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## Modification of Additive Ratio Assessment Method through Distance-Based Weighting Approach for Optimizing Assessment Accuracy

Rakhmat Dedi Gunawan<sup>1</sup>, Muhammad Waqas Arshad<sup>2</sup>, Agung Deni Wahyudi<sup>3</sup>, Ryan Randy Suryono<sup>4</sup>,  
Tri Widodo<sup>5</sup>, Faruk Ulum<sup>6</sup>

<sup>1,3,4,5,6</sup>Faculty Engineering and Computer Science, Universitas Teknokrat Indonesia, Bandar Lampung, Indonesia

<sup>2</sup>Department of Computer Science and Engineering, University of Bologna, Bologna, Italy

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### ABSTRACT

The Additive Ratio Assessment (ARAS) method is one of the approaches in multi-criteria decision making (MCDM) used to determine the best alternative based on a number of predetermined criteria. The drawback of this method is its heavy reliance on the accuracy of the criterion weighting determination; non-objective weights can lead to biased results. This study aims to improve the accuracy of ranking in multicriteria decision-making through the modification of the ARAS method with a distance-based weighting approach called ARAS-D. The ARAS method, known for its simplicity in calculation, was modified to be more responsive to the distribution of alternative data on each criterion. This distance-based weighting approach objectively determines the weight of the criteria based on variations in data performance, thereby reducing subjectivity in the weighting process. A case study was conducted on the selection of a new store location with six main criteria: rental cost, building area, accessibility, consumer traffic, parking availability, and infrastructure. The results of the evaluation show that the ARAS-D method is able to produce more precise ratings than the standard approach. Store locations with the highest utility value are recommended as the best choice, proving the effectiveness of the method in supporting strategic decisions. The results of the New Store Location 5 alternative rating obtained the highest score with a value of 0.9083, indicating that this location is the most optimal choice overall. This is followed by New Store Location 3 with a value of 0.8617 and New Store Location 1 with a value of 0.8415, which also shows excellent performance against the criteria that have been set. This research contributes to the development of more adaptive and data-based decision-making methods.

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### Corresponding Author:

Muhammad Waqas Arshad,  
Department of Computer Science and Engineering,  
University of Bologna,  
Via Zamboni 33, Bologna, Italy, 40126,  
Email: [muhammad.waqas.arshad.1@gmail.com](mailto:muhammad.waqas.arshad.1@gmail.com)

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### INTRODUCTION

Decision Support Systems (DSS) play a very important role in multi-criteria problem solving because they are able to assist decision-makers in assessing various alternatives based on a number of complex and often conflicting criteria (Aytakin, 2022; Mishra et al., 2023; Putra & An'ars, 2024). In real situations, decision-making rarely relies on a single

factor; Instead, various aspects such as cost, quality, time, risk, and benefits should be considered simultaneously. DSS allows this process to be more systematic, objective, and transparent by utilizing data-based decision-making methods and mathematical logic. With DSS, decision-makers can thoroughly evaluate each alternative, compare its strengths and weaknesses, and obtain the best recommendations that

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fit the organization's goals and priorities (Dafitri et al., 2022; Harianto et al., 2022; Ignatius Joko Dewanto et al., 2023). In addition, DSS also improves efficiency and accuracy in the decision-making process, especially in a dynamic and uncertain environment. The existence of a decision support system in a multi-criteria context also allows for the integration of quantitative and qualitative data, so that it is able to reflect real conditions more holistically. This is especially beneficial when decision-making involves various stakeholders with different perspectives and interests. DSS can be used to accommodate each party's preferences through proper weighting and assessment techniques (Jiskani et al., 2022; Said Mohamed et al., 2021; Tiwari et al., 2023). In addition, this system also encourages evidence-based decision-making, reduces subjectivity, and minimizes the potential for errors due to mere intuition. DSS is a strategic tool that not only simplifies the decision-making process, but also improves the quality and accountability of decisions made in complex multi-criteria problems.

The Additive Ratio Assessment (ARAS) method is one of the approaches in multicriteria decision-making (MCDM) that is used to determine the best alternative based on a number of predetermined criteria (Ndruru, 2020; Sahin et al., 2024; Sintaro, 2023). The basic principle of this method is that the effectiveness of an alternative is strongly influenced by the total value of its optimality function which reflects its overall contribution to the decision objective. ARAS works by comparing each alternative to the optimal solution through the process of data normalization, giving weight to each criterion, and calculating the utility value (Hadad, 2023; Sri Agustiani Br Siburian et al., 2023; Wahyudi, 2024). The alternative that has the highest utility value is considered the closest to the ideal solution and is therefore chosen as the best alternative. This method has the advantage of being able to handle both benefit criteria and cost criteria, as well as providing clear, measurable, and easy-to-interpret calculation results. Due to its simplicity and accuracy, ARAS is widely used in various fields such as supplier selection, performance evaluation, strategic planning, and so on.

The ARAS method has a number of advantages that make it popular in multicriteria decision-making (Hutagalung et al., 2022; Jusufbašić, 2023; Nindian Puspa Dewi et al., 2021). One of its advantages is simplicity and ease of application, so that it can be used by various groups without requiring complex mathematical understanding. In addition, ARAS is able to address both profit and cost criteria through an appropriate normalization process, as well as generate utility values that illustrate how close an alternative is to the optimal solution. This value makes it easier for decision-makers to understand the relative effectiveness of each alternative. However, ARAS also has some limitations. This method relies heavily on the accuracy of the determination of the weighting criteria,

non-objective weights can produce biased results (Rong et al., 2024). In addition, ARAS is less effective in handling uncertainty or qualitative information, and does not provide a mechanism for testing consistency between preferences as contained in the AHP method. In cases with a very large number of alternatives and criteria, this method also requires the help of software to maintain efficiency and accuracy.

Determining the weight of objective and data-sensitive criteria is an important challenge in the multicriteria decision-making process (Abbas et al., 2024; Blagojević et al., 2020; Štilić et al., 2022). One of the main difficulties lies in the need to ensure that the weights reflect the real contribution of each criterion to the final decision, without being influenced by the subjectivity of the decision-maker. Subjective approaches in weighting tend to be susceptible to bias and inconsistency because they rely on individual opinions or intuitions. Meanwhile, an objective approach, although data-driven, is often less able to capture the context and preferences of decision-makers as a whole. In addition, methods that are too sensitive to small changes in the data can also lead to instability of the results, making them difficult to rely on in dynamic situations. Therefore, the development of a balanced weighting method that is objective, adaptive to data variations, but remains stable is an important conceptual and technical challenge in decision-making research.

The Distance-Based Weighting Approach is a method that emphasizes the relative proximity of alternatives to ideal solutions in the multicriteria decision-making process (Krishnan et al., 2021; Li et al., 2023; Sahin et al., 2024). By utilizing distance information, this approach is able to give more representative weight to the importance of each criterion based on how much of a role the criteria play in distinguishing the best alternative from the others. This significantly improves the accuracy of the assessment because the weights generated are adaptive to the data, resulting in a more objective and accurate evaluation (Alamoodi et al., 2024; Yang et al., 2025). With the increasing precision of assessment, this approach is particularly relevant to be applied in a variety of decision support system contexts, especially when the differences between alternatives are very thin and require high sensitivity in weighting. In addition, the Distance-Based Weighting Approach is also able to reduce subjective bias because weights are calculated based on the real contribution of criteria to the separation of ideal and non-ideal solutions. This advantage makes this approach an effective alternative in increasing the validity of decision-making results, both in business, technical, and public policy scenarios (Xu et al., 2024).

Although the ARAS method has been widely used in various MCDM research, there are still several limitations that create research gaps. Most previous studies still rely on subjective weights from experts or conventional weighting, making them susceptible to

bias and not fully reflecting the existing data variations. The ranking results of ARAS are also known to be quite sensitive to changes in criterion weights, yet this aspect has not been extensively addressed by previous research. Furthermore, the application of ARAS is generally still limited to simple cases, while explorations in more complex contexts with varied data are still rarely conducted. As a solution to the limitations of conventional ARAS methods, this research proposes a modification by integrating a distance-based weighting approach. This approach assigns weights to criteria more objectively by considering data variations and the proximity of alternatives to the ideal solution, thereby minimizing subjective bias in the decision-making process. Furthermore, this modification is expected to enhance the stability of ranking results, reduce sensitivity to weight changes, and strengthen accuracy and fairness in evaluating alternatives. The application of ARAS combined with distance-based weighting also provides broader exploration opportunities in complex cases while maintaining the simplicity of the ARAS calculation structure.

The urgency of modifying the ARAS method by integrating a distance-based weighting approach. This approach is capable of providing more objective weights because it is based on data distribution and the proximity of alternatives to the ideal solution. This integration is expected to enhance accuracy, stability, and fairness in alternative evaluation. The urgency of this research lies in its contribution to reducing subjectivity in weighting, strengthening the validity of rankings, and providing a stronger methodological foundation for the application of ARAS in various fields. The need for modification of the ARAS Method using distance-based weighting arises in response to the weakness of conventional methods in reflecting the importance of variation between alternatives to certain criteria. In the standard ARAS method, the weight of the criteria is usually predetermined and does not consider how far an alternative is worth from the ideal solution or the worst solution. In fact, in many cases, the difference in distance between alternative values and ideal references is actually an important indicator of the influence of a criterion in the decision-making process. By applying a distance-based weighting approach, a weight that is more adaptive and sensitive to actual data can be generated. This modification allows ARAS to provide a more realistic assessment, as the weight of the criteria is calculated based on how much differentiation contribution each criterion makes in differentiating alternatives. As a result, the evaluation process becomes more dynamic, objective, and responsive to the distribution of values in the data, thereby increasing the reliability of the ARAS method in various decision-making contexts.

This study aims to modify the ARAS method by integrating a distance-based approach to improve accuracy in the alternative ranking process. This modification is focused on developing a more objective

criteria weighting mechanism by considering the distribution or variation of data between alternatives in each criterion. By adopting a distance-based approach, it is hoped that the weight generated will be able to represent the level of importance of the criteria in a more proportionate manner to their influence in the decision-making process. The final goal of this study is to produce a more accurate ARAS method, adaptive to data characteristics, and able to increase the reliability of ranking results in decision support systems. This research provides several important contributions, both from theoretical and practical sides. From a theoretical perspective, this research enriches the MCDM literature by presenting a modification of the ARAS method through the integration of a distance-based weighting approach. This modification offers a new framework for calculating criteria weights that is more objective, thus reducing the subjective bias that often occurs in conventional methods. In addition, this research also provides a methodological foundation that can serve as a reference for the development of other MCDM methods in the future.

## RESEARCH METHOD

### 1. Framework ARAS-D

The Additive Ratio Assessment Method with the Distance-Based Weighting Approach (ARAS-D) is a development of the concept of multi-criteria evaluation that combines the principle of aggregation of criterion utilities with a weighting strategy based on the relative distance between alternatives. This approach aims to produce a more accurate assessment by providing weights that reflect how much of a role each criterion plays in distinguishing the best alternatives from the others. By calculating the proximity of alternatives to ideal solutions and moving them away from anti-ideal solutions, this method is able to capture data dynamics more objectively, resulting in more precise and adaptive decisions in complex assessment contexts. The advantage of the Additive Ratio Assessment Method with the Distance-Based Weighting Approach lies in its ability to produce more objective, adaptive, and precise evaluations. This approach automatically adjusts the weight of criteria based on their contribution to the separation of alternatives, thereby reducing the influence of subjectivity in the decision-making process. Additionally, the method is effective in handling data complexity and subtle differences between alternatives, making it ideal for use in situations where assessment accuracy is critical. The integration between additive ratio assessment and distance-based weighting also allows for a more balanced and thorough analysis, as it considers both the performance value and the data distribution structure simultaneously.

The modified framework of the Additive Ratio Assessment method with a distance-based weighting approach is designed to improve

precision in the multi-criteria evaluation process by integrating the strength of additive analysis and sensitivity to data distribution. In this framework, the weight of criteria is no longer determined subjectively, but is calculated based on the relative distance between alternatives to ideal and anti-ideal solutions, so that each criterion acquires a weight proportional to its contribution in distinguishing alternative performance. This approach allows scoring systems to be more responsive to actual data dynamics, improves the objectivity of results, and provides flexibility in dealing with the complexity of decision-making. Figure 1 is a framework for modifying the ARAS method.

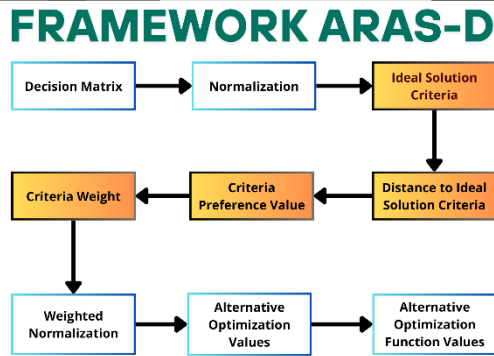


Figure 1. Framework ARAS-D

Figure 1 is the ARAS-D Framework created in this study in the development of the ARAS method in multicriteria decision-making. The description of each step in the workflow of the ARAS-D framework is as follows.

Decision matrix is the first step that presents alternative data to various criteria made using the following equation.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{n1} \\ \vdots & \ddots & \vdots \\ x_{1m} & \cdots & x_{nm} \end{bmatrix} \quad (1)$$

Normalization is the process of normalizing data so that each value is on a scale that can be compared between criteria calculated using the following equation.

$$x_{ij} = \frac{1}{x_{ij}^*} \text{ for cost criteria; } \bar{x}_{ij} = \frac{x_{ij}}{\sum_{i=0}^m x_{ij}} \quad (2)$$

The ideal solution criteria determine the ideal value for each criterion (it can be the maximum value for the profit criterion or the minimum for the cost criterion) determined using the following equation.

$$y_j^+ = \begin{cases} \max_i x_{ij}; & \text{if } j \text{ is a benefit attribute} \\ \min_i x_{ij}; & \text{if } j \text{ is a cost attribute} \end{cases} \quad (3)$$

$$y_j^- = \begin{cases} \min_i x_{ij}; & \text{if } j \text{ is a benefit attribute} \\ \max_i x_{ij}; & \text{if } j \text{ is a cost attribute} \end{cases} \quad (4)$$

The distance to ideal solution criteria measures how far each alternative of a predetermined ideal

solution is calculated using the following equation.

$$D_i^+ = \sqrt{\sum_{j=1}^n (y_i^+ - y_{ij})^2} \quad (5)$$

$$D_i^- = \sqrt{\sum_{j=1}^n (y_{ij} - y_i^-)^2} \quad (6)$$

Criteria preference value calculates the preference or relative importance to each criterion based on the distance from the ideal solution calculated using the following equation.

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (7)$$

Criteria weight determines the weight or importance of each criterion in the decision-making process.

$$w_j = \frac{V_i}{\sum_{j=1}^n V_i} \quad (8)$$

Weighted Normalization multiplies the normalization results by the weighting of the criteria to obtain a value that has taken into account relative importance calculated using the following equation.

$$d_{ij} = \bar{x}_{ij} * w_j \quad (9)$$

Alternative Optimization Values generate the aggregate value for each alternative based on the normalized and weighted values calculated using the following equation.

$$s_i = \sum_{j=1}^n d_{ij} \quad (10)$$

The final result of the ARAS-D process is calculated using the following equation.

$$K_i = \frac{s_i}{s_o} \quad (12)$$

This framework combines the advantages of the ARAS method with a distance approach to the ideal solution to produce a more accurate and objective decision-making system. Suitable for use in situations with many criteria and alternatives.

## 2. Research Stages in Selection of New Store Locations

The research stage generally consists of several systematic steps taken to achieve the research objectives. Each stage in the research process has a strategic function to ensure that research runs systematically, directed, and produces outputs that are valid, useful, and accountable both scientifically and practically. The stages of the research conducted are shown in figure 2.

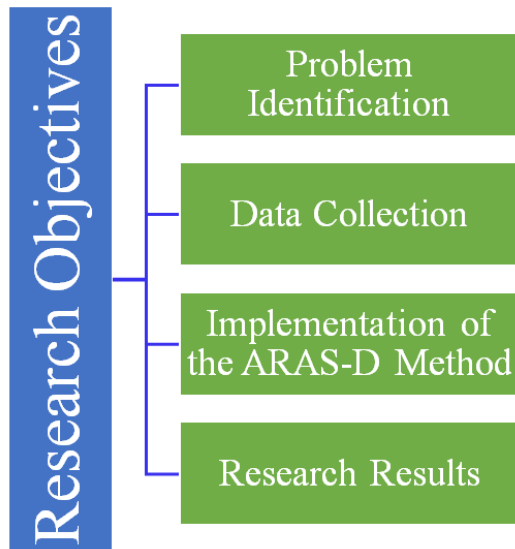


Figure 2. Research in Selection of New Store Locations

Figure 2 explains the main stages in achieving the research objectives using the ARAS-D (Additive Ratio Assessment with Distance-Based Weighting modification) method. Research begins with problem identification, which is to recognize the main issues or needs that are the basis for the research, for example problems in determining the best alternative in a multicriteria decision-making. After that, data collection was carried out which included alternative data and values from each criterion relevant to the research object. The next stage is the implementation of the ARAS-D method, where the data that has been collected will be processed using the ARAS method that has been modified with a weighting approach based on distance between alternatives to improve the accuracy of calculations. The final stage is the presentation of the research results, which is in the form of ranking alternatives, interpretation of results, and conclusions about the best alternatives based on the calculations made. These four stages are a systematic framework to achieve research goals logically and measurably.

## RESULTS AND DISCUSSION

Modification of additive ratio assessment method with distance-based weighting approach to improve rating precision is an approach developed to improve rating accuracy in multicriteria decision-making processes. This method is a modification of the additive ratio assessment (ARAS) method, which is known for its ability to evaluate various alternatives based on the total contribution to the ideal solution. In this development, ARAS was modified with Distance-Based Weighting, which is a weighting approach that calculates the weight of each criterion based on the relative distance between the alternatives to ideal and anti-ideal values. Using distance-based weighting, this method not only considers the absolute value of the alternative, but also takes into account the degree of

proximity of each alternative to the best and worst conditions. The results of this modification are expected to be able to provide a more objective, precise, and reflective ranking of complex decision-making realities in various contexts, such as business location selection, performance evaluation, or business strategy selection.

This research provides several important contributions, both from theoretical and practical sides. From a theoretical perspective, this research enriches the MCDM literature by presenting a modification of the ARAS method through the integration of a distance-based weighting approach. This modification offers a new framework for calculating criteria weights that is more objective, thus reducing the subjective bias that often occurs in conventional methods. In addition, this research also provides a methodological foundation that can serve as a reference for the development of other MCDM methods in the future. The advantages of the ARAS-D method are.

- a. More objective weighting: The distance-based weighting approach does not rely on user subjectivity (such as manual weighting), but rather calculates weights based on the actual data distribution of alternatives to ideal and non-ideal criteria.
- b. Able to overcome benefit and cost criteria simultaneously: This method supports the calculation of benefits and cost criteria without having to carry out complex transformations.
- c. Describing the total contribution to the ideal solution: Like the original ARAS method, this approach considers the total contribution of each alternative to the ideal solution, but is reinforced with more adaptive weight.
- d. Flexible and easy to integrate: These modifications can be used in a variety of data types and decision-making contexts, from business, education, healthcare, to engineering.
- e. Sensitive to variation between alternatives: Because it considers the distance to the ideal solution, this method can distinguish alternatives that are very close to each other more effectively than conventional methods.
- f. Computing-efficient: The calculation structure remains simple and does not require complex processing such as mathematical optimization, making it easy to implement with Excel or simple programs.

The selection of a new store location is a strategic decision that has a significant impact on market reach, operational efficiency, and overall profitability of the company. To ensure accurate decision-making, the MCDM method is often applied, which allows decision-makers to objectively assess the strengths and weaknesses of each location. The ARAS-D method can be used to improve the accuracy of the ranking process. This approach gives weight to criteria based on the relative distance of each alternative to the ideal solution, which ensures that the chosen location is not

only feasible but also optimal according to the business objectives set. The research follows a structured process that includes problem identification, data collection (on alternative locations and criterion values), application of decision-making models, and evaluation of results to recommend the most strategic location for the new store. This systematic approach improves the reliability of the selection process and supports better long-term investment decisions.

### 1. Problem Identification

The selection of a new store location is one of the most crucial strategic decisions for the company. Mistakes in locating can have a direct impact on sales rates, operational effectiveness, and target market achievement. The main problem that often arises is the number of alternative locations available, but each has advantages and disadvantages based on various criteria, such as traffic density, rental costs, accessibility, market potential, distance to the central warehouse, and competition around the location. In addition, decision-making often involves managerial subjectivity and does not comprehensively consider the relationship between criteria. Therefore, a method is needed that can help decision-making objectively and systematically, so that the selected

location truly supports sustainability and business growth in the future.

### 2. Data Collection

Data collection is an important stage in the process of selecting a new store location, as the quality of the data obtained will greatly affect the accuracy and validity of the final decision. At this stage, relevant information is collected related to each alternative location that is being considered. The data collected includes various assessment criteria, namely Rental Cost (S1) as a cost, Building Area (S2) as a benefit, Accessibility (S3) as a benefit, Consumer Traffic (S4) as a benefit, Parking Availability (S5) as a benefit, and Infrastructure (S6) as a benefit. Data collection techniques can be from companies that conduct new location assessments. These quantitative and qualitative data are then compiled into a structured format so that they can be used in the evaluation and calculation process with multicriteria decision-making methods. This stage serves as the basis for further calculations and analysis, and ensures that location selection decisions are made rationally and based on valid information. Table 1 is the assessment data on new location alternatives.

Table 1. New Store Location Assessment Results

Alternative	S1	S2	S3	S4	S5	S6
New Store Locations 1	45	120	8	550	10	9
New Store Locations 2	40	100	7	500	8	8
New Store Locations 3	55	150	9	600	12	9
New Store Locations 4	38	90	6	480	6	7
New Store Locations 5	60	160	8	620	15	10
New Store Locations 6	42	130	9	570	11	8
New Store Locations 7	36	110	7	510	9	7
New Store Locations 8	48	140	8	590	13	9

The data from the assessment results in table 1 is the basis for further calculation and analysis, and ensures that the location selection decision is made rationally and based on valid information.

### 3. Implementation of the ARAS-D Method

The selection of a new store location is one of the most crucial strategic decisions in the business world, as it can affect customer visit rates, operational efficiency, and business growth potential. In facing this complexity, multicriteria decision-making methods are very relevant, one of which is the ARAS-D method. This method is a development of the ARAS method that integrates the concept of distance-based weighting between criterion values, so as to increase objectivity in determining weights and produce a more accurate assessment of alternative locations. The implementation of ARAS-D in the selection of new store locations is expected to assist management in selecting the most optimal location based on quantitative and measurable analysis. The ARAS-D approach not only measures the relative performance of each alternative against

predetermined criteria, but also assigns weights adaptively based on the variation of available data. This allows this method to capture the sensitivity of each criterion to the final decision, in contrast to conventional methods that often use fixed weights. The stages of implementing the ARAS-D method are as follows.

The decision matrix is the first step in the ARAS-D method that presents alternative data based on the assessment data from table 1 against various criteria created using (1).

$$X = \begin{matrix} & \begin{matrix} C_1 & C_2 & C_3 & C_4 & C_5 & C_6 \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \\ A_6 \\ A_7 \\ A_8 \end{matrix} & \begin{bmatrix} 45 & 120 & 8 & 550 & 10 & 9 \\ 50 & 100 & 7 & 500 & 8 & 8 \\ 55 & 150 & 9 & 600 & 12 & 9 \\ 38 & 90 & 6 & 480 & 6 & 7 \\ 60 & 160 & 8 & 620 & 15 & 10 \\ 42 & 130 & 9 & 570 & 11 & 8 \\ 36 & 110 & 7 & 510 & 9 & 7 \\ 48 & 140 & 8 & 590 & 13 & 9 \end{bmatrix} \end{matrix}$$

Normalization is the second step in the ARAS-D

method of normalizing the data so that each value is on a scale that can be compared between the criteria calculated using (2).

$$x_{10} = \frac{1}{\min x_{11,19}^*} = \frac{1}{36} = 0.0278$$

$$\bar{x}_{10} = \frac{x_{10}}{\sum_{i=0}^m x_{10,18}} = \frac{0.0278}{0.2086} = 0.1332$$

The overall results of the normalization value calculation are shown in table 2.

Table 2. Normalization Values

Alternative	S1	S2	S3	S4	S5	S6
X <sub>0</sub>	0.1332	0.1379	0.1268	0.1230	0.1515	0.1299
New Store Locations 1	0.1065	0.1034	0.1127	0.1091	0.1010	0.1169
New Store Locations 2	0.1199	0.0862	0.0986	0.0992	0.0808	0.1039
New Store Locations 3	0.0872	0.1293	0.1268	0.1190	0.1212	0.1169
New Store Locations 4	0.1262	0.0776	0.0845	0.0952	0.0606	0.0909
New Store Locations 5	0.0799	0.1379	0.1127	0.1230	0.1515	0.1299
New Store Locations 6	0.1141	0.1121	0.1268	0.1131	0.1111	0.1039
New Store Locations 7	0.1332	0.0948	0.0986	0.1012	0.0909	0.0909
New Store Locations 8	0.0999	0.1207	0.1127	0.1171	0.1313	0.1169

The ideal solution criterion is the third step in the ARAS-D method to determine the ideal value for

each criterion specified using (3) and (4) shown in table 3.

Table 3. Ideal Solution

	S1	S2	S3	S4	S5	S6
Y <sup>+</sup>	0.0799	0.1379	0.1268	0.1230	0.1515	0.1299
Y <sup>-</sup>	0.1332	0.0776	0.0845	0.0952	0.0606	0.0909

The distance to the ideal solution criterion is the third step in the ARAS-D method to measure how far each predetermined ideal solution alternative is calculated using (5) and (6).

$$D_1^+ = \sqrt{\sum_{j=1}^n (y_1^+ - y_{10,18})^2} = 0.1345$$

$$D_1^- = \sqrt{\sum_{j=1}^n (y_{10,18} - y_1^-)^2} = 0.0858$$

The results of the distance calculation to the ideal solution criteria are shown in Table 4.

Table 4. Distance to Ideal Solution

	S1	S2	S3	S4	S5	S6
D <sub>i</sub> <sup>+</sup>	0.1345	0.1713	0.1415	0.1314	0.2109	0.1469
D <sub>i</sub> <sup>-</sup>	0.0858	0.1185	0.0902	0.0561	0.1752	0.0735

The criterion preference value is the fourth step in the ARAS-D method to calculate the preference or relative importance to each criterion based on the distance from the ideal solution calculated using (7).

$$V_1 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.0858}{0.0858 + 0.1345} = \frac{0.0858}{0.2202} = 0.3895$$

The results of the criterion preference value are shown in Table 5.

Table 5. Criterion Preference Value

	S1	S2	S3	S4	S5	S6
V <sub>i</sub>	0.3895	0.4089	0.3892	0.2992	0.4538	0.3333

The weight of criteria is the fifth step in the ARAS-D method to determine the weight or importance of each criterion in the decision-making process calculated using (8).

$$w_1 = \frac{V_1}{\sum_{j=1}^n V_{1,6}} = \frac{0.3895}{2.2740} = 0.1713$$

The results of the weight of criteria are shown in Table 6.

Table 6. Weight of Criteria

	S1	S2	S3	S4	S5	S6
w <sub>j</sub>	0.1713	0.1798	0.1711	0.1316	0.1996	0.1466

Weighted normalization is the sixth step in the ARAS-D method to multiply the normalization

results by the weighting criteria to obtain a value that has taken into account the relative importance

calculated using (9).

$$d_{10} = \bar{x}_{10} * w_1 = 0.1332 * 0.1713 = 0.0228$$

The results of the weighted normalization are shown in Table 7.

**Table 7. Weighted Normalization Values**

Alternative	S1	S2	S3	S4	S5	S6
X <sub>0</sub>	0.0228	0.0248	0.0217	0.0162	0.0302	0.0190
New Store Locations 1	0.0183	0.0186	0.0193	0.0144	0.0202	0.0171
New Store Locations 2	0.0205	0.0155	0.0169	0.0131	0.0161	0.0152
New Store Locations 3	0.0149	0.0233	0.0217	0.0157	0.0242	0.0171
New Store Locations 4	0.0216	0.0140	0.0145	0.0125	0.0121	0.0133
New Store Locations 5	0.0137	0.0248	0.0193	0.0162	0.0302	0.0190
New Store Locations 6	0.0196	0.0202	0.0217	0.0149	0.0222	0.0152
New Store Locations 7	0.0228	0.0171	0.0169	0.0133	0.0181	0.0133
New Store Locations 8	0.0171	0.0217	0.0193	0.0154	0.0262	0.0171

The alternative optimization value is the eighth step in the ARAS-D method to generate the aggregate value for each alternative based on the normalized and weighted values calculated using (10).

$$s_0 = \sum_{j=1}^n d_{10,60}$$

$$s_0 = 0.0228 + 0.0248 + 0.0217 + 0.0162 + 0.0302 + 0.0190$$

$$s_0 = 0.1157$$

The results of the alternative optimization value are shown in Table 8.

**Table 8. Alternative Optimization Value**

Alternative	S <sub>i</sub>
X <sub>0</sub>	0.1157
New Store Locations 1	0.0907
New Store Locations 2	0.0821
New Store Locations 3	0.0997
New Store Locations 4	0.0747
New Store Locations 5	0.1042
New Store Locations 6	0.0985
New Store Locations 7	0.0882
New Store Locations 8	0.0997

The final result of the ARAS-D process is the process of calculating the final value of each alternative calculated using (11).

$$K_1 = \frac{s_1}{s_0} = \frac{0.1157}{0.0907} = 0.7833$$

The results of the final value of each alternative are shown in Table 9.

**Table 9. Final Value Alternative**

Alternative	K <sub>i</sub>
New Store Locations 1	0.7833
New Store Locations 2	0.7093
New Store Locations 3	0.8617
New Store Locations 4	0.6450
New Store Locations 5	0.9003
New Store Locations 6	0.8507
New Store Locations 7	0.7621
New Store Locations 8	0.8615

The final result of the application of the ARAS-D method in the selection of new store locations is in the form of the final value of each alternative location, which reflects how close the performance

of the alternative is to the optimal (ideal) solution.

#### 4. Research Results

The results from the implementation of the ARAS-D method in the case study of the selection of new store locations, the results were obtained that each alternative location has a different level of utility, depending on its performance against six predetermined criteria, namely rental costs, building area, accessibility, consumer traffic, parking availability, and infrastructure. Using distance-based normalization and weighting, this method is able to objectively identify the weight of criteria based on data variations, so that the resulting rankings better reflect actual conditions. The results of the alternative ranking are shown in figure 3.

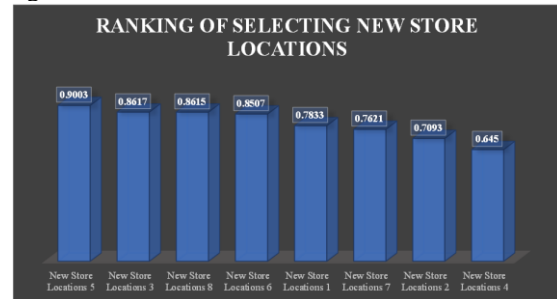


Figure 2. Research in Selection of New Store Locations

The results of the ranking graph in figure 3 show that of the eight alternative new store locations analyzed using the ARAS-D method, New Store Location 5 obtained the highest score with a value of 0.9083, indicating that this location is the most optimal choice overall. This is followed by New Store Location 3 with a value of 0.8617 and New Store Location 1 with a value of 0.8415, which also shows excellent performance against the criteria that have been set. Meanwhile, New Store Location 4 is at the bottom with a value of 0.6445, indicating that this location has the lowest performance and is furthest from the ideal solution. The difference in values between locations provides a clear picture of the relative advantages of each alternative. With these results, the management can be more confident in choosing the best location based on an

objective and measurable analytical approach.

## CONCLUSION

This study modified the Additive Ratio Assessment (ARAS) method with a distance-based weighting approach called ARAS-D which is able to increase rating precision in multi-criteria decision-making. This approach makes a significant contribution to determining the weight of criteria more objectively, as it takes into account the variation and spread of the value of each alternative to each criterion. Thus, the proposed method is more sensitive to differences in performance between alternatives. In the selection of new store locations, the ARAS-D method produces ratings that are not only accurate but also representative of real conditions. Alternatives with better performance on benefit criteria such as building size, accessibility, and consumer traffic, as well as having competitive rental costs, can be identified more precisely. The results of the analysis also show that this

approach is able to reduce the bias in weight determination that is often found in conventional methods. The results of the New Store Location 5 alternative rating obtained the highest score with a value of 0.9083, indicating that this location is the most optimal choice overall. This is followed by New Store Location 3 with a value of 0.8617 and New Store Location 1 with a value of 0.8415, which also shows excellent performance against the criteria that have been set.

Overall, ARAS-D is an effective, adaptive, and reliable method of supporting data-driven decision-making, especially in issues that involve multiple criteria and require precision in the final ranking. This method has great potential to be applied in various fields such as location selection, supplier evaluation, project selection, and other strategic planning.

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