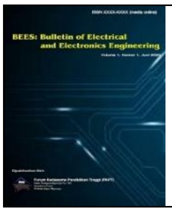

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Comparative Analysis of the Combination of MOORA and GRA with PIPRECIA Weighting in the Selection of Warehouse Heads

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A B S T R A C T

The Head of Warehouse has the main responsibility to manage and supervise the daily operations of the warehouse, including receiving, storing, and dispensing goods. In addition, the warehouse head is responsible for leading the warehouse staff team, providing the necessary direction, training, and supervision to ensure efficiency and safety in warehouse operations. This study aims to select warehouse heads by applying a combination of MOORA and PIPRECIA methods, as well as GRA and PIPRECIA. The combination of MOORA and PIPRECIA as well as GRA and PIPRECIA will be compared based on the final ranking of the two methods used. Based on the ranking results on the MOORA Method, the highest value with a value of 0.40017 was obtained by FHY with rank 1, a value of 0.36637 was obtained by AGL with rank 2, and a value of 0.35721 was obtained by YLS with rank 3 Based on the rating results on the GRA Method, the highest value with a value of 0.12164 was obtained by AGL with rank 1, a value of 0.12017 was obtained by FHY with rank 2, and a value of 0.1054 obtained by TAN with rank 3. Ranking differences between Multi-Method Objective Optimization by Ratio Analysis (MOORA) and Gray Relational Analysis (GRA) can arise due to differences in approaches in evaluating and comparing alternatives. The results of the conformity test can be concluded in the selection of warehouse heads who recommend the GRA method compared to the MOORA method, because the results of the conformity level of the GRA method get a value of 99.99919% higher than the MOORA method.

Keywords: Combination; Comparison; GRA; MOORA; PIPRECIA

1. INTRODUCTION

The Head of Warehouse has the main responsibility to manage and supervise the daily operations of the warehouse, including receiving, storing, and dispensing goods. In addition, the warehouse head is responsible for leading the warehouse staff team, providing the necessary direction, training, and supervision to ensure efficiency and safety in warehouse operations. In addition, the warehouse head must also collaborate with other departments, such as logistics, production, and delivery, to ensure a smooth and effective work flow[1]. By combining leadership skills, logistical knowledge, and strong organizational capabilities, warehouse heads play an important role in maintaining smooth supply chain operations and ensuring customer satisfaction. Selection of warehouse heads is an important process in ensuring the successful operation of a warehouse. In this process, the company conducts a thorough assessment of candidates who have strong leadership skills, in-depth knowledge of logistics management, and relevant experience in related industries. By ensuring that the selected warehouse head has the appropriate qualifications and skills, the company can ensure the smooth operation of the warehouse and support the overall success of the supply chain. In the warehouse head selection process, several potential problems may arise that may hinder the search for ideal candidates[2]. One of the main problems is the lack of candidates who meet all the desired criteria, especially in terms of the combination of leadership skills, logistical knowledge, and relevant industry experience. In the face of these issues, companies need to conduct an in-depth evaluation of their needs, conduct an effective hiring strategy, and ensure that the selection process takes place transparently and objectively to minimize risks and find candidates that best fit the needs and goals of the organization.

Research related to the selection of warehouse heads conducted by Satria (2023) the ranking results of the Visekriterijumsko Compromise Rangiranje (VIKOR) method in the selection of Warehouse Heads showed that the first rank with a final value of 0.045 was obtained by Candidate E[3]. Research conducted by Abdullah (2023) in recruiting warehouse heads by applying the MAUT method with ROC weighting with the best alternative decision results[4]. The research conducted by Azhari (2023) selects workers who are suitable to occupy the position of Head of Warehouse using a combination of ROC and ARAS methods and produces a Head of Warehouse who can manage the warehouse well[5]. Research conducted by Westi (2022) determines the Head of Warehouse using the WASPAS method so that it can provide problem-solving and communication skills for problems with semi-structured and unstructured conditions[6]. Previous research discussing warehouse head selection used a decision support system model to determine the selection process carried out.

Decision Support System (DSS) is an information system designed to assist decision making in complex and data-based situations[7], [8]. DSS also allows decision makers to combine various factors and criteria in the decision-making process, thus gaining a more holistic and in-depth understanding of the situation at hand. With its ability to model alternative scenarios and analyze the consequences of each decision, DSS gives users the ability to simulate and experiment virtually before making a final decision[9], [10]. This not only reduces the risks associated with the decisions made, but also provides an opportunity to understand the implications of each option available. By utilizing information technology and data analysis techniques, DSS is able to integrate various sources of information, analyze them quickly, and provide recommendations or measurable solutions. DSS can be used in areas ranging from business and management, to social sciences and medicine, to help users navigate complex challenges and make better decisions[11], [12]. By providing quick and precise access to relevant information, and applying sophisticated analytical techniques, DSS helps increase efficiency, increase productivity, and reduce the risk of errors in decision making. The research was conducted using Multi-Objective Optimization by Ratio Analysis and Grey Relational Analysis methods in the warehouse head selection process. Selection of warehouse head selection using a decision support system (DSS) is very important in dealing with the complexity and variety of factors that need to be considered. DSS allows stakeholders to systematically integrate data, criteria, and preferences to select candidates that best fit the organization's needs and goals. By utilizing proper analysis and modeling techniques, DSS can help in assessing a candidate's performance and potential based on various factors such as experience, skills, leadership, and industry knowledge. In addition, DSS is also able to provide a structured framework to facilitate discussion and consensus among stakeholders involved in the selection process. Thus, the use of DSS in the selection of warehouse heads not only increases the accuracy and objectivity of decisions, but also speeds up and improves the overall selection process, providing long-term benefits for the efficiency and success of the organization.

The Multi-Objective Optimization by Ratio Analysis (MOORA) method is a powerful approach to complex and multi-criteria decision making. In MOORA, each relevant criterion is weighted and normalized for each alternative evaluated. Then, a comparison of the ratio between the best and worst solutions for each criterion is used to generate a relative ranking of each alternative[13], [14]. MOORA allows decision makers to evaluate alternatives holistically, integrating diverse preferences and interests in a single decision. MOORA provides a robust and systematic framework for dealing with complex decision-making problems in a variety of contexts, from business to social sciences. MOORA becomes a valuable tool in complex decision-making, helping users to gain a better understanding of the implications of each option and choose the solution that best suits their goals and needs. One of the main advantages of the MOORA Method is its ability to deal with multi-criteria decision-making problems with a systematic and measurable approach. MOORA allows users to assess alternatives based on a variety of relevant criteria simultaneously, without having to sacrifice certain aspects of the decision.

The Grey Relational Analysis (GRA) method is a powerful approach in the analysis of relationships between two or more complex and uncertain data series[15], [16]. GRA is used to evaluate the degree of relative relationships between related variables, especially in contexts where the available data are limited or incomplete. By utilizing the concept of grey degree, GRA is able to capture the relationship between these variables by considering the uncertainty and ambiguity involved. Through GRA, users can analyze and understand patterns of relationships that may be hidden in incomplete or ambiguous data. As such, GRA provides a useful method for overcoming uncertainty in decision-making, especially in situations where available data is limited or incomplete, and allows users to make more informed and informed decisions. GRA is becoming a valuable tool in helping users to understand and manage uncertainty in data analysis, as well as supporting better, more evidence-based decision-making processes. One of the main advantages of Grey Relational Analysis (GRA) is its ability to overcome uncertainty and vagueness in incomplete or ambiguous data. GRA is able to capture the relative relationships between variables related to considering gray degrees, thus allowing users to analyze imperfect data more effectively.

Comparative analysis between MOORA and GRA methods in warehouse head selection is essential because both methods offer different approaches to overcome complexity in decision making. MOORA allows for a more detailed assessment by considering multiple criteria in decision making, while GRA highlights linkages and relationships between alternatives, useful in dealing with uncertainty and ambiguity in data. The comparison between MOORA and GRA can also provide deeper insight into how each method manages trade-offs between different criteria in warehouse head selection. The purpose of the comparison between MOORA and GRA in the selection of warehouse heads is to evaluate and understand the advantages and disadvantages of each method in that specific context. By clarifying which approach is more appropriate and effective for considering relevant criteria in warehouse head selection, this analysis helps stakeholders make more informed and rational decisions. In addition, the objectives of this comparison also include to increase understanding of how each method can be used optimally to overcome complexity and uncertainty in decision making, as well as to ensure that the decisions taken reflect the strategic and operational objectives of the company or organization concerned. Thus, comparative analysis between MOORA and GRA becomes an important instrument in supporting a more efficient, transparent, and measurable decision-making process. By comparing MOORA and GRA, stakeholders can gain better insight into the advantages and disadvantages of each method, as well as tailor the approach that best suits the situation at hand. This not only helps improve accuracy and objectivity in decision making, but also strengthens stakeholder confidence in the process. In addition, the comparison between MOORA and GRA can also open up space for innovation and updates in decision-making methods, which in turn can improve the efficiency and overall performance of warehouses and related organizations.

Despite its advantages, both the MOORA and GRA Methods have some disadvantages in criterion weighting. One disadvantage of MOORA is its sensitivity to changes in criterion weighting, where small changes in weights can result in significantly different ratings. In addition, MOORA tends to give unstable results in situations where alternatives have very different scales. Meanwhile, the weakness of GRA in weighting criteria is that the interpretation of the results can be subjective, as GRA involves a complex process of data transformation. In addition, GRA is also susceptible to the influence of improper or irrelevant variable selection, which can result in inaccurate or unreliable analyses. Therefore, users should reconsider these methods carefully and ensure that they are suitable for their analysis and decision-making needs, especially in the context of criteria weighting. In overcoming the weight sensitivity problem experienced by MOORA and GRA, this study uses a weighting method, namely the Pivot Pairwise Relative Criteria Importance Assessment.

The Pivot Pairwise Relative Criteria Importance Assessment (PIPRECIA) weighting method is an approach used to determine the relative weight of criteria used in multi-criteria decision making[17]–[19]. This method has advantages in its simplicity and flexibility in handling different types of criteria and decision-making situations. The PIPRECIA method also has the advantage of promoting the active participation of decision makers, as they are directly involved in the process of weighting criteria. In addition, by using a pair comparison approach, PIPRECIA helps reduce the number of comparisons needed, thereby minimizing decision-maker fatigue and reducing the likelihood of uncertainty or hesitation in determining weights. This method also allows decision makers to capture the nuances and complexities of interactions between existing criteria, which may not be obvious in simpler criteria-weighting approaches. One of the main advantages of the PIPRECIA weighting method is its ability to actively involve decision makers in the process of weighting criteria. By asking decision makers to compare pairs of criteria directly, PPRCIA encourages greater participation and a deeper understanding of the importance of each criterion in the decision-making context.

This study aims to select warehouse heads by applying a combination of MOORA and PIPRECIA methods, as well as GRA and PIPRECIA. The combination of MOORA and PIPRECIA as well as GRA and PIPRECIA will be compared based on the final ranking of the two methods used. The purpose of the comparison between MOORA and GRA is to evaluate the advantages and limitations of each method in a given context. Such comparisons can involve aspects such as accuracy, reliability, complexity, and relatedness to the needs of decision makers. By understanding the advantages and disadvantages of both methods, decision makers can choose the method that best suits their situation and decision-making goals, as well as ensure that the decisions taken are supported by solid and informed analysis. The comparison between MOORA and GRA also aims to determine which method is more in line with the characteristics of the existing data, the degree of uncertainty, and the complexity of the decision-making problem at hand. In addition, this comparison can also help in evaluating the efficiency and effectiveness of each method in producing reliable solutions or recommendations. By considering these various factors, decision makers can make more informed decisions about the most suitable methods to use in a given situation, thereby maximizing the value of the information obtained from the analysis and minimizing the risk of inappropriate decision making.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The stages of research are a series of steps or processes carried out in order to collect data, analyze information, and achieve research objectives[20]. This stage includes research planning, data collection, data analysis, and interpretation of results. Each stage has an important role in directing the course of research and ensuring the validity and reliability of the findings obtained. The stages of research carried out are shown in Figure 1.

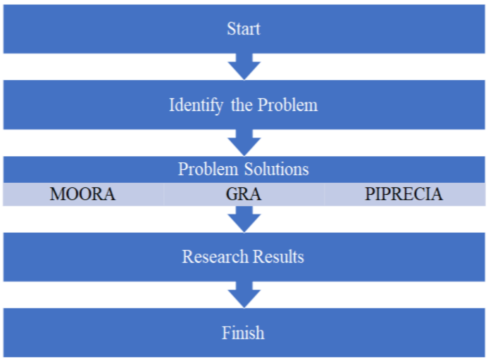

Figure 1. Stages of Research

The stages of research conducted in Figure 1 show the process carried out in this study starting from identifying problems in the selection of warehouse heads, after obtaining problems then determining solutions to problems using MOORA and GRA methods and PIPRECIA for weighting criteria. The result of the problem solution will be the result of research that will compare the MOORA and GRA methods in the selection of warehouse heads.

2.2 Research Problem Solving Framework

The framework of solving research problems is a general structure or plan used by researchers to organize and guide the course of the research process. The framework includes the steps to be followed to resolve the identified research problems. With this framework in place, researchers can direct their efforts systematically and ensure that all relevant aspects of the research have been properly considered and addressed. A research problem-solving framework helps organize the steps necessary to achieve research objectives efficiently and effectively. Research problem solving framework as shown in Figure 2.

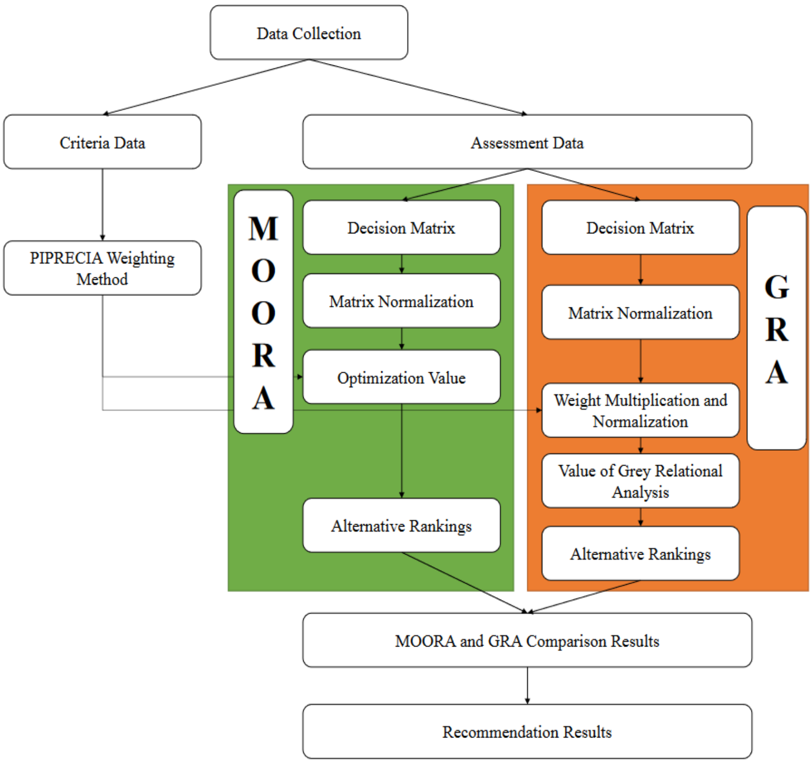

Figure 2. Research Problem Solving Framework

The explanation of each stage carried out in the framework of solving research problems in Figure 2 will be explained in each of the following stages.

a. Data Collection
   The data collection stage in this study is by conducting interviews with the company related to problems in the selection of warehouse heads, in this stage collecting data on criteria that will be used in assessing the selection of warehouse heads and assessment data from each warehouse head candidate. The assessment data will be used in the application of MOORA and GRA methods to determine and recommend candidates for warehouse heads.
b. Criteria Data
   In the selection of warehouse heads, various criteria are required to ensure that the selected individuals have qualifications that match the demands of the job. Data criteria for warehouse head selection can include various aspects relevant to the role and responsibilities of the warehouse head. The criteria data used in the selection of warehouse heads are presented in table 1.

Table 1. Warehouse Head Selection Criteria

Criteria Number	Criteria Name	Initial Value of Criteria
CN-1	Education	1
CN-2	Interview Value	1
CN-3	Work Experience	1
CN-4	Communication Skills	0.6
CN-5	Leadership Skills	0.8
CN-6	Warehouse Management Knowledge	0.8

   Table 1 is the criteria data used in the selection of warehouse head selection, the criteria used are 6 criteria that will be used in the selection process of each existing alternative.
c. Assessment Data
   Alternative assessments are conducted to evaluate the qualifications and abilities of each candidate who may fulfil the role. Alternative assessment data can include various criteria used, namely Education, Interview Value, Work Experience, Communication Skills, Leadership Skills, and Warehouse Management Knowledge. Assessment data against alternatives as shown in table 2.

Table 2. Warehouse Head Selection Assessment Data

Candidate Name	CN-1	CN-2	CN-3	CN-4	CN-5	CN-6
ASD	2	90	4	3	3	5
FHY	3	88	5	4	4	5
BRY	2	95	2	3	3	4
AGL	3	93	3	4	4	5
TAN	4	94	2	4	3	5
YLS	3	89	4	3	4	4
ACB	3	92	3	4	4	4
RNS	2	91	4	3	3	5

Table 2 is the data from the assessment of each alternative that exists for each criterion used in the selection process from existing alternatives.

d. PIPRECIA Weighting Method

In an era of increasingly complex decision-making, the Pivot Pairwise Relative Criteria Importance Assessment (PIPRECIA) Method is emerging as an innovative approach within the MCDM framework. This method emerged as a focused and targeted solution in assessing the relative importance between criteria by utilizing pairwise comparisons. The stages of weighting calculation using PIPRECIA are as follows.

The first stage calculates the relative significance using the following equation.

$$S_j = \begin{cases} 1 & jika\ c_j > c_1 \\ 1 & jika\ c_j = c_1 \\ 1 & jika\ c_j < c_1 \end{cases} \quad (1)$$

Next steps Establish the value of the coefficient using the following equation:

$$k_j = \begin{cases} 1\ jika\ j = 1 \\ 2 - s_j\ jika\ j > 1 \end{cases} \quad (2)$$

The next step is calculating the weight using the following equation:

$$q_j = \begin{cases} 1\ jika\ j = 1 \\ \frac{1}{k_j}\ jika\ j > 1 \end{cases} \quad (3)$$

The final stage calculates the relative final weight of the criterion using the following equation.

$$w_j = \frac{q_j}{\sum_{\kappa=1}^{n} q_\kappa} \quad (4)$$

e. MOORA Method

Multi-Objective Optimization by Ratio Analysis (MOORA) involves several systematic stages in the decision-making process. Each stage in MOORA plays a key role in helping decision makers detail, assess, and compare alternatives based on predetermined criteria. This entire process helps to achieve a solution that matches the preferences and goals that have been set. The stages carried out in solving problems using the MOORA method include:

The first stage creates a decision matrix based on alternative assessment data using the following equation.

$$X = \begin{bmatrix} x_{11} & x_{21} & x_{n1} \\ x_{12} & x_{22} & x_{n2} \\ x_{1m} & x_{2m} & x_{nm} \end{bmatrix} \quad (5)$$

The second stage normalizes the matrix using the following equation.

$$x_{ij}^* = \frac{x_{ij}}{\sqrt{\left[\sum_{i=1}^{j} x_{ij}^2\right]}} \quad (6)$$

The third stage determines the value of the optimization criteria for each alternative using the following equation.

$$y_i = \sum_{j=1}^{n} w_j * x_{ij}^* - \sum_{j=g+1}^{n} w_j * x_{ij}^* \quad (7)$$

f. GRA Method

The stages of Grey Relational Analysis (GRA) involve a systematic process to evaluate and rank alternatives based on relevant criteria. Through this series of stages, the GRA provides a robust analytical framework to support multi-criteria decision-making in situations of uncertainty and complexity. Careful implementation at each stage can improve the accuracy and reliability of GRA results. The stages carried out in solving problems using the GRA method include.

The first stage normalizes the matrix using the following equation.

$$X_{ij} = \frac{x_{ij} - x_{\min ij}}{x_{\max ij} - x_{\min ij}} \quad (8)$$

After normalization is carried out, then making the matrix gray relational analysis G is the result of the normalization matrix, namely:

$$G = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \quad (9)$$

The next step is to determine the relative weight for each variable. This weight reflects the level of importance of each variable in the GRA analysis. Furthermore, the GRA method is to give a weighting to each criterion that refers to the level of importance of the criterion. The following is a formula for doing calculations.

$$V_{ij} = x_{i,j}.w_j \quad (10)$$

The final stage calculates the gray relation value calculated for each variable based on a matrix of gray relations and relative weights that have been determined using the following equation.

$$GRG_i = \frac{1}{n}\sum_{j=1}^{n} V_{ij} \quad (11)$$

g. MOORA and GRA Comparison Method Results
Evaluation of the comparison results between the MOORA and GRA methods in alternative rankings needs to be done carefully to understand the advantages and disadvantages of each method. It is important to compare the consistency and stability of results between the two methods, both in rankings and in relative assessments of alternatives.

h. Recommendation Results
Based on the results of the comparison between the MOORA Method and GRA Method in alternative ranking, decision makers can choose the method that best suits their needs and ensure that the results of alternative ranking obtained are reliable and relevant for better decision making.

3. RESULT AND DISCUSSION

A comparative analysis of the combination of Multi-Objective Optimization by Ratio Analysis (MOORA) and Grey Relational Analysis (GRA) methods with the weighting of the Pivot Pairwise Relative Criteria Importance Assessment (PIPRECIA) in the selection of warehouse heads will provide valuable insights in the decision-making process. MOORA can be used to rank alternatives relative to established criteria, while GRA can identify relative relationships between alternatives and criteria. The combination of these two methods with PIPRECIA weighting allows researchers to integrate the advantages of each method and overcome the limitations that a single method may have. Thus, this analysis can produce more holistic and informed recommendations in the selection of warehouse heads, taking into account various aspects and dimensions relevant in the context of such selection.

3.1 PIPRECIA Weighting Method

PIPRECIA provides a systematic framework for evaluating and comparing criteria taking into account the relative preferences between them. This method of weighting criteria provides a solid foundation for decision makers to make more informed and consistent decisions, and optimize the use of available resources. The results of the calculation of weighting criteria using equations (1), (2), (3), and (4) as shown in table 3.

Table 3. Warehouse Head Selection Criteria

Criteria Number	Criteria Name	S_j	kj	q_j	w_j
CN-1	Education	1	1	1	0.186
CN-2	Interview Value	1	1	1	0.186
CN-3	Work Experience	1	1	1	0.186
CN-4	Communication Skills	0.6	1.4	0.714	0.133
CN-5	Leadership Skills	0.8	1.2	0.833	0.155
CN-6	Warehouse Management Knowledge	0.8	1.2	0.833	0.155

Table 3 is the data from the calculation of the weight of each criterion using the PIPRECIA weighting method, the results of this criterion weight will be used in the MOORA and GRA methods.

3.2 Implementation of MOORA and PIPRECIA Methods

The application of the Pivot Pairwise Relative Criteria Importance Assessment (PIPRECIA) and Multi-Objective Optimization by Ratio Analysis (MOORA) weighting methods in the context of warehouse head selection will provide a comprehensive approach in evaluating and selecting the most suitable candidates. PIPRECIA is used to determine the relative weight of relevant criteria. Once the weight of the criteria is established, MOORA can be used to rank each candidate relative based on their scores against those criteria. By combining these two methods, decision makers can obtain more comprehensive and structured information in the warehouse head selection process, making it possible to make more informed and measurable decisions. The first stage in the MOORA method is to make a decision matrix based on alternative assessment data using equation (5), the general form of decision matrix results is as follows.

$$X = \begin{bmatrix} x_{11} & x_{21} & x_{31} & x_{41} & x_{51} & x_{61} \\ x_{12} & x_{22} & x_{32} & x_{42} & x_{52} & x_{62} \\ x_{13} & x_{23} & x_{33} & x_{43} & x_{53} & x_{63} \\ x_{14} & x_{24} & x_{34} & x_{44} & x_{54} & x_{64} \\ x_{15} & x_{25} & x_{35} & x_{45} & x_{55} & x_{65} \\ x_{16} & x_{26} & x_{36} & x_{46} & x_{56} & x_{66} \\ x_{17} & x_{27} & x_{37} & x_{47} & x_{57} & x_{67} \\ x_{18} & x_{28} & x_{38} & x_{48} & x_{58} & x_{68} \end{bmatrix}$$

The result of the decision matrix is based on the general form as follows.

$$X = \begin{bmatrix} 2 & 90 & 4 & 3 & 3 & 5 \\ 3 & 88 & 5 & 4 & 4 & 5 \\ 2 & 95 & 2 & 3 & 3 & 4 \\ 3 & 93 & 3 & 4 & 4 & 5 \\ 4 & 94 & 2 & 4 & 3 & 5 \\ 3 & 89 & 4 & 3 & 4 & 4 \\ 3 & 92 & 3 & 4 & 4 & 4 \\ 2 & 91 & 4 & 3 & 3 & 5 \end{bmatrix}$$

The next stage calculates matrix normalization based on the decision matrix that has been made using equation (6), the result of matrix normalization is as follows.

$$x_{11}^{*} = \frac{x_{11}}{\sqrt{\left[\sum_{i=1}^{j} x_{11;18}^{2}\right]}} = \frac{2}{\sqrt{2^2+3^2+2^2+3^2+4^2+3^2+32^2+2^2}} = \frac{2}{\sqrt{64}} = \frac{2}{\sqrt{8}} = 0.25$$

The overall result of matrix normalization is as shown in table 4.

Table 4. Matrix Normalization Results

Candidate Name	CN-1	CN-2	CN-3	CN-4	CN-5	CN-6
ASD	0.25	0.348	0.402	0.3	0.3	0.38
FHY	0.375	0.340	0.503	0.4	0.4	0.38
BRY	0.25	0.367	0.201	0.3	0.3	0.304
AGL	0.375	0.359	0.302	0.4	0.4	0.38
TAN	0.5	0.363	0.201	0.4	0.3	0.38
YLS	0.375	0.344	0.402	0.3	0.4	0.304
ACB	0.375	0.355	0.302	0.4	0.4	0.304
RNS	0.25	0.352	0.402	0.3	0.3	0.38

Table 4 is the data from the results of matrix normalization for each alternative based on existing assessment data using the MOORA method. The last stage in the MOORA method is to calculate the optimization value using equation (7), the result of the optimization value is as follows.

$$y_1 = (w_1 * x_{11}^{*}) + (w_2 * x_{21}^{*}) + (w_3 * x_{31}^{*}) + (w_4 * x_{41}^{*}) + (w_5 * x_{51}^{*}) + (w_6 * x_{61}^{*})$$

$$y_1 = (0.186 * 0.25) + (0.186 * 0.348) + (0.186 * 0.402) + (0.133 * 0.3) + (0.155 * 0.3) + (0.155 * 0.38)$$

$$y_1 = 0.33096$$

The overall result of the final optimization value is as shown in table 5.

Table 5. Final Value of Optimization

Candidate Name	Final Value
ASD	0.33096
FHY	0.40017
BRY	0.28538
AGL	0.36637
TAN	0.35615
YLS	0.35721
ACB	0.35387
RNS	0.33168

Table 5 represents the final value of optimazation of each alternative using a combination of weighting methods using PIPRECIA and MOORA methods. The results of alternative ranking using the Multi-Objective Optimization by Ratio Analysis (MOORA) Method provide a relative sequence of alternatives based on established criteria. The alternative that has the best score for each criterion will rank higher in the final ranking. The ranking results are as shown in Figure 3.

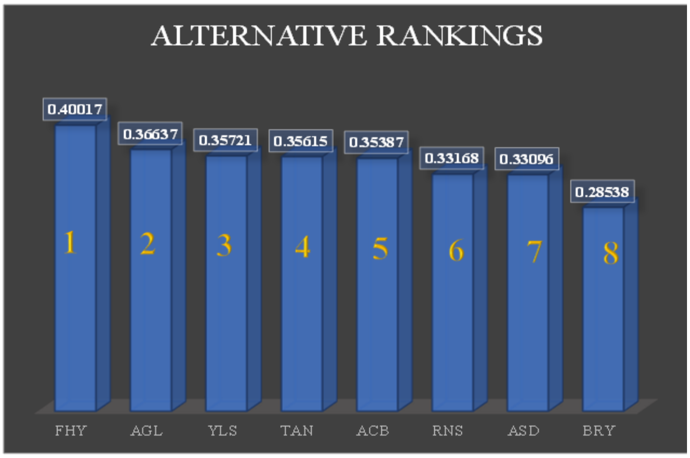

Figure 3. Alternative Ranking Using MOORA

Based on the ranking results in figure 3 for the highest value with a value of 0.40017 obtained by FHY with rank 1, a value of 0.36637 obtained by AGL with rank 2, and a value of 0.35721 obtained by YLS with rank 3.

3.3 Implementation of GRA and PIPRECIA Methods

The application of Pivot Pairwise Relative Criteria Importance Assessment (PIPRECIA) and Grey Relational Analysis (GRA) weighting methods can provide a strong approach in alternative assessments and rankings in the context of warehouse head selection. Initially, PIPRECIA was used to determine the relative weights of each criterion relevant for warehouse head selection, while GRA was used to identify relative relationships between alternatives and criteria based on degree of grayness. By combining the two, we can consider the importance of each criterion and the relative relationship between alternatives in the final ranking. This allows decision makers to gain a more holistic and structured understanding of each alternative, and ensures that decisions taken are based on robust and informed information.

The first stage in the GRA method is matrix normalization based on alternative assessment data using equation (8), the results of matrix normalization are as follows.

$$X_{11} = \frac{x_{ij11} - x_{\min 11;18}}{x_{\max 11;18} - x_{\min 11;18}} = \frac{2-2}{4-2} = 0$$

The overall result of matrix normalization is as shown in table 6.

Table 6. Matrix Normalization Results

Candidate Name	CN-1	CN-2	CN-3	CN-4	CN-5	CN-6
ASD	0	0.286	0.667	0	0	1
FHY	0.5	0	1	1	1	1
BRY	0	1	0	0	0	0
AGL	0.5	0.714	0.333	1	1	1
TAN	1	0.857	0	1	0	1
YLS	0.5	0.143	0.667	0	1	0
ACB	0.5	0.571	0.333	1	1	0
RNS	0	0.429	0.667	0	0	1

Table 6 is the data from the results of matrix normalization for each alternative based on existing assessment data using the GRA method. After normalization, a relational analysis of the gray G matrix was then made which is the result of matrix normalization using equation (9), the results of the GRA matrix are as follows.

$$X = \begin{bmatrix} 0 & 0.286 & 0.667 & 0 & 0 & 1 \\ 0.5 & 0 & 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0.5 & 0.714 & 0.333 & 1 & 1 & 1 \\ 1 & 0.857 & 0 & 1 & 0 & 1 \\ 0.5 & 0.143 & 0.667 & 0 & 1 & 0 \\ 0.5 & 0.571 & 0.333 & 1 & 1 & 0 \\ 0 & 0.429 & 0.667 & 0 & 0 & 1 \end{bmatrix}$$

The next step is to calculate the weight multiplication of the criterion with the matrix G using equation (10), the result of weight multiplication is as follows.

$V_{11} = x_{11} * w_1 = 0.186 * 0 = 0$

The overall result of weight multiplication by matrix G as in table 7.

Table 7. The Result of Weight Multiplication

Candidate Name	CN-1	CN-2	CN-3	CN-4	CN-5	CN-6
ASD	0	0.053	0.124	0	0	0.155
FHY	0.093	0	0.186	0.132	0.155	0.155
BRY	0	0.186	0	0	0	0
AGL	0.093	0.133	0.062	0.132	0.155	0.155
TAN	0.186	0.159	0	0.132	0	0.155
YLS	0.093	0.027	0.124	0	0.155	0
ACB	0.093	0.106	0.062	0.132	0.155	0
RNS	0	0.08	0.124	0	0	0.155

Table 7 is the result of weight multiplication between normalized results and criteria weights using the PIPRECIA weighting method. The last stage calculates the gray relation value calculated for each variable based on the gray relation matrix and the relative weight that has been determined using equation (11), the calculation result is as follows.

$$GRG_1 = \frac{1}{6}(v_{11} + v_{21} + v_{31} + v_{41} + v_{51} + v_{61})$$

$$GRG_1 = \frac{1}{6}(0 + 0.053 + 0.124 + 0 + 0 + 0.155) = 0.05536$$

The results of all GRA values are as shown in table 8.

Table 8. Final Value of Optimization

Candidate Name	GRA Final Value
ASD	0.05536
FHY	0.12017
BRY	0.031
AGL	0.12164
TAN	0.1054
YLS	0.06643
ACB	0.09138
RNS	0.05979

Table 8 represents the final value of optimazation of each alternative using a combination of weighting methods using PIPRECIA and GRA methods. The results of alternative ranking with the Gray Relational Analysis (GRA) Method provide a relative sequence of alternatives based on predetermined criteria. The alternative that has the best score for each criterion will rank higher in the final ranking. The ranking results are as shown in Figure 4.

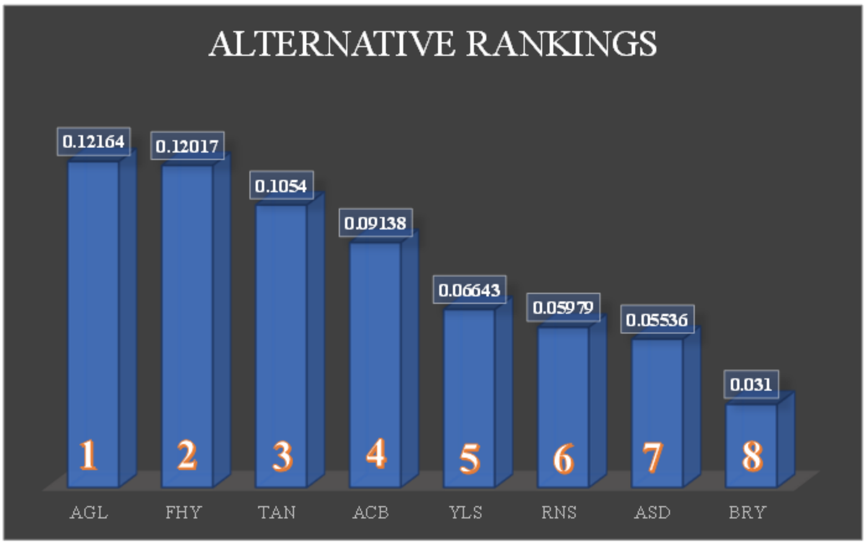

Figure 4. Alternative Ranking Using GRA

Based on the ranking results in figure 3 for the highest value with a value of 0.12164 obtained by AGL with rank 1, a value of 0.12017 obtained by FHY with rank 2, and a value of 0.1054 obtained by TAN with rank 3.

3.4 MOORA and GRA Comparison Method Results

The results of the comparison between the Multi-Objective Optimization by Ratio Analysis (MOORA) and Grey Relational Analysis (GRA) methods can provide valuable insights in the context of warehouse head selection. MOORA assigns a relative ranking of alternatives based on predefined criterion values, whereas GRA identifies relative relationships between alternatives and criteria based on degree of grayness. In the context of warehouse head selection, a comparison between these two methods allows for a holistic evaluation of each alternative and a deeper understanding of the quality and relevance of the criteria used in the selection process. By analyzing and comparing results from MOORA and GRA, decision makers can make more informed and reasoned decisions in choosing the head of warehouse that best fits the needs of the organization. Comparison results of alternative ranking using MOORA and GRA methods as shown in Figure 4.

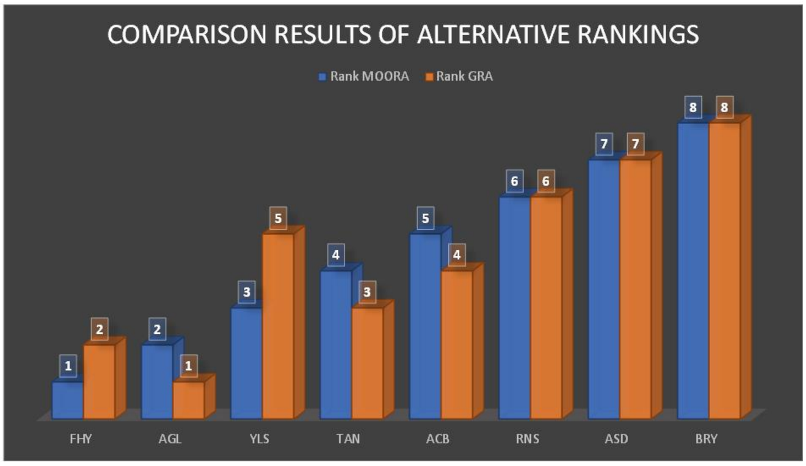

Figure 5. Comparison Results of Alternative Rankings

Differences in rankings between Multi-Objective Optimization by Ratio Analysis (MOORA) and Grey Relational Analysis (GRA) methods can arise due to different approaches in evaluating and comparing alternatives. MOORA uses predefined criteria values to assign relative ratings, while GRA identifies relative relationships between alternatives and criteria based on degrees of grayness. Therefore, ranking differences can be due to sensitivity to criteria weighting, treatment of data uncertainty, and complexity of relationships between variables in GRA. In addition, specific characteristics of the data and research context can also influence ranking differences. Analysis of ranking differences between these two methods is important to understand the different perspectives they offer and ensure that the decisions taken are based on informed and relevant information.

3.5 Recommendation Results

Based on the results of the ranking comparison from the MOORA and GRA methods, there are differences in rankings in 5 data. The next stage is to analyze the level of data suitability from the MOORA and GRA methods using the following equation.

$$T_{ki} = 100 - \frac{x_1}{Data\ (100\%)}$$

The first step calculates the sum of the entire data and divides it by the number of existing alternatives as follows.

$$MOORA = \frac{Total\ Final\ Grade}{Number\ of\ Alternatives} = \frac{2.78179}{8} = 0.34772375$$

$$GRA = \frac{Total\ Final\ Grade}{Number\ of\ Alternatives} = \frac{0.65117}{8} = 0.08139625$$

The final step calculates the degree of suitability of each method as follows.

$$T_{ki(MOORA)} = 100 - \frac{0.34772375}{100} = 99.99652\%$$

$$T_{ki(GRA)} = 100 - \frac{0.08139625}{100} = 99.99919\%$$

Based on the results of the conformity level, it can be concluded in the selection of the warehouse head to recommend the GRA method compared to the MOORA method, because the results of the conformity level of the GRA method get a value of 99.99919% higher than the MOORA method which gets a value of 99.99652%.

4. CONCLUSION

This study aims to select warehouse heads by applying a combination of MOORA and PIPRECIA methods, as well as GRA and PIPRECIA. The combination of MOORA and PIPRECIA as well as GRA and PIPRECIA will be compared based on the final ranking of the two methods used. Based on the ranking results on the MOORA Method, the highest value with a value of 0.40017 was obtained by FHY with rank 1, a value of 0.36637 was obtained by AGL with rank 2, and a value of 0.35721 was obtained by YLS with rank 3. Based on the ranking results in the GRA Method, the highest value with a value of 0.12164 was obtained by AGL with rank 1, a value of 0.12017 was obtained by FHY with rank 2, and a value of 0.1054 was obtained by TAN with rank 3. Ranking differences between Multi-Method Objective Optimization by Ratio Analysis (MOORA) and Gray Relational Analysis (GRA) can arise due to different approaches in evaluating and comparing alternatives. The results of the conformity level test can be concluded in the selection of warehouse heads recommending the GRA method compared to the MOORA method, because the conformity rate results of the GRA method get a value of 99.99919% higher than the MOORA method. MOORA method which obtained a value of 99.99652%.

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