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Implementation of Entropy and Additive Ratio Assessment Methods in Determining the Best Warehouse Location

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Abstract−The main problems in determining warehouse location include high operational costs, inadequate accessibility and infrastructure, and strict and complex local regulations. In addition, environmental risks and natural disasters, as well as economic fluctuations and market dynamics also add to the challenge of choosing an optimal location. The purpose of this study is to apply the Entropy and ARAS methods in evaluating the potential of optimal warehouse locations, thereby providing clear and structured guidance for decision-makers in choosing the optimal warehouse location to meet the company's operational and strategic needs. The implementation of the entropy and ARAS methods in determining the best warehouse location involves a systematic approach in evaluating several criteria that are important for optimal decision-making. The Entropy method helps in objectively assessing the importance of each criterion by quantifying the uncertainty or variation present in the data. The ARAS method complements this by allowing comparative analysis of alternative warehouse locations based on their performance against ideal criteria, taking into account both quantitative and qualitative aspects. Thus, both methods provide a solid framework for selecting warehouse locations that not only meet logistics requirements efficiently but are also in line with strategic business objectives, ensuring a well-informed decision-making process in supply chain management and logistics. The results of the ranking of the best warehouse location selection using the entropy and ARAS methods show AB Location as the first rank with a value of 0.9781, DD Location as the second place with a value of 0.8362, and IP Location as the third place with a value of 0.8143.

Keywords: ARAS Method; Determining; Entropy; Location; Warehouse

1. INTRODUCTION

Determining the location of a new warehouse is a very important strategic decision in supply chain management, which has a direct impact on operational efficiency and customer satisfaction. The main factors to consider in selecting this location include proximity to the source of raw materials, accessibility to major transportation networks such as highways, railways, and ports, and proximity to key markets to minimize distribution time and costs. In addition, aspects of operational costs, including land or building rent, labor costs, and local taxes, must also be taken into account. Environmental factors such as natural disaster risk and local zoning regulations also need to be evaluated. By comprehensively considering these factors, companies can choose the optimal warehouse location to support the long-term growth and sustainability of their operations.

The main problems in determining warehouse location include high operational costs, inadequate accessibility and infrastructure, and strict and complex local regulations. In addition, environmental risks and natural disasters, as well as economic fluctuations and market dynamics also add to the challenge of choosing an optimal location. Determining the optimal warehouse location is very important for companies because it has a direct impact on operational efficiency, logistics costs, and customer satisfaction. Research in determining the best warehouse location is necessary to consider various factors such as accessibility, land cost, proximity to suppliers and customers, and supporting infrastructure. The solution for selecting the best warehouse location using a decision support system (DSS) involves an in-depth and structured analysis of various important factors. DSS collects and processes data from various sources, then uses mathematical models and simulations to evaluate each potential location based on predetermined criteria. By presenting the results of the analysis in an easy-to-understand form, such as interactive graphs and maps, DSS helps decision-makers comprehensively compare alternative locations. The implementation of DSS ensures that the selection of warehouse locations is carried out efficiently, accurately, and based on accurate data, thereby minimizing risks and maximizing operational efficiency.

The Additive Ratio Assessment (ARAS) method is one of the techniques in multi-criteria decision-making used to evaluate and select the best alternative based on a number of predetermined criteria[1]–[3]. This method involves the process of determining the relative value of each alternative through the comparison of additives between the desired criterion value and the existing criterion value of the alternative. In its application, each alternative is assessed based on its additional ratio to the ideal criteria, which is then summed to obtain a total score. This score is used to sort and determine the best alternative. The advantages of the ARAS method lie in its simplicity in calculations and its ability to handle qualitative and quantitative data, so it is often used in various fields, including management, engineering, and economics for more objective and accurate decision-making[4], [5].

ARAS not only improves objectivity in alternative assessments, but also helps in producing more optimal and thoroughly informed solutions. One of the main drawbacks of the Additive Ratio Assessment (ARAS) method lies in its sensitivity to the weight of the set criteria. When the criteria weights are not selected correctly or do not reflect the importance of each criterion proportionally, the results of the ARAS evaluation can become biased or inaccurate. In addition, the determination of the weighting of criteria that are subjective or not based on a robust analysis can lead to inconsistent or unstable judgments of the alternatives being evaluated. This demonstrates the importance of the ARAS method to engage experienced decision-makers and obtain extensive input from stakeholders to ensure the weights of the criteria applied reflect exactly the desired priorities of each criterion in the specific decision-making context.

The entropy method is an analytical tool that is useful in complex multi-criteria decision-making[6]–[8]. The main concept of this method is to measure the degree of uncertainty or diversity in the data criteria used to evaluate alternatives. In the context of decision-making, entropy is used to identify the most important or significant criteria, as well as to assess the degree of consistency or inconsistency in a decision-maker's preferences. The entropy method makes it possible to calculate the entropy of each criterion and select alternatives that have higher consistency based on the lower entropy[9]–[11].

The main advantage of this method is its ability to overcome uncertainty and subjectivity in decision-making, as well as provide valuable information in determining the relative weight of each criterion used. However, the use of entropy methods also requires a good understanding of the interpretation of outcomes and careful adjustment to the specific context of each decision-making situation. One of the main advantages of the entropy method in determining the weighting of criteria is its ability to provide an objective measure of the importance of each criterion in multi-criteria decision-making. Entropy helps identify the criteria that are most significant or have a substantial effect on the final outcome of the evaluation.

By calculating the entropy of each criterion, this method makes it possible to determine a proportional weight based on the degree of variability or diversity of information that each criterion has[12], [13]. This not only increases transparency in the decision-making process, but also helps reduce subjectivity in setting criteria weights, as the resulting weights are based on mathematical analysis of existing data. Thus, the entropy method provides a more scientific and structured approach in setting criteria priorities, thus reinforcing the decisions taken.

Research related to the determination of new warehouse locations was carried out, among others, by Wahyudi (2024) Recommendations for new warehouse placement can be generated by integrating the TOPSIS and PIPRECIA methods, the results of alternative rankings provide recommendations in the selection of new warehouse locations, namely the first rank with a value of 0.8223[14]. Research from Azis (2023) The results of this study show that the city of Tarakan is the most appropriate location to be used as the best warehouse location that will be used as a warehouse using the Weight Product Method[15]. Research from Prayoga (2023) This research starts from collecting data related to the selection of warehouse locations, then related to data analysis using the Vikor method to help business people in determining strategic warehouse locations[16].

Research from Naibaho (2021) This study aims to determine the location of transit warehouses using the Simple Additive Weight method and the Weight Aggregated Sum Product Assessment method. The results of the calculation of the weight of the criteria produce a choice that can help the management of PT. TG in making decisions on the location of transit warehouses[17]. The difference with previous research that has been carried out in this study is that the entropy weighting method is applied to produce a subjective weight of criteria from the assessment data that has been carried out. The Decision Support System (DSS) is the right tool to solve this problem because it can process complex data and provide in-depth analysis through mathematical models and simulations. DSS assists decision-makers by providing a variety of scenarios and solutions generated from real-time and historical data, thereby minimizing risk and improving accuracy in warehouse location selection.

The implementation of the entropy and ARAS methods in determining the best warehouse location involves a systematic approach in evaluating several criteria that are important for optimal decision-making. The Entropy method helps in objectively assessing the importance of each criterion by quantifying the uncertainty or variation present in the data. The ARAS method complements this by allowing comparative analysis of alternative warehouse locations based on their performance against ideal criteria, taking into account both quantitative and qualitative aspects. Thus, both methods provide a solid framework for selecting warehouse locations that not only meet logistics requirements efficiently but are also in line with strategic business objectives, ensuring a well-informed decision-making process in supply chain management and logistics.

The purpose of this study is to apply the Entropy and ARAS methods in evaluating the potential of optimal warehouse locations, thereby providing clear and structured guidance for decision-makers in choosing the optimal warehouse location to meet the company's operational and strategic needs.

2. RESEARCH METHODOLOGY

2.1 Research Stages

Research stages are systematic steps taken to answer research questions or achieve predetermined goals[18]. The main objective of this stage is to ensure that the research is carried out with valid and reliable methods, so that the results are accurate and trustworthy[19], [20]. This stage includes the identification of research problems or questions, literature review, hypothesis formulation, research planning and implementation, data analysis, to the presentation of results and conclusions. By following these stages, researchers can avoid bias, ensure that research can be replicated by others, and make a significant contribution to knowledge in the field being studied. Figure 1 is the research stage carried out in determining the best warehouse location.

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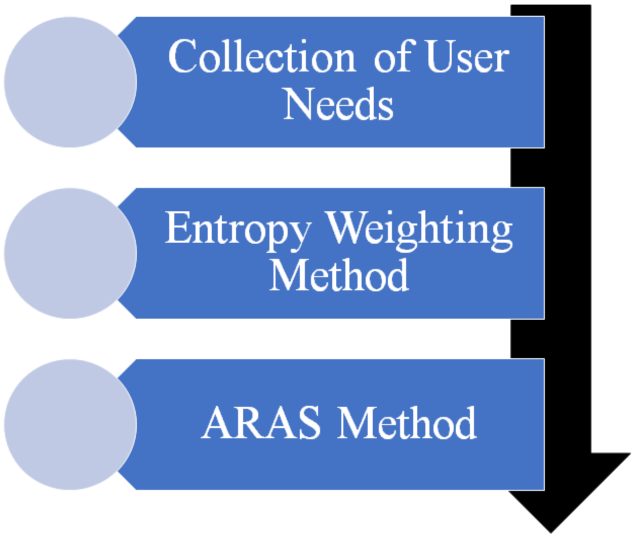

Figure 1. Research Stage

The research stage figure 1 is the stage of research carried out, User Needs Collection is an early stage in the product or service development process, where information about user needs and preferences is collected through various methods such as surveys, interviews, and observations. The Entropy Weighting Method is used to determine the relative weights of various criteria evaluated in a decision by measuring the degree of uncertainty or variation in the data; The higher the variation, the lower the weight of the criterion. The ARAS method is a multi-criteria decision-making technique that evaluates multiple alternatives based on various criteria that have been weighted, by converting the criterion values into utility values that can be summed to determine the final rating of each alternative. The combination of these three methods allows for more objective and informed judgments in the decision-making process, ensuring that the choices made are tailored to the user's needs and are based on robust data analysis.

2.2 Collection of User Needs

User needs collection is a critical process in the development of a product or service that aims to deeply understand what the end user wants and needs[21]–[23]. This process involves various methods such as interviews, surveys, focus group discussions, and direct observation to collect qualitative and quantitative data about user preferences, problems, and expectations. The information obtained is then analyzed to identify relevant patterns and trends, which will be the basis for designing effective and satisfactory solutions for users. By comprehensively understanding user needs, developers can create products or services that not only meet expectations, but also provide significant added value, increasing user satisfaction and loyalty. This process ensures that decisions are based on comprehensive analysis and accurate data, optimizing warehouse locations to support efficient operations and reduce logistics costs.

2.3 Entropy Weighting Method

The entropy weighting method is an analytical technique used to determine the relative weights of various criteria in the decision-making process, based on the degree of variation or uncertainty in the data. The basic principle of this method is that the greater the variation in the data of a criterion, the higher the information provided by the criterion, and vice versa. A decision matrix is a tool used in the decision-making process to evaluate various alternatives based on several criteria. This decision matrix in organizing and analyzing the data, making it easier to determine the best alternative. The decision matrix is made using equation (1).

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \tag{1}$$

Matrix normalization is an important step in the entropy weighting method that aims to convert the initial values in the decision matrix into a form that can be directly compared. Matrix normalization is made using equation (2).

$$k_{ij} = \frac{x_{ij}}{\sum_{j=1}^{n} x_{ij}} \tag{2}$$

The value of entropy is an important concept in information theory and statistics, which measures the degree of uncertainty or surprise of a data or probability distribution. The entropy value is calculated using equation (3).

$$E_j = \left[\frac{-1}{\ln m}\right] \sum_{j=1}^{n} \left[k_{ij} * \ln k_{ij}\right] \tag{3}$$

The degree of diversity is a measure of the degree of data variation in each criterion. The degree of diversity is calculated using equation (4).

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$$D_j = 1 - E_j \quad (4)$$

The relative weight of the criteria shows the relative contribution of each criterion to the overall decision-making. The relative weights of the criteria are calculated using equation (5).

$$w_j = \frac{D_j}{\sum D_j} \quad (5)$$

The entropy method not only provides a systematic and mathematical approach to determining the weight of criteria, but also presents advantages in terms of objectivity, flexibility, and the ability to handle complex variations of information in multi-criteria decision-making.

2.4 ARAS Method

The ARAS (Additive Ratio Assessment) method is one of the methods used in multi-criteria decision-making to evaluate alternatives based on predetermined criteria. This method is based on a pair comparison approach, where each alternative is assessed relative to the existing criteria. Matrix normalization aims to convert the initial values in the decision matrix into a form that can be directly compared. The normalization of the matrix was made using equation (6) for the benefit criterion, and equation (7) for the cost criterion.

$$r_{ij} = \frac{x_{ij}}{\sum_{j=1}^{n} x_{ij}} \quad (6)$$

$$r_{ij} = \frac{1}{x_{ij}};\ x_{ij} = \frac{x_{ij}}{\sum_{j=1}^{n} x_{ij}} \quad (7)$$

The normalized matrix weights provide a systematic guide to determine the relative weights of criteria in multi-criteria decision-making using the ARAS method. This process ensures that decisions made based on evaluations are objective and measurable. The normalized matrix weights are calculated using equation (8).

$$d_{ij} = w_j * r_{ij} \quad (8)$$

Optimization value refers to the decision-making process that produces the best alternative based on predetermined criteria. The optimization value is calculated using equation (9)

$$S_i = \sum_{j=1}^{n} d_{ij} \quad (9)$$

The final score of the alternative is the result of a multi-criteria evaluation process carried out to determine the best alternative. This score is then used to calculate the final score or optimization value of each alternative. The final value of the alternative is calculated using equation (10).

$$K_i = \frac{S_i}{S_0} \quad (10)$$

The final result in the ARAS method is an alternative that gets the highest final score after going through a multi-criteria evaluation process. The ARAS method uses a pair comparison approach to evaluate alternatives based on pre-established criteria.

3. RESULT AND DISCUSSION

The implementation of entropy and ARAS methods in determining the best warehouse location involves a systematic approach to evaluating various criteria and making decisions based on objective analysis. The entropy method is used to assess the diversity and variation of the criteria. By calculating the entropy for each criterion, the method identifies criteria that have high variation, indicating a greater degree of uncertainty or diversity of data. The ARAS method is applied to rank potential warehouse locations based on normalized scores from paired comparisons of each location against predetermined criteria. This method ensures that subjective preferences and objective data are considered, providing a balanced evaluation framework. By integrating these two methods, decision-makers can assign weights to each criterion based on its entropy value, thus prioritizing criteria with lower entropy (which indicates higher certainty or uniformity). ARAS then facilitates alternative ranking of warehouse locations, taking into account the relative importance of each criterion to determine the optimal location. The joint use of entropy and ARAS methods offers several advantages, including objectivity in decision-making, consideration of various criteria, and a structured approach to evaluating diverse alternatives. This approach ensures that the chosen warehouse location is in line with strategic objectives, while minimizing risk and maximizing efficiency in logistics and supply chain operations.

3.1 Collection of User Needs

User demand collection is a critical stage in the development of a product or service that aims to deeply understand what the end user wants or needs. This process involves gathering information from a variety of sources, including interviews with potential users, direct observations, surveys, and analysis of historical data. The goal is to identify the problems that users face, their desires, user preferences, and expectations regarding the product or service to be developed. By

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understanding user needs well, development teams can design relevant and effective solutions, minimize the risk of product failure, and ultimately improve user satisfaction. This stage also helps ensure that the development of the product or service focuses on solving the actual problems faced by users, rather than just based on the company's internal assumptions or preferences. Table 1 is assessment data based on the collection of natural user needs for the selection of the best warehouse location.

Table 1. Best Warehouse Location Assessment Data Based on User Needs Collection

Location Name	Operational Costs	Transportation Accessibility	Capacity and Size	Infrastructure	Security
AB Location	120	5	5	5	4
DF Location	175	3	4	4	5
RY Location	155	4	3	5	4
WH Location	145	4	3	4	5
IP Location	160	4	4	5	4
GY Location	180	5	3	4	5
DD Location	160	4	4	5	5

The assessment data obtained in table 1 will be used in the selection of the best warehouse location in this study.

3.2 Determining the Weight of Criteria Using the Entropy Method

Determining the weight of criteria using the entropy method involves steps to measure the degree of variation or uncertainty of each relevant criterion in a decision-making. This decision matrix in organizing and analyzing the data, making it easier to determine the best alternative. The decision matrix is made using equation (1).

$$X = \begin{bmatrix} 120 & 5 & 5 & 5 & 4 \\ 175 & 3 & 4 & 4 & 5 \\ 155 & 4 & 3 & 5 & 4 \\ 145 & 4 & 3 & 4 & 5 \\ 160 & 4 & 4 & 5 & 4 \\ 180 & 5 & 3 & 4 & 5 \\ 160 & 4 & 4 & 5 & 5 \end{bmatrix}$$

Matrix normalization is an important step in the entropy weighting method that aims to convert the initial values in the decision matrix into a form that can be directly compared. Matrix normalization is made using equation (2).

$$k_{11} = \frac{x_{11}}{\sum_{j=1}^{n} x_{11,17}} = \frac{120}{1095} = \frac{120}{1095}$$

Table 2 is the result of the overall normalization calculation for each alternative and criteria.

Table 2. Normalization Matrix

Location Name	Operational Costs	Transportation Accessibility	Capacity and Size	Infrastructure	Security
AB Location	0.1096	0.1724	0.1923	0.1563	0.1250
DF Location	0.1598	0.1034	0.1538	0.1250	0.1563
RY Location	0.1416	0.1379	0.1154	0.1563	0.1250
WH Location	0.1324	0.1379	0.1154	0.1250	0.1563
IP Location	0.1461	0.1379	0.1538	0.1563	0.1250
GY Location	0.1644	0.1724	0.1154	0.1250	0.1563
DD Location	0.1461	0.1379	0.1538	0.1563	0.1563

The value of entropy is an important concept in information theory and statistics, which measures the degree of uncertainty or surprise of a data or probability distribution. The entropy value is calculated using equation (3).

$$E_1 = \left[\frac{-1}{\ln 7}\right] \sum_{j=1}^{n} \left[k_{11;17} * \ln k_{11;17}\right] = \left[\frac{-1}{\ln 7}\right] - 1.9387 = 0.9963$$

$$E_2 = \left[\frac{-1}{\ln 7}\right] \sum_{j=1}^{n} \left[k_{21;27} * \ln k_{21;27}\right] = \left[\frac{-1}{\ln 7}\right] - 1.9338 = 0.9938$$

$$E_3 = \left[\frac{-1}{\ln 7}\right] \sum_{j=1}^{n} \left[k_{31;37} * \ln k_{31;37}\right] = \left[\frac{-1}{\ln 7}\right] - 1.9285 = 0.9910$$

$$E_4 = \left[\frac{-1}{\ln 7}\right] \sum_{j=1}^{n} \left[k_{41;47} * \ln k_{41;47}\right] = \left[\frac{-1}{\ln 7}\right] - 1.9400 = 0.9970$$

$$E_5 = \left[\frac{-1}{\ln 7}\right] \sum_{j=1}^{n} \left[k_{51;57} * \ln k_{51;57}\right] = \left[\frac{-1}{\ln 7}\right] - 1.9400 = 0.9970$$

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The degree of diversity is a measure of the degree of data variation in each criterion. The degree of diversity is calculated using equation (4).

$D_1 = 1 - E_1 = 1 - 0.9963 = 0.0037$
$D_2 = 1 - E_2 = 1 - 0.9938 = 0.0062$
$D_3 = 1 - E_3 = 1 - 0.9910 = 0.0090$
$D_4 = 1 - E_4 = 1 - 0.9970 = 0.0030$
$D_5 = 1 - E_5 = 1 - 0.9970 = 0.0030$

The relative weight of the criteria shows the relative contribution of each criterion to the overall decision-making. The relative weights of the criteria are calculated using equation (5).

$$w_1 = \frac{D_1}{\sum D_{1;5}} = \frac{0.0037}{0.025} = 0.1482$$
$$w_2 = \frac{D_2}{\sum D_{1;5}} = \frac{0.0062}{0.025} = 0.2489$$
$$w_3 = \frac{D_3}{\sum D_{1;5}} = \frac{0.0090}{0.025} = 0.3855$$
$$w_4 = \frac{D_4}{\sum D_{1;5}} = \frac{0.0030}{0.025} = 0.1221$$
$$w_5 = \frac{D_5}{\sum D_{1;5}} = \frac{0.0030}{0.025} = 0.1221$$

The final result of the criterion weight using the entropy method is the result of objective weight determination based on assessment data from the location of the warehouse selection that has been carried out.

3.3 Choosing the Best Warehouse Location Using the ARAS Method

Selecting the best warehouse locations using the ARAS method involves a systematic approach to evaluating various criteria and ranking potential locations based on their performance against these criteria. The ARAS method is particularly effective in multi-criteria decision-making scenarios where the importance of each criterion may vary, and objective measurement preferences. The ARAS method provides a structured and transparent framework for choosing the best warehouse location with a balance between quantitative data and qualitative insights. It allows decision-makers to effectively prioritize criteria and make informed decisions to optimize logistics efficiency and achieve business goals.
The normalization of the matrix was made using equation (6) for the benefit criterion, and equation (7) for the cost criterion.

$$x_{10} = \frac{1}{x_{10}} = \frac{1}{120} = 0.0083$$
$$r_{10} = \frac{1}{x_{10;17}} = \frac{0.0083}{0.0538} = 0.1549$$

Table 3 is the result of the overall normalization calculation for each alternative and criteria.

Table 3. Normalization Matrix

Location Name	Operational Costs	Transportation Accessibility	Capacity and Size	Infrastructure	Security
	0.1549	0.1471	0.1613	0.1351	0.1351
AB Location	0.1549	0.1471	0.1613	0.1351	0.1081
DF Location	0.1062	0.0882	0.1290	0.1081	0.1351
RY Location	0.1200	0.1176	0.0968	0.1351	0.1081
WH Location	0.1282	0.1176	0.0968	0.1081	0.1351
IP Location	0.1162	0.1176	0.1290	0.1351	0.1081
GY Location	0.1033	0.1471	0.0968	0.1081	0.1351
DD Location	0.1162	0.1176	0.1290	0.1351	0.1351

The normalized matrix weights provide a systematic guide to determine the relative weights of criteria in multi-criteria decision-making using the ARAS method. This process ensures that decisions made based on evaluations are objective and measurable. The normalized matrix weights are calculated using equation (8).

$$d_{10} = w_1 * r_{10} = 0.2489 * 0.1549 = 0.0230$$

Table 4 is the result of the overall normalized matrix weights for each alternative and criteria.

Table 4. Normalized Matrix Weights

Location Name	Operational Costs	Transportation Accessibility	Capacity and Size	Infrastructure	Security
	0.0230	0.0366	0.0579	0.0165	0.0165

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Location Name	Operational Costs	Transportation Accessibility	Capacity and Size	Infrastructure	Security
AB Location	0.0230	0.0366	0.0579	0.0165	0.0132
DF Location	0.0157	0.0220	0.0463	0.0132	0.0165
RY Location	0.0178	0.0293	0.0347	0.0165	0.0132
WH Location	0.0190	0.0293	0.0347	0.0132	0.0165
IP Location	0.0172	0.0293	0.0463	0.0165	0.0132
GY Location	0.0153	0.0366	0.0347	0.0132	0.0165
DD Location	0.0172	0.0293	0.0463	0.0165	0.0165

Optimization value refers to the decision-making process that produces the best alternative based on predetermined criteria. The optimization value is calculated using equation (9)

$S_0 = d_{10} + d_{20} + d_{30} + d_{40} + d_{50}$
$S_0 = 0.0230 + 0.0366 + 0.0579 + 0.0165 + 0.0165$
$S_0 = 0.1504$
$S_1 = d_{11} + d_{21} + d_{31} + d_{41} + d_{51}$
$S_1 = 0.0230 + 0.0366 + 0.0579 + 0.0165 + 0.0132$
$S_1 = 0.1471$
$S_2 = d_{12} + d_{22} + d_{32} + d_{42} + d_{52}$
$S_2 = 0.0157 + 0.0220 + 0.0463 + 0.0132 + 0.0165$
$S_2 = 0.1137$
$S_3 = d_{13} + d_{23} + d_{33} + d_{43} + d_{53}$
$S_3 = 0.0178 + 0.0293 + 0.0347 + 0.0165 + 0.0132$
$S_3 = 0.1115$
$S_4 = d_{14} + d_{24} + d_{34} + d_{44} + d_{54}$
$S_4 = 0.0190 + 0.0293 + 0.0347 + 0.0132 + 0.0165$
$S_4 = 0.1127$
$S_5 = d_{15} + d_{25} + d_{35} + d_{45} + d_{55}$
$S_5 = 0.0172 + 0.0293 + 0.0463 + 0.0165 + 0.0132$
$S_5 = 0.1225$
$S_6 = d_{16} + d_{26} + d_{36} + d_{46} + d_{56}$
$S_6 = 0.0153 + 0.0366 + 0.0347 + 0.0132 + 0.0165$
$S_6 = 0.1163$
$S_7 = d_{17} + d_{27} + d_{37} + d_{47} + d_{57}$
$S_7 = 0.0172 + 0.0293 + 0.0463 + 0.0165 + 0.0165$
$S_7 = 0.1258$

The final score of the alternative is the result of a multi-criteria evaluation process carried out to determine the best alternative. This score is then used to calculate the final score or optimization value of each alternative. The final value of the alternative is calculated using equation (10).

$$K_1 = \frac{S_1}{S_0} = \frac{0.1471}{0.1504} = 0.9781$$
$$K_2 = \frac{S_2}{S_0} = \frac{0.1137}{0.1504} = 0.7558$$
$$K_3 = \frac{S_3}{S_0} = \frac{0.1115}{0.1504} = 0.7411$$
$$K_4 = \frac{S_4}{S_0} = \frac{0.1127}{0.1504} = 0.7492$$
$$K_5 = \frac{S_5}{S_0} = \frac{0.1225}{0.1504} = 0.8143$$
$$K_6 = \frac{S_6}{S_0} = \frac{0.1163}{0.1504} = 0.7733$$
$$K_7 = \frac{S_7}{S_0} = \frac{0.1285}{0.1504} = 0.8362$$

Ranking in the selection of the best warehouse location involves evaluation and comparison between several locations based on predetermined criteria. This process aims to determine the location that best suits the company's needs and goals in terms of operational efficiency and service to customers. Ranking in selecting the best warehouse locations allows companies to make informed and strategic decisions based on an in-depth analysis of a variety of critical factors, thereby maximizing operational efficiency and customer satisfaction in their supply chain. Figure 2 is the ranking result in selecting the best warehouse location.

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Figure 2. The Ranking Result in Selecting the Best Warehouse Location

The results of the ranking of the best warehouse location selection using the entropy and ARAS methods show AB Location as the first rank with a value of 0.9781, DD Location as the second place with a value of 0.8362, and IP Location as the third place with a value of 0.8143.

4. CONCLUSION

The implementation of the entropy and ARAS methods in determining the best warehouse location involves a systematic approach in evaluating several criteria that are important for optimal decision-making. The Entropy method helps in objectively assessing the importance of each criterion by quantifying the uncertainty or variation present in the data. The ARAS method complements this by allowing comparative analysis of alternative warehouse locations based on their performance against ideal criteria, taking into account both quantitative and qualitative aspects. The implementation of the entropy and ARAS methods in determining the best warehouse location involves a systematic approach in evaluating several criteria that are important for optimal decision-making. The Entropy method helps in objectively assessing the importance of each criterion by quantifying the uncertainty or variation present in the data. The ARAS method complements this by allowing comparative analysis of alternative warehouse locations based on their performance against ideal criteria, taking into account both quantitative and qualitative aspects. The results of the ranking of the best warehouse location selection using the entropy and ARAS methods show AB Location as the first rank with a value of 0.9781, DD Location as the second place with a value of 0.8362, and IP Location as the third place with a value of 0.8143.

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