



Combination of MOORA and ITARA Methods in Decision Support Systems for Measuring the Performance of Quality Control Teams

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Abstract—The problems that often arise in evaluating the performance of the Quality Control team are the subjectivity in determining the weight of criteria and the limitations of traditional methods in producing objective and consistent rankings. To address this issue, this research integrates the Indifference Threshold-based Attribute Ratio Analysis (ITARA) and Multi-Objective Optimization on the basis of Ratio Analysis (MOORA) methods within a decision support system. The ITARA method is used to determine the weights of criteria based on data variation, making them more representative of real conditions, with the result that Accuracy of Product Defect Identification becomes the most dominant criterion with a weight of 0.3999, followed by Response Speed to Issues at 0.1877, while other criteria have lower weights. Furthermore, the MOORA method is used to calculate the preference of alternatives, resulting in a final ranking. The analysis results indicate that the Quality Assurance Team ranks first, followed by the Quality Improvement Team in second place, while the Quality Inspection Team is in the last position. To test the reliability of the model, a sensitivity analysis was conducted by varying the weights of the main criteria. The results show that the ranking structure is relatively stable, with changes only occurring in the positions of the first and second ranks when the accuracy weight is reduced by 0.2. In conclusion, the combination of ITARA-MOORA proves to be capable of producing objective, robust, and reliable performance evaluations as a basis for strategic decision-making in enhancing the quality of the quality control teams.

Keywords: Decision Support System; ITARA Method; MOORA Method; Quality Control Performance; Sensitivity Analysis

1. INTRODUCTION

The performance measurement of the quality control team plays a very important role in maintaining product quality because through this process, the company can assess the extent to which procedures, standards, and quality targets have been achieved and identify areas that require improvement (Yan et al., 2024). Without a systematic evaluation, the company risks experiencing a decline in quality consistency, which ultimately impacts customer satisfaction and brand reputation. By conducting targeted measurements, the quality control team is not only able to detect defects or production errors early but can also provide constructive feedback for process improvements, increasing workforce skills, and optimizing resource use (Stanković et al., 2024). Additionally, the data from performance measurements can serve as a basis for more accurate managerial decision-making, such as in determining quality improvement strategies, controlling production costs, and meeting industry certification standards. Therefore, performance measurement is not merely an administrative activity, but a strategic instrument that ensures the achievement of products with consistent quality, high competitiveness, and in accordance with consumer expectations.

The challenge of subjectivity in team performance evaluation arises when assessments are more influenced by perceptions, personal preferences, or evaluator biases, rather than by objective and measurable indicators, thus potentially resulting in evaluations that do not reflect the actual conditions (Zhang et al., 2025). In an organizational context, subjectivity is often evident in managers' or superiors' tendencies to make judgments based on personal closeness, brief impressions, or limited experiences, rather than on actual performance achievements. This can create serious problems, such as decreased motivation among team members who feel they are not being assessed fairly, the emergence of internal conflicts, and reduced trust in the evaluation system applied. Furthermore, strategic decisions based on biased evaluation results can lead to mistakes in promotions, incentive distribution, or human resource development planning. Therefore, reducing subjectivity becomes crucial through the implementation of standardized evaluation instruments, the use of verifiable quantitative data, and training for assessors to be able to evaluate consistently and objectively, so that team performance evaluations can truly function as tools to improve productivity and work quality.

Decision Support Systems (DSS) based on the Multi-Criteria Decision Making (MCDM) method play a significant role in addressing the challenges of subjectivity in team performance evaluation (Alamoodi et al., 2024; Kara et al., 2024; Mizrak et al., 2025), as this approach can provide a systematic, transparent, and measurable assessment framework. Through the use of MCDM methods, each performance criterion can be clearly defined, weighted according to its importance, and consistently calculated using structured data, thereby reducing the dominance of subjective factors from the evaluator. MCDM-based DSS also allows for the integration of various assessment



perspectives, both quantitative and qualitative, into a comprehensive decision-making model (Hendrastuty et al., 2024; Megaraty et al., 2024), resulting in evaluations that are more objective, fair, and accountable. In addition, this system facilitates the management of large amounts of information and helps decision-makers compare alternatives or individuals based on the same criteria with a consistent approach (Fetanat & Tayebi, 2024). The MCDM-based DSS not only enhances the reliability of team performance evaluation results but also strengthens the legitimacy of managerial decisions related to promotions, awards, and the development of human resource competencies. The main advantage of implementing MCDM-based DSS is its ability to produce more objective decisions because it is based on measurable calculations, not just the perceptions of the evaluators. This system also increases the efficiency of the evaluation process by integrating various criteria into a single model that is easy to understand and access. Furthermore, MCDM-based decision support systems provide organizations with the flexibility to adjust the weights of the criteria according to strategic needs, ensuring that the evaluation results remain relevant to the company's long-term goals (Anjum et al., 2024).

The Multi-Objective Optimization based on Ratio Analysis (MOORA) is a widely used MCDM method due to its simplicity and ability to deliver objective and consistent result (Isnain & Rahmanto, 2024; Magableh, 2024; Rani et al., 2023). The advantage of MOORA lies in its capability to handle complex decision-making problems with a large number of criteria and alternatives, without compromising the accuracy of the evaluation results (Gunasekaran et al., 2025; Mota et al., 2024). The advantage of the MOORA method is its relatively simple calculation process, making it easy to understand and apply by practitioners and researchers alike. This method also has a high level of flexibility as it can accommodate criteria with both profit and cost characteristics simultaneously. Furthermore, MOORA has proven to be efficient in processing complex data, providing evaluations that are objective, consistent, and can serve as a reliable basis for decision-making.

The Indifference Threshold-Based Attribute Ratio Analysis (ITARA) method is one approach in determining criterion weights that focuses on the degree of difference or sensitivity among attributes in the decision-making process (Ahmadi Pargo & Hashemkhani Zolfani, 2025; M. Wu et al., 2024). The advantage of ITARA lies in its ability to reduce distortion caused by minor fluctuations in data, making the resulting criterion weights more stable, fair, and reflective of the true relevance of each criterion in the context of evaluation (Simic et al., 2023; Meiqin Wu et al., 2023). Another advantage of the ITARA method is its ability to produce more representative criterion weights because it considers meaningful thresholds of relevant differences (M. Wu et al., 2024). This method also minimizes the influence of noise or minor variations in insignificant data, resulting in more stable and reliable weighting results. Furthermore, ITARA provides flexibility in adjusting the sensitivity of assessments according to the decision context, making it more adaptive to both practical and academic needs.

Previous studies have shown that weighting in MCDM, particularly in the MOORA and ITARA methods, remains a major concern in improving the objectivity of decision-making outcomes. Research from (Hatefi, 2019) introduced ITARA to reduce subjectivity in weighting and demonstrated improved weight stability; however, it has not been compared with subjective methods such as AHP within the same context. Research from (Ulutaş et al., 2020) integrated CCSD-ITARA-MARCOS for logistics equipment selection, yet the application remains limited and lacks explicit comparisons between objective and subjective weighting. Research from (Singh et al., 2024), through a literature review, found that MOORA is widely applied due to its simplicity, but subjective expert-based weighting remains dominant and consistency in objective weighting is still lacking. Research from (Prayoga et al., 2022) compared ROC and FUCOM within MOORA and achieved high ranking accuracy, but did not incorporate objective weighting such as ITARA to validate improvements in decision quality. Therefore, this research is conducted to bridge these gaps by integrating ITARA and MOORA to produce more objective, accurate, and accountable alternative rankings.

The integration of the ITARA weighting method and the MOORA ranking method in evaluating the performance of the quality control team makes an important contribution to creating a more objective, fair, and comprehensive assessment system. ITARA plays a role in producing more accurate criterion weights by considering the threshold of significant differences among attributes, allowing each criterion relevant to the team's performance to be assessed according to its level of importance proportionally. Meanwhile, MOORA is used to perform the ranking process for alternatives based on normalization results and ratio calculations, which can provide a clear and measurable comparison of performance among team members or units. The integration of these two methods not only reduces the potential subjectivity in evaluation but also increases the reliability of the results that can serve as a basis for managerial decision-making related to promotions, training, and the development of quality improvement strategies. Thus, the combination of ITARA and MOORA presents a more effective evaluation model in supporting the achievement of product quality standards and strengthening the competitiveness of the organization. Most previous studies still used subjective weighting in MOORA, which could potentially lead to bias in the ranking of alternatives. Therefore, this study aims to fill the gap by applying more objective weighting to improve the accuracy and credibility of decision-making results.

In this study, the proposed method is applied to a case study at XYZ manufacturing company, which faces challenges in evaluating and determining the best alternatives. Direct application in a real industrial environment provides insight into the effectiveness of the approach under actual operational conditions. Thus, this study not only contributes theoretically but also provides practical benefits for decision-makers in the manufacturing sector. The purpose of this research is to apply a performance evaluation model for the quality control team by integrating the

ITARA weighting method and the MOORA ranking method, resulting in more objective, accurate, and consistent assessment outcomes. Through this integration, the research aims to minimize subjectivity in the evaluation process, while also ensuring that each criterion is assessed according to its level of importance and that performance alternatives can be compared fairly and measurably. The contribution of this research lies in providing a new approach to decision-making in the field of quality management, particularly in assessing the effectiveness of quality control teams, which can serve as a reference for both practitioners and academics. Moreover, the results of this research are expected to provide an empirical basis for the development of product quality improvement strategies, more targeted human resource management, and to support companies in maintaining competitiveness through consistent and assured quality.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The stages of the research in the combination of MOORA and ITARA methods to measure the performance of the quality control team by building a decision support system that can provide performance evaluation results objectively, fairly, and accurately. The stages of research applied in this study are shown in figure 1.

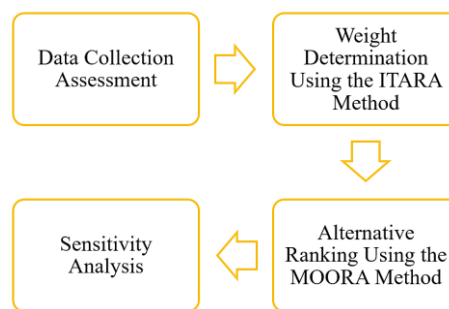


Figure 1. Research Stage

Figure 1 is the research flow that illustrates the systematic stages in performance evaluation with the integration of ITARA and MOORA methods. The process begins with data collection for assessment, where information related to criteria and alternatives is comprehensively gathered to represent the actual conditions of the evaluated team. Next, the weight determination stage using the ITARA method is conducted to determine the relative importance levels of each criterion by considering the threshold of significant differences, so that the obtained weights are more objective and stable. After the criteria weights are determined, the process continues to the ranking of alternatives using the MOORA method, where the normalized data is processed to compare the performance of each alternative based on both benefit and cost criteria, resulting in a final ranking order. The last stage is sensitivity analysis, which aims to test the reliability and stability of the calculations by examining how changes in the criteria weights affect the ranking of alternatives, thereby ensuring the model's validity. With this flow, the research is able to produce a measurable, objective, and accountable performance evaluation in the context of managerial decision-making.

2.2 Data Collection and Research Context

This study is conducted within the operational environment of quality management, focusing on the performance evaluation of eight Quality Control (QC) teams, namely the Main Quality Control Team, Quality Inspection Team, Product Evaluation Team, Quality Assurance Team, Quality Audit Team, Production Monitoring Team, Quality Improvement Team, and Quality Verification Team, all of which play a crucial role in ensuring the consistency and reliability of the company's product quality. The performance of each team is assessed based on five key criteria established by the management: Accuracy of Product Defect Identification, Response Speed to Issues, Compliance with Standard Operating Procedures (SOP), Rework Error Rate, and Achievement of Inspection Targets. These criteria were selected to comprehensively reflect both technical capabilities and the operational effectiveness of quality control practices. The assessment data utilized in this research comes from the company's historical records, including periodic performance reports and documented results of internal quality audits, ensuring objective and evidence-based evaluation. This work adopts a case study research design, as it specifically analyzes the QC evaluation system within a single organization. Furthermore, the ITARA method is applied to determine the objective significance of each criterion, while MOORA is employed to generate a more accurate and systematic ranking of the QC teams. The outcomes of this study are expected to support strategic decision-making in continuous improvement initiatives, contributing to enhanced efficiency and competitive performance within the company's quality management framework.

2.3 Indifference Threshold-based Attribute Ratio Analysis (ITARA) Method

The ITARA method is one of the criterion weighting methods in MCDM used to determine the relative importance level of each criterion by considering the indifference threshold. The main principle of ITARA is that not all differences



in values between alternatives are considered significant, so only differences that exceed a certain threshold will affect the criterion weights (Hatefi, 2019; Simić et al., 2023). Thus, the resulting weights are more representative, stable, and aligned with the actual relevance of each criterion in the evaluation process.

The first stage of the ITARA method is to compile a decision matrix that contains the performance data of each alternative against various criteria. This matrix includes the initial values of each alternative according to the predefined indicators using the following equation.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1j} \\ \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} \end{bmatrix}; i = 1, 2, \dots, m; j = 1, 2, \dots, n \quad (1)$$

The second stage of the ITARA method is to calculate the normalization value and the normalization of the indifference threshold, as each criterion may have different units or scales. The values in the decision matrix are normalized to be fairly compared using the following equation.

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

$$NIT_j = \frac{IT_j}{\sum_{i=1}^m x_{ij}} \quad (3)$$

The third stage of the ITARA method is to sort the elements of matrix X in ascending order to form matrix β . Here, the rows of matrix β do not represent alternatives, which are used as the basis for the normalized values to assess the weight of risk factors. The aspiration level $\beta_{aspire,j}$ must be the minimum value, thus it will be sorted as the first one indicated in Equation (4).

$$\beta = \beta_{ij} = \begin{bmatrix} \beta_{aspire,1} & \cdots & \beta_{aspire,j} \\ \beta_{11} & \cdots & \beta_{1j} \\ \vdots & \ddots & \vdots \\ \beta_{i1} & \cdots & \beta_{ij} \end{bmatrix}; i = 1, 2, \dots, m; j = 1, 2, \dots, n \quad (4)$$

The fourth stage of the ITARA method is to calculate the ideal value of each criterion. This ideal value usually represents the best score for each criterion, which will serve as a reference in assessing the differences between alternatives calculated using the following equation.

$$\gamma_{ij} = \beta_{i+1,j} - \beta_{ij} \quad (5)$$

The fifth stage of the ITARA method is to calculate the difference with the indifference threshold. If the difference is smaller than the threshold, it is considered insignificant and ignored. Conversely, if the difference is greater than the threshold, the difference is deemed meaningful and affects the criteria weights using the following equation.

$$\varepsilon_{ij} = \begin{cases} \gamma_{ij} - NIT_j; & \text{for } \gamma_{ij} > NIT_j \\ 0 & ; \text{for } \gamma_{ij} \leq NIT_j \end{cases} \quad (6)$$

In the ITARA method, the indifference threshold value serves to determine whether differences between values in a criterion are considered significant and influential in weighting. In this study, the value of ε was set at 0.5, referring to common practices in previous research that used ITARA in the context of performance evaluation based on operational data. The selection of this ε value aims to maintain methodological consistency and ensure that variations in values with sufficiently large differences can be identified and contribute proportionally to weight determination. By adopting a threshold value that has been validated in previous studies, the weighting process in this research maintains the principle of objectivity and can be compared with the results of similar studies more credibly.

The sixth stage of the ITARA method is to calculate the number of significant differences for each criterion collected to produce the variable scores or sensitivity levels of each criterion. The more frequently a criterion shows significant differences between alternatives, the greater its contribution to the weighting using the following equation.

$$v_j = \left(\sum_{i=1}^{m-1} \varepsilon_{ij} \right)^{1/p} \quad (7)$$

The seventh stage of the ITARA method is to calculate the relative weights of each criterion that reflect the level of importance of these criteria in distinguishing alternatives effectively using the following equation.

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

The weighting results using the ITARA method show that the obtained criteria weighting is more representative because it considers significant differences among alternatives by taking into account the indifference threshold. The resulting weights not only reflect mathematical values, but also the actual relevance of each criterion in distinguishing the performance of alternatives. This makes the weighting results more stable, objective, and capable of reducing the



influence of minor variations that are not meaningful in the data. Therefore, the ITARA method can be a reliable approach in weighting criteria to support a more accurate and fair decision-making process.

2.4 Multi-Objective Optimization based on Ratio Analysis (MOORA) Method

The MOORA method is a popular technique in the MCDM framework used to solve multi-criteria decision-making problems. This method is widely recognized for its simplicity, efficiency, and its ability to produce objective and consistent evaluation results. The basic principle of MOORA is to normalize the alternative values against each criterion, and then perform ratio calculations to assess how close an alternative is to the best condition.

The initial step of the MOORA method is to form a decision matrix that contains the alternatives to be evaluated and the performance scores of each alternative against a number of criteria. These values can be in the form of quantitative data or data that has been converted into numeric form using equation (1).

The next step in the MOORA method is the normalization of the decision matrix, as each criterion may have different units and scales, normalization is necessary to ensure that all values are on the same scale using the following equation.

$$x_{ij}^* = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (9)$$

The final step of the MOORA method is to calculate the optimization value for each alternative by summing all the normalized values for the benefit criteria, then subtracting the normalized values for the cost criteria calculated using the following equation.

$$y_i = \sum_{j=1}^g (x_{ij}^* * w_j) - \sum_{j=g+1}^n (x_{ij}^* * w_j) \quad (10)$$

The MOORA method emphasizes that this technique is one of the simple yet effective approaches in MCDM that helps in decision-making with many criteria; this method is able to produce objective, transparent, and easily understood rankings of alternatives.

2.5 Sensitivity Analysis

Sensitivity analysis is an important approach in research as well as in decision-making practices aimed at assessing the extent to which changes in input parameters, such as criterion weights or alternative values, can affect the final evaluation results. In the context of MCDM, sensitivity analysis is used to test the stability of alternative rankings generated by a given method. This is done by gradually changing the weights or values of certain criteria and then observing the impact on the ranking positions of alternatives. In this way, both researchers and decision-makers can understand which criteria have the most influence on the evaluation results and ensure that the decisions made are not only based on static calculations but also take into account variations that may occur in real conditions.

Sensitivity analysis serves as a validation tool that enhances the credibility of the evaluation model by demonstrating the reliability and consistency of results. If the ranking results do not change much despite variations in the weights of the criteria, the model is considered stable and can serve as a strong basis for decision-making. Conversely, if small changes in weights lead to significant shifts in rankings, this indicates a need for more attention to the criteria or even a revision in weighting determination. Therefore, sensitivity analysis not only provides an overview of decision resilience but also helps organizations identify the most critical determining factors, allowing for more targeted strategies and reducing the risk of errors in decision-making.

Sensitivity analysis in this study is conducted to evaluate the stability of the ranking results when the criterion weights obtained from ITARA undergo changes. Four scenarios are applied: a decrease of 0.2, a decrease of 0.1, an increase of 0.2, and an increase of 0.1 for each criterion individually, while the remaining criteria weights are proportionally adjusted to ensure the total weight remains equal to 1. For each scenario, the rankings are recalculated using the MOORA method to determine whether significant changes occur in the final ranking order. If the ranking results remain consistent despite weight variations, the decision-making model can be considered robust and reliable for supporting managerial strategic decisions.

3. RESULTS AND DISCUSSION

The combination of the MOORA and ITARA methods in decision support systems offers a systematic approach to measuring the performance of quality control teams. MOORA is used to evaluate alternatives based on the optimal ratios of various criteria, making the comparison results more measurable and objective. Meanwhile, ITARA works in determining the weight of criteria by considering the threshold of indifference among attributes, resulting in a more realistic and unbiased weighting process. By combining these two methods, the performance evaluation of quality control teams can take into account the differences in importance among criteria while also producing accurate rankings of alternatives. In measuring the performance of the quality control team, the combination of MOORA and ITARA can assist management in identifying staff or teams with the best performance based on structured data. ITARA provides more representative criteria weights that reflect real conditions, while MOORA optimizes the final results through a ratio calculation process. The results obtained not only reflect performance rankings but also provide a strong



foundation for strategic decision-making, such as in determining promotions, evaluating productivity, or improving work processes. This approach ensures that the evaluation of the quality control team's performance is transparent, measurable, and relevant to the organization's goals.

3.1 Data Collection Assessment

Data collection is a very important initial stage in the assessment process because it serves as the main foundation for further analysis. At this stage, data is systematically collected from various relevant sources according to the research or evaluation objectives, whether through direct observation, interviews, questionnaires, or documentation. The quality and completeness of the data obtained will greatly influence the accuracy of the assessment results, making careful planning necessary in determining the types of data, collection techniques, and instruments used. With a structured approach, the data collection process can produce valid and reliable information to support objective decision-making. Data collection assessment in measuring the performance of quality control teams is a crucial stage for obtaining accurate and comprehensive information related to the activities, responsibilities, and results of the team's work. This process involves collecting data through inspection records, production reports, quality audit results, and customer feedback, allowing for an objective analysis of performance. The data obtained not only reflects the level of achievement of quality targets but also serves as a basis for identifying weaknesses, strengths, and improvement opportunities. With systematic data collection, organizations can ensure that the performance assessment of quality control teams is conducted in a measurable, transparent manner and supports continuous quality improvement. Table 1 presents the results of data collection from the performance of quality control teams.

Table 1. Results of data collection assessment

Team Name	Accuracy of Product Defect Identification (Benefit)	Response Speed to Issues (Benefit)	Compliance with Standard Operating Procedures (Benefit)	Rework Error Rate (Benefit)	Achievement of Inspection Targets (Benefit)
Main Quality Control Team	72	85	60	90	75
Quality Inspection Team	80	78	70	85	82
Product Evaluation Team	65	88	55	88	78
Quality Assurance Team	90	70	68	92	80
Quality Audit Team	75	82	62	80	74
Production Monitoring Team	68	76	66	86	70
Quality Improvement Team	82	84	64	89	77
Quality Verification Team	70	79	58	83	73

The data presented in table 1 is the result of the performance assessment of the Quality Control (QC) team based on a number of measurable criteria. This data source is obtained from the company's internal reports through a combination of methods, such as quality audit results, daily inspection records, production reports, and performance evaluations of QC staff by supervisors. In addition, some of the data may come from direct observations in the field or recapitulations of product inspection results over a certain period. Thus, the data represents a quantitative depiction of the QC team's performance achievements that can be used as a basis for analysis in the decision support system.

3.2 Weight Determination Using the ITARA Method

The determination of weights using the ITARA method is conducted with a ratio-based approach and an indifference threshold to ensure that insignificant differences in criteria values do not excessively affect the final results. The advantage of ITARA lies in its ability to provide more realistic weights because not all value differences are considered significant. Thus, the resulting weights are more representative of real conditions, especially in cases where criteria have almost identical values. In the context of measuring the performance of the quality control team, the application of ITARA helps management obtain objective and logical criterion weights, making the evaluation results fairer and supporting informed decision-making.

The first stage of the ITARA method is to compile a decision matrix containing performance data for each alternative based on various criteria. This matrix includes the initial values of each alternative based on the criteria from Table 1, which was created using equation (1), the results of the decision matrix are as follows.

$$X = \begin{bmatrix} 72 & 85 & 60 & 90 & 75 \\ 80 & 78 & 70 & 85 & 82 \\ 65 & 88 & 55 & 88 & 78 \\ 90 & 70 & 68 & 92 & 80 \\ 75 & 82 & 62 & 80 & 74 \\ 68 & 76 & 66 & 86 & 77 \\ 82 & 84 & 64 & 89 & 77 \\ 70 & 79 & 58 & 83 & 73 \end{bmatrix}$$



The second stage of the ITARA method is to calculate the normalization value and the normalization of the indifferent threshold, as each criterion may have different units or scales. The normalization value is calculated using equation (2), and the results of the normalization value calculations are displayed in table 2.

Table 2. Normalization results of the ITARA method

Team Name	Accuracy of Product Defect Identification	Response Speed to Issues	Compliance with Standard Operating Procedures	Rework Error Rate	Achievement of Inspection Targets
Main Quality Control Team	0.1196	0.1324	0.1193	0.1299	0.1232
Quality Inspection Team	0.1329	0.1215	0.1392	0.1227	0.1346
Product Evaluation Team	0.1080	0.1371	0.1093	0.1270	0.1281
Quality Assurance Team	0.1495	0.1090	0.1352	0.1328	0.1314
Quality Audit Team	0.1246	0.1277	0.1233	0.1154	0.1215
Production Monitoring Team	0.1130	0.1184	0.1312	0.1241	0.1149
Quality Improvement Team	0.1362	0.1308	0.1272	0.1284	0.1264
Quality Verification Team	0.1163	0.1231	0.1153	0.1198	0.1199

Next, calculate the normalization value of the indifferent threshold using equation (3), the result of the calculation of the normalization value of the indifferent threshold is displayed in table 3.

Table 3. Normalization value of the indifferent threshold results of the ITARA method

	Accuracy of Product Defect Identification	Response Speed to Issues	Compliance with Standard Operating Procedures	Rework Error Rate	Achievement of Inspection Targets
NIT_j	0.0017	0.0016	0.0020	0.0014	0.0016

In the ITARA method, the indifference threshold determines whether the difference between values in each criterion is significant in the weighting process. In this study, the threshold was set to 0.5, based on previous ITARA applications in performance evaluation studies. This value ensures methodological consistency and allows significant variations in criterion values to be properly reflected in the objective weighting results.

The third stage of the ITARA method is to sort the elements of matrix X in ascending order to form matrix β created using Equation (4).

$$X = \begin{bmatrix} 0.0767 & 0.0723 & 0.0904 & 0.0673 & 0.0759 \\ 0.0997 & 0.1012 & 0.0995 & 0.1077 & 0.1062 \\ 0.1043 & 0.1098 & 0.1049 & 0.1117 & 0.1108 \\ 0.1074 & 0.1127 & 0.1085 & 0.1144 & 0.1123 \\ 0.1104 & 0.1142 & 0.1121 & 0.1157 & 0.1138 \\ 0.1150 & 0.1185 & 0.1157 & 0.1184 & 0.1168 \\ 0.1227 & 0.1214 & 0.1193 & 0.1198 & 0.1184 \\ 0.1258 & 0.1228 & 0.1230 & 0.1211 & 0.1214 \\ 0.1380 & 0.1272 & 0.1266 & 0.1238 & 0.1244 \end{bmatrix}$$

The fourth stage of the ITARA method is calculating the ideal value for each criterion. This ideal value usually represents the best score for each criterion calculated using equation (5), and the calculation results are presented in table 4.

Table 4. The ideal score result for each criterion of the ITARA method

Accuracy of Product Defect Identification	Response Speed to Issues	Compliance with Standard Operating Procedures	Rework Error Rate	Achievement of Inspection Targets
0.0230	0.0289	0.0091	0.0404	0.0303
0.0046	0.0086	0.0054	0.0040	0.0046
0.0031	0.0029	0.0036	0.0027	0.0015
0.003	0.0015	0.0036	0.0013	0.0015
0.0046	0.0043	0.0036	0.0027	0.003
0.0077	0.0029	0.0036	0.0014	0.0016
0.0031	0.0014	0.0037	0.0013	0.003
0.0122	0.0044	0.0036	0.0027	0.003

The fifth stage of the ITARA method is to calculate the difference with the indifference threshold, this difference is considered significant and affects the weight of the criteria calculated using equation (6), the calculation results are displayed in table 5.



Table 5. The difference with the indifference threshold of the ITARA method

Accuracy of Product Defect Identification	Response Speed to Issues	Compliance with Standard Operating Procedures	Rework Error Rate	Achievement of Inspection Targets
0.0213	0.0273	0.0071	0.0390	0.0287
0.0029	0.0070	0.0034	0.0026	0.0030
0.0014	0.0013	0.0016	0.0013	0.0000
0.0013	0.0000	0.0016	0.0000	0.0000
0.0029	0.0027	0.0016	0.0013	0.0014
0.0060	0.0013	0.0016	0.0000	0.0000
0.0014	0.0000	0.0017	0.0000	0.0014
0.0105	0.0028	0.0016	0.0013	0.0014

The sixth stage of the ITARA method is to calculate the number of significant differences for each criterion collected to produce a score for the variable or the sensitivity level of each criterion calculated using equation (7), with the calculation results displayed in table 6.

Table 6. The significant differences for each criterion of the ITARA method

Accuracy of Product Defect Identification	Response Speed to Issues	Compliance with Standard Operating Procedures	Rework Error Rate	Achievement of Inspection Targets
0.2996	0.1406	0.1188	0.1017	0.0884

The seventh stage of the ITARA method is to calculate the relative weight of each criterion that reflects the importance level of that criterion in effectively distinguishing alternatives using equation (8), the calculation results are displayed in table 7.

Table 7. The relative weight of each criterion of the ITARA method

Accuracy of Product Defect Identification	Response Speed to Issues	Compliance with Standard Operating Procedures	Rework Error Rate	Achievement of Inspection Targets
0.3999	0.1877	0.1586	0.1357	0.1181

The results of the weight determination using the ITARA method show that the Accuracy of Product Defect Identification received the highest weight of 0.3999, indicating that precision in identifying product defects is the most dominant factor in measuring the performance of the Quality Control team. Furthermore, Response Speed to Issues has a weight of 0.1877, reflecting the importance of the team's speed in addressing quality issues. Compliance with Standard Operating Procedures is at a weight of 0.1586, indicating that adherence to standard procedures still significantly contributes to the effectiveness of quality control. Meanwhile, Rework Error Rate received a weight of 0.1357, emphasizing that the rate of rework errors needs to be monitored, although it is not as significant as the other factors. Finally, the Achievement of Inspection Targets has the lowest weight, which is 0.1181, meaning that the achievement of the number of inspections remains relevant but is not as important as the accuracy of defect identification in products. Overall, these weight results reaffirm that the quality aspects of inspections are prioritized over merely the quantity of inspections in assessing the performance of the QC team.

3.3 Alternative Ranking Using the MOORA Method

The MOORA method is used to determine the ranking of alternatives based on their relative performance against a set of weighted criteria. In measuring the performance of Quality Control teams, each team serves as an alternative for comparison. The team with the highest optimization score is considered to have the best performance because it meets the assessment criteria more effectively than other teams. Meanwhile, lower rankings reflect the need for evaluation and improvement in certain aspects. With the MOORA approach, decision-making becomes more transparent because each ranking is based on an objective mathematical calculation process, rather than solely on subjective considerations.

The initial step of the MOORA method is to form a decision matrix that contains the alternatives to be evaluated and the performance scores of each alternative against a number of criteria. These values can be in the form of quantitative data or data that has been converted into numeric form using equation (1).

$$X = \begin{bmatrix} 72 & 85 & 60 & 90 & 75 \\ 80 & 78 & 70 & 85 & 82 \\ 65 & 88 & 55 & 88 & 78 \\ 90 & 70 & 68 & 92 & 80 \\ 75 & 82 & 62 & 80 & 74 \\ 68 & 76 & 66 & 86 & 77 \\ 82 & 84 & 64 & 89 & 77 \\ 70 & 79 & 58 & 83 & 73 \end{bmatrix}$$

The next step in the MOORA method is the normalization of the decision matrix, as each criterion may have different units and scales, normalization is necessary to ensure that all values are on the same scale calculated using equation (9), the calculation results are shown in table 8.

Table 8. Normalization results of the MOORA method

Team Name	Accuracy of Product Defect Identification	Response Speed to Issues	Compliance with Standard Operating Procedures	Rework Error Rate	Achievement of Inspection Targets
Main Quality Control Team	0.3365	0.3736	0.3364	0.3670	0.3479
Quality Inspection Team	0.3739	0.3429	0.3925	0.3466	0.3804
Product Evaluation Team	0.3038	0.3868	0.3084	0.3588	0.3618
Quality Assurance Team	0.4206	0.3077	0.3813	0.3752	0.3711
Quality Audit Team	0.3505	0.3605	0.3476	0.3262	0.3433
Production Monitoring Team	0.3178	0.3341	0.3701	0.3507	0.3247
Quality Improvement Team	0.3832	0.3693	0.3588	0.3629	0.3572
Quality Verification Team	0.3272	0.3473	0.3252	0.3385	0.3386

The last step of the MOORA method is to calculate the optimization value for each alternative by summing all the normalized values for the benefit criteria, then subtracting the normalized values for the cost criteria calculated using equation (10), with the calculation results displayed in table 9.

Table 9. Optimization value for each alternative of the MOORA method

Team Name	Optimization Value
Main Quality Control Team	0.3489
Quality Inspection Team	0.3681
Product Evaluation Team	0.3344
Quality Assurance Team	0.3812
Quality Audit Team	0.3478
Production Monitoring Team	0.3344
Quality Improvement Team	0.3709
Quality Verification Team	0.3335

The final result of applying the MOORA method produces alternative rankings that show the performance order of the Quality Control teams based on calculated optimization values. Each team receives a composite score from a combination of normalization values and ITARA weights, where beneficial criteria such as accuracy in identifying product defects, response speed, adherence to SOPs, and achieving inspection targets contribute positively, while cost criteria such as the rate of rework diminish the total value. The team with the highest optimization value is ranked first as the best-performing team, while the team with the lowest score occupies the last position, indicating a significant need for improvement. Thus, this ranking result not only provides an objective picture of each team's position but also serves as a strong foundation for management to conduct evaluations, coaching, and make strategic decisions related to quality improvement. Thus, the results of this ranking not only provide an objective picture of the positions of each team but also serve as a strong foundation for management in conducting evaluations, mentoring, and making strategic decisions related to quality improvement. Figure 2 shows the results of the alternative ranking.



Figure 2. Results of Alternative Ranking

The ranking results of the Quality Control team's performance using the MOORA method show that the Quality Assurance Team ranks first with a score of 0.3812, indicating the best performance compared to other teams. The second position is held by the Quality Improvement Team with a score of 0.3709, followed by the Quality Inspection Team with a score of 0.3681. Next, the Main Quality Control Team has a score of 0.3489, followed by the Quality

Audit Team with 0.3478. The other three teams, namely the Product Evaluation Team and the Production Monitoring Team, each have the same score of 0.3344, while the Quality Verification Team ranks last with a score of 0.3335. These results show a variation in performance among QC teams, where teams with higher scores are considered more effective in carrying out quality control tasks, while teams with lower scores need special attention to improve performance. Based on the obtained decision results, the management should prioritize strategic corrective actions for the Quality Verification Team—which currently occupies the lowest rank with a performance score of 0.3335—by identifying the root causes of their low achievement and implementing targeted interventions through enhanced training programs, increased supervision, and improvements in workflow efficiency to strengthen their contribution to the overall quality control system.

3.4 Sensitivity Analysis

Sensitivity Analysis in the context of decision support systems is a process to test how stable the ranking results of alternatives are when there are changes in the criteria weights or initial data values. This analysis is important to perform because in practice, determining the criteria weights often contains uncertainties, both due to the subjectivity of decision-makers and variations in real conditions in the field. By conducting sensitivity analysis, it can be determined whether the ranking results of the Quality Control team remain consistent or experience significant shifts when certain criteria weights are increased or decreased. In the case of measuring the performance of the QC team using a combination of ITARA and MOORA methods, sensitivity analysis helps evaluate how much the dominant criteria, such as the Accuracy of Product Defect Identification, impact the final ranking order. If small changes in the weights of key criteria cause significant shifts in the ranking results, then the system is considered sensitive and management needs to be cautious in assigning weights. Conversely, if the relative rankings remain stable despite changes in weights, then the evaluation results can be considered more robust and reliable as a basis for decision-making.

The scenario of weight change in sensitivity analysis is formulated to test the extent to which the ranking results of alternatives are influenced by shifts in the importance level of each criterion. In this study, the initial weights obtained from the ITARA method are used as a reference, followed by variations on the main criterion, namely the Accuracy of Product Defect Identification, with a decrease of 20 percent and 10 percent as well as an increase of 10 percent and 20 percent, while the weights of other criteria are adjusted proportionally so that the total weight remains equal to one. This approach aims to assess the stability of the MOORA ranking results, identify the criteria that are most sensitive to changes, and ensure that the decision recommendations remain consistent despite differences in weight emphasis among criteria. Table 10 presents the scenario of weight changes in criteria.

Table 10. Criteria weight change scenario

Criteria	Baseline	A decrease of 0.2	A decrease of 0.1	An increase of 0.2	An increase of 0.1
Accuracy of Product Defect Identification	0.3999	0.3199	0.3599	0.4399	0.4799
Response Speed to Issues	0.1877	0.2127	0.2002	0.1752	0.1627
Compliance with Standard Operating Procedures	0.1586	0.1797	0.1692	0.148	0.1375
Rework Error Rate (cost)	0.1357	0.1538	0.1447	0.1267	0.1176
Achievement of Inspection Targets	0.1181	0.1338	0.126	0.1102	0.1024

The results of the MOORA ranking from the weight change scenario show how variations in the importance level of criteria affect the position of alternatives in evaluating the performance of the quality control team. Using the initial weight of ITARA as a basis, testing was conducted on the criteria of Accuracy of Product Defect Identification, which was altered and increased across several scales, and then compared with the baseline ranking results. The results of the weight change ranking are displayed in Figure 3.

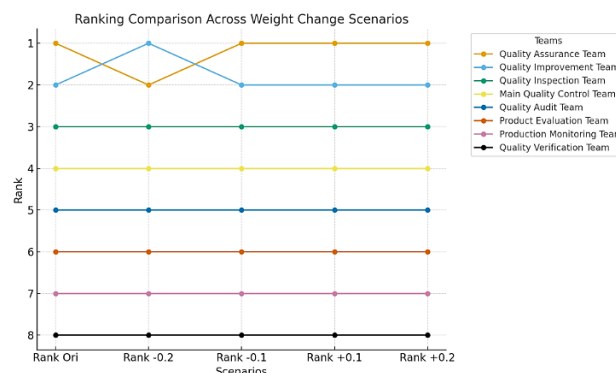


Figure 3. Ranking Results from Weight Changes



The comparison ranking graph shows that most Quality Control teams maintain a consistent position across all scenarios of weight changes, thus affirming the stability of the MOORA method results. There is only a shift in the Quality Assurance Team and Quality Improvement Team when the weight of Accuracy of Product Defect Identification is reduced by 20 percent, where the Quality Assurance team drops to second place and the Quality Improvement team rises to first place. Meanwhile, other teams such as the Quality Inspection Team, Main Quality Control Team, and others remain in their original rankings without change. This consistency indicates that the decision-making model is relatively insensitive to moderate changes in criterion weights, making the performance evaluation results considered reliable.

The results of the sensitivity analysis show that the ranking results of the Quality Control team are relatively stable even though the weight of the Accuracy of Product Defect Identification criterion has been modified in various scenarios. Rank shifts only occurred for the Quality Assurance Team and the Quality Improvement Team when the accuracy weight was reduced by 20 percent, while other teams remained consistent in their original positions. This confirms that the MOORA model used is quite robust against variations in weight, so the performance evaluation results can be relied upon. Thus, the sensitivity analysis contributes to reinforcing the confidence that this decision support system is capable of providing recommendations that are stable, transparent, and valid despite changes in the factors determining the weight.

3.5 Discussion

The application of the MOORA method in evaluating the performance of Quality Control teams has successfully produced a structured and objective ranking outcome based on multiple performance indicators. The Quality Assurance Team emerged as the top performer, followed by the Quality Improvement Team and the Quality Inspection Team. This finding highlights that their operational practices are more effective in ensuring product quality consistency and meeting performance targets compared to other teams. Meanwhile, teams with lower scores, such as the Quality Verification Team, require managerial attention and targeted performance improvement programs to reduce gaps in quality control execution. Overall, the MOORA-based ranking provides a transparent and justifiable evaluation mechanism for organizational decision-making.

The findings also indicate that the criteria of Accuracy of Product Defect Identification plays a dominant role in determining team performance. This emphasis aligns with the core function of Quality Control, where accurate defect detection is essential to preventing downstream production disruptions and enabling corrective actions. The integration of ITARA weighting further ensures that such dominance arises from objective differentiation in performance levels, instead of subjective managerial judgment. This reinforces the validity of the evaluated performance outcomes and reduces the potential for bias in assessing team contributions to organizational quality outcomes.

Sensitivity analysis confirms the robustness of the decision support model, as changes in weights—whether decreased or increased—resulted in minimal shifts in the final ranking. Only a significant bias reduction scenario (-20%) led to position changes between the top two teams, while the remaining teams retained their original rankings. This stability suggests that the evaluation framework remains reliable even under uncertainty in assessment priorities or operational fluctuations. Moreover, the weight assigned to Accuracy of Product Defect Identification (0.3999) through ITARA is higher than in some prior studies using AHP or expert-based subjective weighting, demonstrating that the integration of MOORA–ITARA yields more objective and consistent results compared to standalone MOORA or other MCDM approaches such as TOPSIS and AHP. Thus, the combination of ITARA and MOORA strengthens the credibility of performance evaluations and serves as a more robust basis for continuous improvement decisions in Quality Control management.

4. CONCLUSION

The integration of ITARA and MOORA in this study demonstrates a methodological advancement compared to conventional single-method MCDM approaches, as it combines objective variability-based weighting and a robust preference ranking system in evaluating Quality Control team performance. Based on the ranking results shown in the chart, the Quality Assurance Team achieved the highest performance score (0.3812), placing it in 1st rank, indicating its strong effectiveness in ensuring product conformity and compliance with quality standards. In the 2nd position, the Quality Improvement Team obtained a score of 0.3709, demonstrating significant contributions in driving corrective actions and continuous enhancement of product quality. The Quality Inspection Team ranked 3rd with a score of 0.3681, reflecting a solid performance in executing inspection activities and detecting product issues. Meanwhile, the Quality Verification Team recorded the lowest score (0.3335), placing it in the last rank, which implies that its current performance still requires strategic evaluation and improvement to align with the company's overall quality objectives. The criterion weights derived through ITARA clearly position Accuracy of Product Defect Identification as the most dominant factor (0.3999), reflecting its strategic significance in quality management. The conducted sensitivity analysis further confirms that the ranking outcomes remain stable despite ± 0.1 – 0.2 variations in weighting values, indicating the strong robustness and reliability of the MOORA–ITARA framework compared to traditional methods such as standalone MOORA, TOPSIS, or AHP. Despite its empirical contributions, this study is limited to a single case context within one company and relies solely on internal historical performance data. Future research is recommended to



incorporate multi-source assessment data, involve cross-industry comparisons, and apply additional advanced weighting methods to further validate and enhance the generalizability and adaptability of the proposed decision model.

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