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# Modification of the Grey Relational Analysis Method in Determining the Best Mechanic

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**Abstract**−Determining the best mechanics in the industry has an important role to ensure the quality and reliability of the products and services offered. Competent and experienced mechanics are able to diagnose and repair accurately and efficiently, thereby minimizing operational downtime and increasing productivity. Without a structured system, mechanical performance appraisals tend to be subjective and inconsistent, which can lead to dissatisfaction among employees and customers. Mechanics may not get clear and constructive feedback on their performance, thus hindering skill development and professionalism. The purpose of the research of the modified Grey Relational Analysis (GRA) using standard deviation is to improve the accuracy and reliability of the decision-making process in situations where the data has a high degree of variability or significant uncertainty. By integrating standard deviations into the GRA, the study aims to account for variations and fluctuations in the data, which allows for more accurate and representative assessment of the criteria. This modification is expected to overcome the weaknesses of traditional GRAs that may not adequately consider data uncertainty, as well as produce more robust and realistic alternative rankings. The results of the best ranking of mechanics, Mechanic FR ranks first with a value of 0.11, followed by Mechanic HS with a value of 0.104. The third place was occupied by Mechanic AY with a score of 0.099.

**Keywords**: Alternative; GRA; Modification; Rankings; Standard Deviation

## 1. INTRODUCTION

Determining the best mechanics in the industry has an important role to ensure the quality and reliability of the products and services offered. Competent and experienced mechanics are able to diagnose and repair accurately and efficiently, so that they can minimize operational downtime and increase productivity. In addition, the best mechanics also contribute to reducing the risk of work errors that can lead to financial losses and occupational safety. Choosing the best mechanic is a strategic investment to improve the company's performance and reputation in the long run. In addition to the technical aspect, the best mechanics also play an important role in maintaining good relations with customers. Reliable and professional mechanics are able to provide satisfactory service, thereby increasing customer satisfaction and loyalty. High customer satisfaction has the potential to generate positive recommendations that can improve the company's image and competitiveness in the market. In a highly competitive industry, a good reputation and strong relationships with customers are key to maintaining and growing market share. Therefore, determining the best mechanic is not only about technical ability, but also about building trust and maintaining good relationships with customers. The absence of the best mechanical determination system poses various problems for companies, especially in terms of efficiency and service quality. Without a structured system, mechanical performance appraisals tend to be subjective and less consistent, which can lead to dissatisfaction among employees and customers. Mechanics may not get clear and constructive feedback on their performance, thus hindering skill development and professionalism. Additionally, without objective assessment methods, companies risk making incorrect decisions in placement or promotion, which can ultimately affect the company's productivity and reputation. Therefore, the implementation of a comprehensive, data-driven mechanical determination system is essential to ensure that companies can identify and develop the best talent, improve customer satisfaction, and remain competitive in the industry. Solutions in the selection of the best mechanics can be implemented with a decision support system approach.

A Decision Support System (DSS) is a very useful tool in assisting with complex and structured decision-making [1][3]. One of its key benefits is its ability to efficiently analyze large and complex data, resulting in relevant and in-depth information for more informed decision-making. DSS allows its users to consider various alternatives and potential impacts of each decision, by providing simulations, risk analysis, and what-if scenarios. DSS can increase the speed of decision-making, which is crucial in a dynamic and competitive business situation. The advantages of using DSS include increased efficiency and accuracy in the decision-making process. DSS can process and analyze large amounts of data quickly, providing accurate and relevant information to help in choosing the best option. This allows for faster decision-making, which is crucial in a dynamic business environment. Additionally,

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DSS can reduce human subjectivity and preferences, as decisions are based on objective data and analysis [4][6]. The system also supports risk management by providing analysis of various scenarios and projecting the impact of each decision. One of the methods in DSS is the gray relational analysis method.

Grey Relational Analysis (GRA) is an analysis method used to evaluate and sort various alternatives based on several criteria [7][9]. This method is useful especially in situations where the available information or data is incomplete or uncertain. GRA works by measuring the degree of relationship between data sets, called the degree of gray relationship, to determine the degree of influence of one factor over another. This method is particularly beneficial in multi-criteria decision-making because it can handle systems that have limited information and generate rankings that provide insight into the best alternatives. GRA is often used in fields such as management, engineering, and economics to aid in the analysis and solving of complex problems. The advantage of GRA lies in its ability to handle incomplete or uncertain data, making it particularly useful in situations where available information is limited [10][12]. GRA can quickly analyze the relationships between variables and provide accurate results without the need for complex data distribution assumptions. The GRA method allows for multi-criteria decision-making by considering various factors simultaneously, thus providing a comprehensive and objective view of the alternatives that exist. With this approach, GRA assists decision-makers in choosing the best option in an efficient and effective way. One of the main drawbacks of the GRA method is its reliance on subjective selection of weights and scales, which can affect the results of the analysis and result in biased interpretations. In addition, GRA may be less accurate when dealing with very large datasets or when there is too little information available, as these methods are not always able to capture the complexity of the relationships between variables in depth. The data normalization process in GRA can also be challenging, especially if the data at hand has a very varied range. In addition, although the GRA can handle incomplete data, its accuracy still depends on the quality and relevance of the available data, which can affect the validity of the conclusions produced.

Standard deviation is a statistical measure that describes how scattered the data is in a set of its mean values [13][15]. It measures the variability or dispersion of data by calculating the mean of the squares of the deviation of each value against the overall mean. A low standard deviation indicates that the values in the dataset tend to cluster close to the mean, while a high standard deviation indicates that the values are spread further away from the mean. It is an essential tool in data analysis because it provides insights into consistency and variability, as well as helps in assessing data risk and uncertainty [16][17]. Standard deviations can be helpful in identifying unusual outliers or data, which can significantly affect the analysis and results. Modification of the GRA using standard deviation aims to improve accuracy and accuracy in evaluating alternatives based on uncertain or incomplete criteria. By integrating standard deviations, these modifications take into account variability and uncertainty in the data, which helps in assigning more precise weight to more consistent and stable criteria. The standard deviation is used to assess how much the value fluctuates in each criterion, so that the weight of the GRA can be modified to reflect the impact of data variability on the final decision. This approach allows for a more realistic and robust assessment of alternatives, especially in situations where the data used shows a significant degree of variation, thereby improving the quality and reliability of decision analysis results.

Research on the selection of the best mechanic was carried out by Refika (2021) applying the OCRA (Operational Competitiveness Rating Analysis) method in selecting the best mechanic based on the historical data of each mechanic, this method helps the Head of the Workshop in making decisions on the Selection of the Best Mechanic to increase the objectivity of the decision [18]. Research by Sinaga (2022) the MOORA (Multi-Objective Optimization On The Basis Of Ratio Analysis) method is very simple, stable, and effective in producing the best motorcycle mechanical decisions [19]. Research by Badrul (2023) the Analytical Hierarchy Process (AHP) method can help in determining the priority of several criteria by conducting a paired comparative analysis of each criterion to produce the best mechanical determination decision [20]. Research by Rahmah (2023) AHP method to assess mechanics in workshops, determine mechanics, and determine mechanical assessment criteria that can affect workshop quality [21]. Research by Nainggolan (2024) the SAW (simple additive weighting) method based on criteria and weights that have been determined in determining the best mechanics at PT Arista Auto Lestari Ringrood Branch [22]. The difference with the research carried out is in the method used, in the research the method used is a modification of the GRA method with standard deviation (GRA-S).

The purpose of the research of the modified Grey Relational Analysis (GRA) using standard deviation is to improve the accuracy and reliability of the decision-making process in situations where the data has a high degree of variability or significant uncertainty. By integrating standard deviations into the GRA, the study aims to account for variations and fluctuations in the data, which allows for more accurate and representative assessment of the criteria. This modification is expected to overcome the weaknesses of traditional GRA that may not adequately consider data uncertainty, as well as produce more robust and realistic alternative rankings. Ultimately, this study aims to improve the quality of decisions taken based on multi-criteria analysis by giving more appropriate weight to relevant and stable criteria. The modification grey relational analysis and standard deviation (GRA-S) methods provide more accurate results in the analysis of relationships between variables compared to the traditional GRA method. Another advantage of this method is its ability to improve the reliability and validity of the analysis, especially when faced with datasets that have fluctuations or uneven distribution of data. Overall, GRA-S offers a more robust and adaptive approach to data-driven decision-making.

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# 2. RESEARCH METHODOLOGY

## 2.1 Research Stages

The research stages provide a systematic framework to ensure that research is carried out in a structured and thorough manner, with the research stages being conducted can make a more in-depth and applicable contribution, and ensure that the results of the research are well translated into useful scientific practice and knowledge. Figure 1 is the stage of the research carried out.

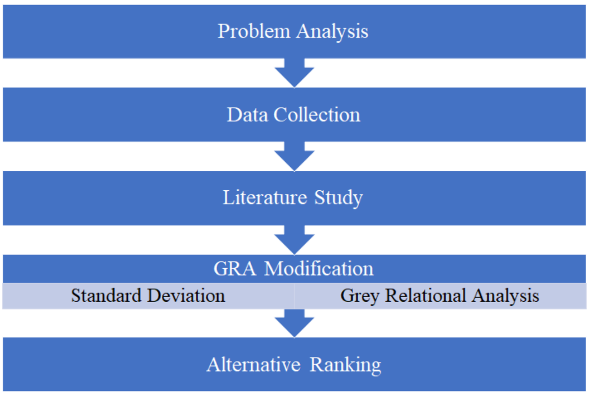


**Figure 1.** Research Stage

Problem analysis in the selection of the best mechanic involves assessing the various criteria and attributes that determine the skill and performance of a mechanic. The process begins by identifying specific needs and quality standards that must be met, such as technical skills, experience, work speed, problem-solving ability, and customer satisfaction. The research phase begins with the identification and collection of relevant data from the alternatives to be evaluated, followed by an initial analysis to understand the basic characteristics of the data. The study of literature in the GRA method involves an in-depth study of various GRA research and applications in various fields, such as engineering, management, and social sciences. The purpose of this study is to understand the development, modification, and application of GRA as an effective multi-criteria analysis tool. In the literature, GRA is often compared to other methods of analysis, to highlight its advantages and disadvantages in dealing with incomplete data and uncertainty. The literature study also explores various innovations in GRA, such as integration with other methods or use in complex contexts. By studying the existing literature, researchers and practitioners can gain valuable insights into how GRA can be effectively applied to solve complex decision problems, improve the accuracy of analysis, and provide a solid foundation for data-driven decision-making. The next step involves calculating the standard deviation for each criterion to measure the variability and uncertainty of the data. After that, the Grey Relational Analysis (GRA) method is modified by including standard deviations in the calculation of criterion weights, which are then used to evaluate and rank alternatives. The stage ended with a finding-based recommendation for the application of modified methods in multi-criteria decision-making.

## 2.2 Standard Deviation

Standard deviation is a statistical measure that shows how far the data in a set spreads out from its average value. This gives an idea of the level of variation or diversity within the data [23]. The larger the standard deviation value, the greater the spread of the data around the mean, which indicates that the data has significant variation. In contrast, a small standard deviation indicates that the data tends to cluster around the mean, signaling low variation. The use of standard deviation is very common in statistical analysis, as it helps researchers and analysts to understand the distribution of data, identify outliers, and make more informed decisions based on the data they have. The use of standard deviation has several important advantages in statistical analysis including providing a deeper understanding of the degree of variation in the data, which helps in assessing the consistency and stability of the process or phenomenon being studied. Standard deviation allows for more meaningful comparisons between different data sets, as it measures how spread the data is around their average. Third, in the context of normal distribution, standard deviation is used to calculate probabilities and make predictions, as a lot of natural data follows this distribution pattern. In addition, standard deviation helps in detecting outliers or data that deviates far from the mean, allowing researchers to conduct more thorough and accurate analysis.

## 2.3 Modification Grey Relational Analysis and Standard Deviation (GRA-S) Method

The Grey Relational Analysis (GRA) method is an analysis technique used to assess the relationship between various alternatives and criteria in situations with incomplete or unclear information. By combining GRA with standard deviation (GRA-S), this approach improves the accuracy of the analysis by taking into account the variation and uncertainty in the data. In GRA-S, standard deviations are used to measure the extent to which alternative values spread out from the mean value, which helps identify alternatives that are not only close to ideal but also have high

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consistency. This approach provides a more comprehensive and robust picture in decision-making by considering data variability, thereby increasing the reliability of analysis results. The first stage in GRA-S is to create a decision matrix using equation (1).

$$X = \begin{bmatrix} x_{11} & x_{21} & x_{2n} \\ x_{12} & x_{22} & x_{2n} \\ x_{m1} & x_{m2} & x_{mn} \end{bmatrix} \tag{1}$$

The decision matrix is organized in a row and column format, where each row represents an available alternative and each column describes the criteria applied. The next stage in GRA-S is to calculate the normalization value of the matrix using equation (2).

$$x_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \tag{2}$$

Data normalization is an important step to ensure that all data is at the same scale so that it can be fairly compared. This process helps in converting the data values into a uniform range, usually between 0 and 1, or in some other consistent form. The next stage in GRA-S is to calculate the standard deviation value of each criterion using equation (3).

$$\sigma_i = \sqrt{\frac{1}{n}\sum_{i=1}^{j}(x_{ij} - \bar{x}_{ij})^2} \tag{3}$$

Standard deviation criteria is a statistical measure that describes how much the value of data on a criterion varies or spreads from the average value. The next stage in GRA-S is to calculate the value of the criterion weights using equation (4).

$$w_j = \frac{\sigma_i}{\sum_{j=1}^{n}\sigma_i} \tag{4}$$

The criterion weight value is a number that reflects the importance or priority of each criterion in the evaluation and decision-making process. The weighting of the criteria is used to exert an appropriate influence on the final calculation, with the aim of adjusting the contribution of each criterion to the total assessment of the alternatives. The next stage in GRA-S is to calculate the value of the alternative relative weight using equation (5).

$$V_{ij} = x_{ij} * w_j \tag{5}$$

The relative value of an alternative is a measure that shows the extent to which an alternative meets the criteria that have been set in the evaluation process. The relative value of an alternative is calculated by considering how well the alternative relates to the criteria compared to other alternatives and the ideal value. The next stage in GRA-S is to calculate the gray relational coefficient value of the equation (6).

$$GRG_i = \frac{1}{n}\sum_{i=1}^{j} V_{ij} \tag{6}$$

The Gray Relational Coefficient value is a measure used in the Gray Relational Analysis (GRA) to describe the extent to which the relationship between the alternative and the criterion is compared to the ideal or reference value. This coefficient gives an indication of how close an alternative is to the ideal value, taking into account the distance between the alternative value and the reference value.

## 3. RESULT AND DISCUSSION

Modification of the Grey Relational Analysis (GRA) method in determining the best mechanics involves adjusting the basic technique to accommodate data variability and specific preferences. In this approach, standard deviations from criteria are used to assess the consistency of mechanical performance, measuring how stable each mechanic is in meeting various criteria such as service quality, completion time, and cost. By modifying the GRA to include these factors, the analysis not only considers how close each mechanic is to the ideal value, but also assesses their stability and consistency of performance. The result is a more comprehensive and accurate assessment, which allows for the selection of mechanics that are not only relatively superior but also reliable in the long run. Through these modifications, the updated GRA method can provide more relevant and practical results, especially in the context of mechanical selection where consistency and quality of service are key. The addition of standard deviation elements helps identify mechanics that not only meet the criteria well but also exhibit consistent and stable performance in a variety of situations. By integrating variability analysis into calculations, final decisions become more data-driven and reflect the specific preferences and needs of customers or users.

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### 3.1 Data Collection

Data collection for the best mechanical assessment involves a systematic process of gathering relevant information regarding mechanical performance based on various evaluation criteria. The first step is to determine the assessment criteria that include important aspects such as quality of work, knowledge, rigor, time efficiency, skills, and communication. Once the data is collected, the analysis process can be carried out to compare and determine the mechanics that best meet the criteria and expectations that have been set. Table 1 is the result of collecting requirements for mechanical performance.

**Table 1.** The result of collecting requirements for mechanical performance

| Name | Quality of Work | Knowledge | Thoroughness | Time Efficiency | Skills | Communication |
|---|---|---|---|---|---|---|
| Mechanic AY | 8 | 9 | 9 | 8 | 7 | 8 |
| Mechanic RD | 6 | 8 | 8 | 7 | 8 | 7 |
| Mechanic FR | 8 | 7 | 9 | 8 | 9 | 8 |
| Mechanic GL | 7 | 8 | 8 | 9 | 8 | 9 |
| Mechanic BS | 8 | 9 | 9 | 7 | 7 | 8 |
| Mechanic HS | 9 | 8 | 9 | 7 | 9 | 7 |
| Mechanic YD | 7 | 8 | 9 | 8 | 8 | 8 |

The mechanical assessment data in table 1 obtained from companies usually includes various types of information that are relevant to evaluate the performance and quality of mechanics in carrying out their duties. This data is obtained through the company's management system, internal reports, customer surveys, and direct observation. By analyzing this data, companies can comprehensively assess mechanical performance, identify strengths and areas of improvement, and make informed decisions regarding assignments, further training, or awards.

### 3.2 Implementation of the GRA-S Method in the Best Mechanical Assessment

The implementation of the GRA-S method in the best mechanical assessment involves a more comprehensive approach by integrating data variability analysis into the evaluation process. In this method, GRA is used to measure the proximity of mechanical performance to ideal criteria, while standard deviations are applied to assess the consistency of mechanical performance in various situations. By combining these two elements, GRA-S allows for assessments that consider not only how well mechanics meet the criteria standards but also how stable and reliable their performance is. The result is a more accurate and representative evaluation, which helps in selecting a mechanic who is not only superior in terms of work results but also consistent in the quality of its services. The first stage in GRA-S is to create a decision matrix using equation (1).

$$X = \begin{bmatrix} 8 & 9 & 9 & 8 & 7 & 8 \\ 6 & 8 & 8 & 7 & 8 & 7 \\ 8 & 7 & 9 & 8 & 9 & 8 \\ 7 & 8 & 8 & 9 & 8 & 9 \\ 8 & 9 & 9 & 7 & 7 & 8 \\ 9 & 8 & 9 & 7 & 9 & 7 \\ 7 & 8 & 9 & 8 & 8 & 8 \end{bmatrix}$$

The next stage in GRA-S is to calculate the normalization value of the matrix using equation (2).

$$x_{11} = \frac{x_{11} - \min x_{11,17}}{\max x_{11,17} - \min x_{11,17}} = \frac{8-6}{9-6} = \frac{2}{3} = 0{,}667$$

The overall results of the calculation of the matrix normalization value in Table 2.

**Table 2.** The overall results of the calculation of the matrix normalization value

| Name | Quality of Work | Knowledge | Thoroughness | Time Efficiency | Skills | Communication |
|---|---|---|---|---|---|---|
| Mechanic AY | 0,667 | 1 | 1 | 0,5 | 0 | 0,5 |
| Mechanic RD | 0 | 0,5 | 0 | 0 | 0,5 | 0 |
| Mechanic FR | 0,667 | 0 | 1 | 0,5 | 1 | 0,5 |
| Mechanic GL | 0,333 | 0,5 | 0 | 1 | 0,5 | 1 |
| Mechanic BS | 0,667 | 1 | 1 | 0 | 0 | 0,5 |
| Mechanic HS | 1 | 0,5 | 1 | 0 | 1 | 0 |
| Mechanic YD | 0,333 | 0,5 | 1 | 0,5 | 0,5 | 0,5 |

The next stage in GRA-S is to calculate the standard deviation value of each criterion using equation (3).

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$$\sigma_1 = \sqrt{\frac{1}{7}\sum_{i=1}^{j}(x_{11,17} - \bar{x}_{11,17})^2} = \sqrt{\frac{1}{7}(1{,}315259132)} = 0{,}4335$$

$$\sigma_2 = \sqrt{\frac{1}{7}\sum_{i=1}^{j}(x_{21,27} - \bar{x}_{21,27})^2} = \sqrt{\frac{1}{7}(1{,}408289982)} = 0{,}4485$$

$$\sigma_3 = \sqrt{\frac{1}{7}\sum_{i=1}^{j}(x_{31,37} - \bar{x}_{31,37})^2} = \sqrt{\frac{1}{7}(3)} = 0{,}6547$$

$$\sigma_4 = \sqrt{\frac{1}{7}\sum_{i=1}^{j}(x_{41,47} - \bar{x}_{41,47})^2} = \sqrt{\frac{1}{7}(1{,}868611089)} = 0{,}5167$$

$$\sigma_5 = \sqrt{\frac{1}{7}\sum_{i=1}^{j}(x_{51,57} - \bar{x}_{51,57})^2} = \sqrt{\frac{1}{7}(3{,}066360475)} = 0{,}6619$$

$$\sigma_6 = \sqrt{\frac{1}{7}\sum_{i=1}^{j}(x_{61,67} - \bar{x}_{61,67})^2} = \sqrt{\frac{1}{7}(1{,}431392194)} = 0{,}4522$$

The next stage in GRA-S is to calculate the value of the criterion weights using equation (4).

$$w_1 = \frac{\sigma_1}{\sum_{j=1}^{n}\sigma_i} = \frac{0{,}4335}{0{,}4335+0{,}4485+0{,}6547+0{,}5167+0{,}6619+{,}4522} = 0{,}1369$$

$$w_2 = \frac{\sigma_2}{\sum_{j=1}^{n}\sigma_i} = \frac{0{,}4485}{0{,}4335+0{,}4485+0{,}6547+0{,}5167+0{,}6619+{,}4522} = 0{,}1416$$

$$w_3 = \frac{\sigma_3}{\sum_{j=1}^{n}\sigma_i} = \frac{0{,}6547}{0{,}4335+0{,}4485+0{,}6547+0{,}5167+0{,}6619+{,}4522} = 0{,}2067$$

$$w_4 = \frac{\sigma_4}{\sum_{j=1}^{n}\sigma_i} = \frac{0{,}5167}{0{,}4335+0{,}4485+0{,}6547+0{,}5167+0{,}6619+{,}4522} = 0{,}1631$$

$$w_5 = \frac{\sigma_5}{\sum_{j=1}^{n}\sigma_i} = \frac{0{,}6619}{0{,}4335+0{,}4485+0{,}6547+0{,}5167+0{,}6619+0{,}4522} = 0{,}2090$$

$$w_6 = \frac{\sigma_6}{\sum_{j=1}^{n}\sigma_i} = \frac{0{,}4522}{0{,}4335+0{,}4485+0{,}6547+0{,}5167+0{,}6619+0{,}4522} = 0{,}1428$$

The next stage in GRA-S is to calculate the value of the alternative relative weight using equation (5).

$$V_{11} = x_{11} * w_1 = 0{,}667 * 0{,}1369 = 0{,}091$$

The overall result calculates the value of the alternative relative weight in Table 3.

**Table 3.** The overall result calculates the value of the alternative relative weight

| Name | Quality of Work | Knowledge | Thoroughness | Time Efficiency | Skills | Communication |
|---|---|---|---|---|---|---|
| Mechanic AY | 0,091 | 0,142 | 0,207 | 0,082 | 0 | 0,071 |
| Mechanic RD | 0 | 0,071 | 0 | 0 | 0,104 | 0 |
| Mechanic FR | 0,091 | 0 | 0,207 | 0,082 | 0,209 | 0,071 |
| Mechanic GL | 0,046 | 0,071 | 0,000 | 0,163 | 0,104 | 0,143 |
| Mechanic BS | 0,091 | 0,142 | 0,207 | 0 | 0 | 0,071 |
| Mechanic HS | 0,137 | 0,071 | 0,207 | 0,000 | 0,209 | 0 |
| Mechanic YD | 0,046 | 0,071 | 0,207 | 0,082 | 0,104 | 0,071 |

The next stage in GRA-S is to calculate the gray relational coefficient value of the equation (6).

$$GRG_1 = \frac{1}{6}\sum_{i=1}^{j} V_{11,61}$$

$$GRG_1 = \frac{1}{6} * (0{,}091 + 0{,}142 + 0{,}207 + 0{,}082 + 0 + 0{,}071)$$

$$GRG_1 = \frac{1}{6} * (0{,}592) = 0{,}099$$

$$GRG_2 = \frac{1}{6}\sum_{i=1}^{j} V_{12,62}$$

$$GRG_2 = \frac{1}{6} * (0 + 0{,}071 + 0 + 0 + 0{,}104 + 0)$$

$$GRG_2 = \frac{1}{6} * (0{,}175) = 0{,}029$$

$$GRG_3 = \frac{1}{6}\sum_{i=1}^{j} V_{13,63}$$

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$$GRG_3 = \frac{1}{6} * (0{,}091 + 0 + 0{,}207 + 0{,}082 + 0{,}209 + 0{,}071)$$
$$GRG_3 = \frac{1}{6} * (0{,}660) = 0{,}110$$
$$GRG_4 = \frac{1}{6} \sum_{i=1}^{j} V_{14,64}$$
$$GRG_4 = \frac{1}{6} * (0{,}046 + 0{,}071 + 0 + 0{,}163 + 0{,}104 + 0{,}143)$$
$$GRG_4 = \frac{1}{6} * (0{,}527) = 0{,}088$$
$$GRG_5 = \frac{1}{6} \sum_{i=1}^{j} V_{15,65}$$
$$GRG_5 = \frac{1}{6} * (0{,}091 + 0{,}142 + 0{,}207 + 0 + 0 + 0{,}071)$$
$$GRG_5 = \frac{1}{6} * (0{,}511) = 0{,}085$$
$$GRG_6 = \frac{1}{6} \sum_{i=1}^{j} V_{16,66}$$
$$GRG_6 = \frac{1}{6} * (0{,}137 + 0{,}071 + 0{,}207 + 0 + 0{,}209 + 0)$$
$$GRG_6 = \frac{1}{6} * (0{,}623) = 0{,}104$$
$$GRG_7 = \frac{1}{6} \sum_{i=1}^{j} V_{17,67}$$
$$GRG_7 = \frac{1}{6} * (0{,}046 + 0{,}071 + 0{,}207 + 0{,}082 + 0{,}104 + 0{,}071)$$
$$GRG_7 = \frac{1}{6} * (0{,}581) = 0{,}097$$

The results of the Gray Relational Coefficient (GRG) value provide a clear indicator of how close each alternative is to the expected ideal value on each criterion. By calculating this coefficient, which ranges from 0 to 1, we can measure the relative proximity between the alternative value and the ideal value. A GRG value close to 1 indicates that the alternative is very close to the ideal value, indicating good performance in the context of the criteria. Conversely, a value close to 0 indicates that the alternative is far from the ideal value, indicating less than optimal performance. These GHG results allow for objective comparisons between alternatives and aid in decision-making by selecting the alternative that best meets the criteria standards.

### 3.3 Best Mechanical Ranking Using the GRA-S Method

The best mechanical ranking using the Grey Relational Analysis with Standard Deviation (GRA-S) method involves a systematic process that integrates the analysis of grey relations with the evaluation of performance consistency. In this approach, an assessment of each mechanic is first carried out based on predetermined criteria, such as quality of work, time efficiency, and cost. The gray relation coefficient is calculated to measure the proximity of mechanical performance to the ideal value. Then, standard deviations are used to assess the consistency and stability of mechanical performance in various situations. The final value is obtained by combining the results of the relationship coefficient and consistency considerations, which results in a mechanical ranking based on overall performance and stability. This GRA-S approach ensures that the selected mechanics are not only superior in terms of results, but also reliable and consistent in providing quality services. Figure 2 is the result of the ranking of the best mechanical assessment.

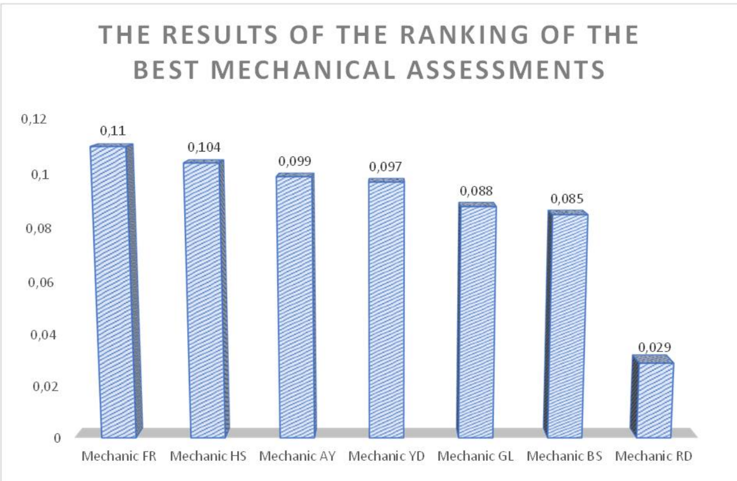


**Figure 1.** The results of the ranking of the best mechanical assessments.

The results of the best ranking of mechanics in figure 2, Mechanic FR ranks first with a value of 0.11, followed by Mechanic HS with a value of 0.104. The third place was occupied by Mechanic AY with a score of 0.099, and

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Mechanic YD was ranked fourth with a score of 0.097. Furthermore, Mechanic GL is ranked fifth with a score of 0.088, followed by Mechanic BS in sixth place with a score of 0.085. Lastly, Mechanic RD ranks seventh with a score of 0.029.

## 4. CONCLUSION

The purpose of the research of the modified Grey Relational Analysis (GRA) using standard deviation is to improve the accuracy and reliability of the decision-making process in situations where the data has a high degree of variability or significant uncertainty. By integrating standard deviations into the GRA, the study aims to account for variations and fluctuations in the data, which allows for more accurate and representative assessment of the criteria. This modification is expected to overcome the weaknesses of traditional GRAs that may not adequately consider data uncertainty, as well as produce more robust and realistic alternative rankings. Ultimately, this study aims to improve the quality of decisions taken based on multi-criteria analysis by giving more appropriate weight to relevant and stable criteria. The results of the best ranking of mechanics, Mechanic FR ranks first with a value of 0.11, followed by Mechanic HS with a value of 0.104. The third place was occupied by Mechanic AY with a score of 0.099, and Mechanic YD was ranked fourth with a score of 0.097. Furthermore, Mechanic GL is ranked fifth with a score of 0.088, followed by Mechanic BS in sixth place with a score of 0.085. Lastly, Mechanic RD ranks seventh with a score of 0.029.

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