The alternative with the highest relative closeness value is considered the most preferred alternative because it has the closest overall performance to the positive ideal solution. The complete ranking results are presented in Figure 2.

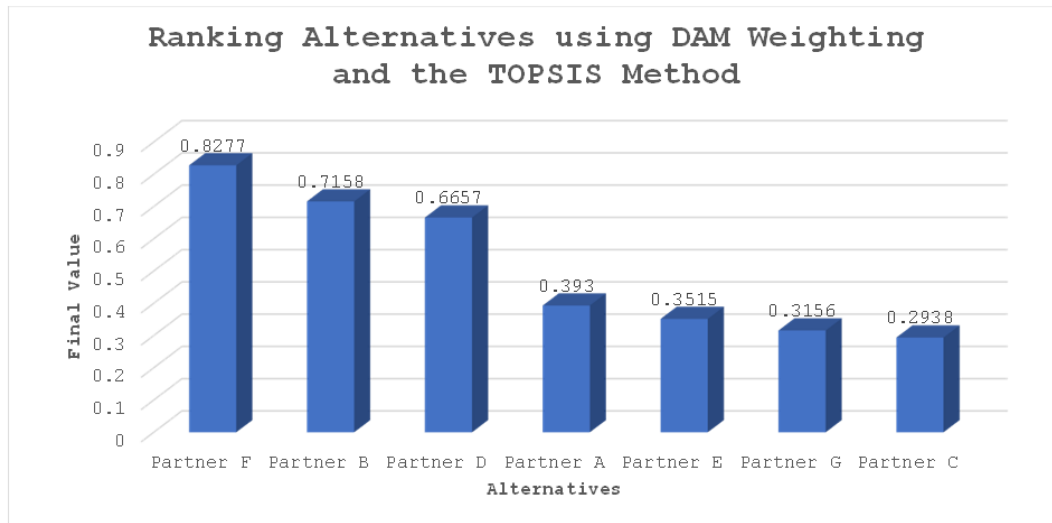


Figure 2. Alternative Rank

The ranking results obtained using the DAM Weighting and TOPSIS method show that Partner F is the most preferred collaboration partner, achieving the highest preference value of 0.8277. It is followed by Partner B with a preference value of 0.7158 and Partner D with 0.6567, indicating that these alternatives demonstrate strong overall performance across the evaluation criteria. Partner A ranks fourth with a preference value of 0.3930, followed by Partner G with 0.3156, Partner E with 0.3150, and Partner C with 0.2938. Overall, the results indicate a clear performance advantage for Partner F, while Partner C represents the least preferred alternative based on its relative proximity to the ideal solution.

3.3. Sensitivity Analysis of Changes in Criteria Weight

Sensitivity analysis was conducted to examine the robustness and stability of the ranking results generated through the integration of the DAM Weighting and TOPSIS methods. This analysis investigates the extent to which changes in the importance of the evaluation criteria influence the preference values and ranking positions of the collaboration partner alternatives. Since the criterion weights determined by the DAM Weighting method directly affect the overall evaluation process, variations in these weights may lead to changes in the relative performance of the alternatives. Therefore, sensitivity analysis is important for assessing whether the proposed decision-making model can maintain consistent results when the decision-maker's priorities or the relative importance of the criteria change. A robust model is expected to produce relatively stable rankings under reasonable changes in the criteria weights.

In this study, several weight-change scenarios were developed by systematically modifying the original criterion weights to represent different decision conditions. For each scenario, the adjusted weights were incorporated into the TOPSIS calculation, and the preference values and ranking positions of all collaboration partner alternatives were



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recalculated. The resulting rankings were subsequently compared with the original ranking to identify potential changes in the position of each alternative and to evaluate the overall stability of the decision results. This analysis provides additional evidence regarding the reliability of the proposed DAM Weighting and TOPSIS integration and its ability to support collaboration partner selection under varying weighting conditions. The scenarios of changes in criteria weights used in the sensitivity analysis are presented in Table 9.

Table 9. Testing Scenario for Criteria Weight Changes

Scenario	CP1	CP2	CP3	CP4	CP5	CP6	CP7
Initial Weight	0.2414	0.1105	0.1384	0.1537	0.1212	0.1408	0.094
S1: CP1 -0.06	0.1914	0.1178	0.1462	0.1624	0.1292	0.1501	0.1002
S2: CP1 +0.06	0.2914	0.1032	0.1258	0.1398	0.1132	0.1315	0.0878
S3: CP2 -0.06	0.255	0.0605	0.1464	0.1626	0.128	0.1487	0.0993
S4: CP2 +0.06	0.2278	0.1605	0.1314	0.1459	0.1144	0.1329	0.0887
S5: CP3 -0.06	0.2554	0.1169	0.0884	0.1623	0.1282	0.149	0.0995
S6: CP3 +0.06	0.2274	0.1041	0.1884	0.1398	0.1142	0.1326	0.0885
S7: CP4 -0.06	0.2557	0.117	0.1453	0.1037	0.1284	0.1491	0.0996
S8: CP4 +0.06	0.2271	0.104	0.1309	0.2037	0.114	0.1325	0.0884
S9: CP5 -0.06	0.2551	0.1168	0.1451	0.161	0.0712	0.1488	0.0993
S10: CP5 +0.06	0.2277	0.1042	0.1314	0.1461	0.1712	0.1328	0.0887
S11: CP6 -0.06	0.2554	0.1169	0.1453	0.1614	0.1283	0.0908	0.0995
S12: CP6 +0.06	0.2274	0.1041	0.1314	0.1459	0.1141	0.1908	0.0885
S13: CP7 -0.06	0.2547	0.1166	0.146	0.162	0.1279	0.1486	0.044
S14: CP7 +0.06	0.2281	0.1044	0.1309	0.1458	0.1145	0.133	0.144
Initial Weight	0.2414	0.1105	0.1384	0.1537	0.1212	0.1408	0.094

To examine the sensitivity and stability of the ranking results to changes in criterion weights, a scenario analysis was conducted using DAM Weighting for determining the criterion weights and TOPSIS for ranking the alternatives. In each scenario, the initial weight of a selected criterion was increased or decreased according to the predetermined adjustment value, while the weights of the other criteria were proportionally adjusted to ensure that the total weight remained equal to 1. The revised weights were then applied to the TOPSIS method to recalculate the preference values and ranking positions of all alternatives. The ranking results obtained from each scenario were compared with the baseline ranking based on the initial weights to identify changes in the positions of the alternatives resulting from variations in criterion importance. This analysis was performed to determine whether changes in the weights of specific criteria substantially affected the ranking order or whether the resulting rankings remained relatively consistent. Therefore, the scenario analysis provides an indication of the robustness and stability of the decision results produced by the integration of DAM Weighting-TOPSIS under different weight configurations. The ranking results for all weight-change scenarios are presented in Figure 3.

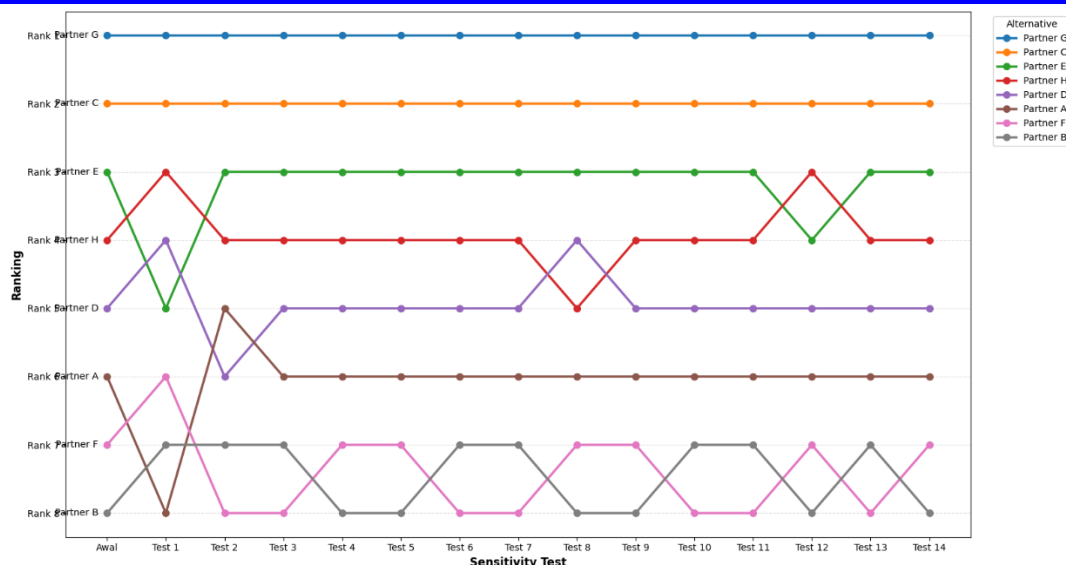


Figure 3. Alternative Rank

Figure 3 illustrates the ranking changes of the seven partners across the initial condition and 14 sensitivity test scenarios based on variations in the criterion weights. Partner G and Partner C consistently maintain Rank 1 and Rank 2, respectively, throughout all sensitivity tests, indicating that their positions are highly stable despite changes in the weights. Partner E generally remains in Rank 3, although it temporarily changes to Rank 5 in Test 1 and Rank 4 in Test 12, before returning to Rank 3 in the subsequent scenarios. Partner H shows moderate variation, moving between Rank 3 and Rank 5, while Partner D fluctuates mainly between Rank 4 and Rank 5. In contrast, Partner A, Partner F, and Partner B exhibit greater ranking changes across the sensitivity scenarios, particularly in the lower-ranked positions. Partner A changes from Rank 6 to Rank 7 and later returns to Rank 6, whereas Partner F and Partner B alternate between Ranks 7 and 8. Overall, the results indicate that the upper-ranked alternatives, particularly Partner G and Partner C, demonstrate strong ranking stability, while the lower-ranked alternatives are more sensitive to changes in criterion weights.

Following the ranking process, a Spearman rank correlation analysis is performed to evaluate the consistency and stability of the alternative rankings obtained across the different test scenarios. The analysis compares the original ranking with the rankings generated in each sensitivity test (Test 1-Test 14), thereby providing a quantitative measure of how closely the ranking results correspond to the baseline ranking. Spearman's ρ is particularly appropriate for this evaluation because it assesses the relationship between two sets of ordinal rankings without requiring the data to follow a particular distribution. A coefficient closer to 1 indicates a very strong positive association, meaning that the relative positions of the alternatives remain highly consistent with the original ranking, whereas lower values indicate greater changes in the ranking order. Therefore, the resulting Spearman correlation coefficients are used to assess the robustness of the proposed ranking approach under different test conditions. The calculated correlation values for all sensitivity tests are subsequently presented graphically in Figure 4, allowing the stability and consistency of the ranking results across all test scenarios to be observed more clearly.

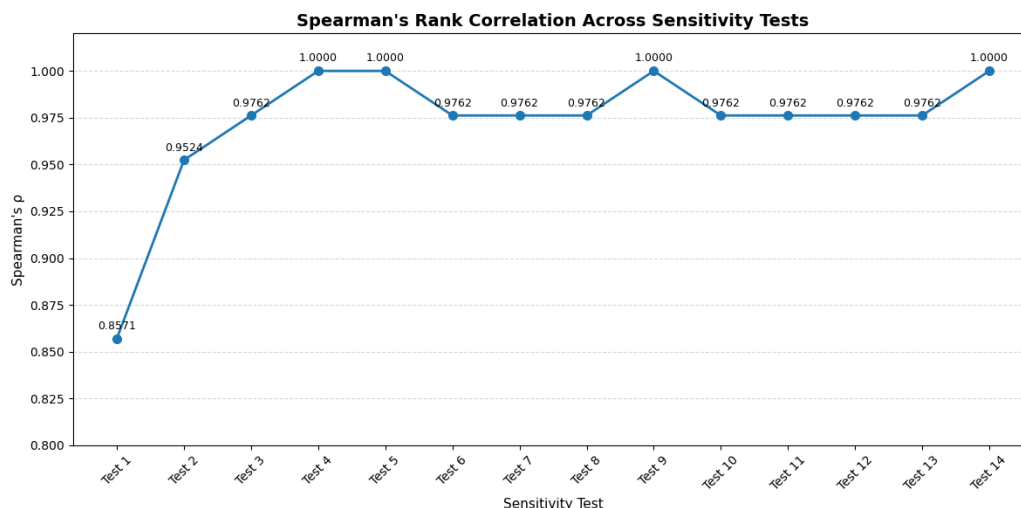


Figure 4. Comparison of Correlation Values

The correlation analysis presented in Figure 4 demonstrates a very high level of consistency between the original ranking and the rankings obtained across all sensitivity tests. The Spearman's ρ values range from 0.8571 to 1.0000, with the lowest correlation observed in Test 1 ($\rho = 0.8571$), followed by Test 2 ($\rho = 0.9524$), while Tests 3, 6-8, and 10-13 produce a correlation of 0.9762. Meanwhile, Test 4, Test 5, Test 9, and Test 14 achieve a perfect correlation of 1.0000, indicating that the ranking order remains completely unchanged compared with the original ranking. Overall, the consistently high correlation coefficients across all 14 tests indicate that the resulting rankings are highly stable and robust to variations introduced during the sensitivity analysis. The absence of substantial decreases in Spearman's ρ further suggests that the proposed decision-making approach maintains a consistent ordering of alternatives under different testing conditions.

Overall, the sensitivity analysis demonstrates that the DAM Weighting-TOPSIS approach produces highly stable ranking results under variations in criterion weights. The consistency of Partner G and Partner C across the sensitivity scenarios indicates that the leading alternatives remain relatively unaffected by changes in the weight configuration, while fluctuations observed among several lower-ranked alternatives do not substantially alter the overall ranking structure. This finding is further supported by the Spearman's rank correlation coefficients, which range from 0.8571 to 1.0000 across the 14 sensitivity tests. The lowest correlation is observed in Test 1 ($\rho = 0.8571$), whereas Tests 4, 5, 9, and 14 achieve a perfect correlation ($\rho = 1.0000$), indicating identical ranking orders to the original ranking. The remaining tests also exhibit very strong correlations, with values of 0.9524 or 0.9762, demonstrating that variations in criterion weights have only a limited effect on the relative ordering of the alternatives. Therefore, the combination of consistent leading alternatives and high Spearman's ρ values confirms that the DAM Weighting-TOPSIS method provides a robust and stable ranking framework for supporting partner selection decisions under different weighting conditions.



IV. Conclusion

This study developed an integrated Decision Support System approach for strategic business partner selection by combining DAM Weighting and TOPSIS. The proposed approach was designed to address the limitations of subjective criterion weighting and to provide a systematic, transparent, and data-driven evaluation of multiple strategic business partner alternatives. DAM Weighting was employed to determine the objective importance of the evaluation criteria, while TOPSIS was used to rank the alternatives according to their relative closeness to the positive ideal solution and distance from the negative ideal solution. The integration of both methods provides a structured decision-making framework for evaluating strategic business partners across multiple and potentially conflicting criteria.

The sensitivity analysis further demonstrates the importance of examining the robustness of the ranking results under changes in criterion weights. The ranking patterns show that some alternatives maintain their positions across the sensitivity scenarios, whereas several alternatives experience fluctuations when the importance of individual criteria is increased or decreased. Partner G and Partner C demonstrate particularly stable ranking positions in the sensitivity ranking dataset, while Partner E, Partner H, Partner D, Partner A, Partner F, and Partner B show varying degrees of movement across the tested scenarios. These changes indicate that the influence of criterion weights is not uniform across alternatives and that alternatives with relatively similar performance can be more sensitive to changes in criterion importance.

Overall, the findings demonstrate that the DAM Weighting-TOPSIS framework provides a systematic, objective, and reproducible approach for strategic business partner selection. DAM Weighting reduces dependence on subjective determination of criterion importance, while TOPSIS provides a clear ranking based on the alternatives' relative closeness to the ideal solution. The sensitivity analysis adds further evidence concerning the robustness of the decision model by demonstrating how ranking positions respond to changes in criterion weights. Consequently, the proposed framework can support organizations in making more transparent and data-driven strategic business partner selection decisions. Future work may focus on evaluating the performance of DAM Weighting against other objective weighting methods, such as CRITIC, MEREC, LOPCOW, and Entropy, to determine the consistency and sensitivity of the resulting criterion weights. In addition, alternative MCDM methods can be integrated with DAM Weighting to examine whether different ranking mechanisms produce comparable results across various decision-making scenarios. Future studies may also employ larger and more diverse datasets, incorporate additional criteria relevant to partner evaluation, and conduct broader sensitivity and robustness analyses. These extensions are expected to provide stronger empirical validation of the DAM Weighting-TOPSIS framework and improve its generalizability for partner selection in different decision-making contexts.



CRedit Authorship Contribution Statement

Setiawansyah: Writing - review & editing, Writing - original draft, Validation, Software, Methodology, Conceptualization. **R.R. Suryono:** Writing - original draft, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

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

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

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

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