



# Multi-Criteria Decision Model for Ranking the Best Marketplace Using CRISUS Weighting and OPARA Ranking

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**Abstract:** The rapid growth of e-commerce marketplaces in Indonesia has increased competition among platforms and created challenges in identifying the most suitable marketplace for users and businesses. Previous studies commonly applied conventional Multi-Criteria Decision-Making (MCDM) approaches, yet many of these methods rely heavily on subjective weighting or limited data-based evaluation, which may lead to inconsistent ranking results. Therefore, this study aims to develop a more objective decision-making model for marketplace evaluation by integrating the CRISUS weighting method with the OPARA ranking approach. The dataset consists of quantitative marketplace performance indicators collected from public digital statistics, including monthly visits, annual visits, application ratings, number of downloads, and the number of active sellers for several major marketplaces operating in Indonesia. The CRISUS method is used to determine criterion weights based on actual data variation to reduce subjective bias, while OPARA evaluates the alternatives through an optimized pairwise ratio mechanism to obtain the final preference values. The experimental results indicate that Shopee achieves the highest score of 0.3078, followed by Lazada with 0.2476 and Tokopedia with 0.2327, demonstrating their stronger performance compared with other marketplace alternatives based on the evaluated criteria. These findings contribute both academically and practically by providing a transparent and data-driven MCDM framework that improves the reliability of marketplace ranking and can support stakeholders in making more informed platform selection decisions.

**Keywords:** Multi-Criteria Decision Making (MCDM); CRISUS Weighting; OPARA Method; Marketplace Ranking; Decision Support System (DSS)

## 1. INTRODUCING

In recent years, the growth of digital marketplaces such as Tokopedia, Shopee, Lazada, and Bukalapak has accelerated rapidly, driven by changes in consumer shopping behavior, wider internet penetration, and the ease of app-based transactions[1]. These platforms not only offer millions of products across categories but also provide a range of features such as dynamic promotions, customer review systems, digital wallet integration, and constantly updated instant logistics services to maintain competitiveness. On the other hand, this rapid development presents its own challenges for both consumers and business players because the available choices have become very numerous and varied. Each marketplace has different characteristics, ranging from cost structure, search algorithms, return policies, transaction security, to customer service quality, making the selection process no longer simple.

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Consumers need to consider price, seller reputation, product ratings, and delivery speed simultaneously, while sellers must analyze market potential, competition, promotion effectiveness, and system stability before deciding on the most suitable platform. This complexity shows that choosing a marketplace is not just a matter of popularity but a strategic decision that involves many criteria and rational considerations.

Determining the best marketplace is not a simple matter because the process involves many interconnected criteria that often change over time[2]. However, beyond the general growth of the digital online market, an important scientific issue arises regarding how the performance of online markets can be evaluated objectively and systematically when involving multiple criteria and dynamic data. In practice, users should consider several aspects such as product price, sales rate, customer ratings and reviews, service fees, return policy, and the stability of the platform's system[3], [4]. Each criterion may have a different level of importance depending on the perspective of the decision-maker, making the evaluation process increasingly complex. This challenge is further compounded by the dynamic nature of data, where prices can change quickly, ratings can fluctuate as reviews increase, and promotional programs are updated regularly. In addition, subjective perceptions related to service quality and user trust can also influence decision-making. Therefore, the combination of various criteria, rapidly changing data, and subjective evaluation highlights the need for a structured analytical approach capable of supporting a more objective and systematic process of determining the best market.

Amid the abundance of alternatives and the complexity of criteria that must be considered, the presence of a multi-criteria decision making (MCDM)-based decision support system (DSS) becomes increasingly important to assist in making more directed and rational decisions. DSS is designed to process data systematically, integrating various variables into a structured analytical framework[5]–[7]. The MCDM approach allows each criterion to be weighted according to its level of importance, so that the resulting decision is not solely dependent on one dominant factor but is the result of a comprehensive evaluation[8]–[11]. Methods such as TOPSIS, AHP, and SAW are often used in this framework because they can objectively compare alternatives based on their proximity to the ideal solution. By utilizing a DSS based on MCDM, decision-makers can minimize subjectivity, increase transparency in the evaluation process, and obtain more consistent results even when the data being analyzed is complex and dynamic.

Criterion Importance based on Sum of Squares (CRISUS) is one of the objective weighting methods in the framework of MCDM, which emphasizes mathematical calculations based on data variation to determine the importance level of each criterion[12]–[14]. This method works by calculating the sum of squares of the values of each criterion across all alternatives, so that criteria with greater data spread or variation will receive higher weights because they are considered to have stronger discriminating power. Unlike subjective methods that rely on expert judgment or individual preferences, CRISUS fully utilizes numerical information available in the decision matrix, thereby minimizing bias and enhancing the consistency of weighting results. This characteristic makes CRISUS relevant in situations where the data is quantitative and dynamic; the method helps ensure that the weights produced truly reflect the relative contribution of each criterion to the decision-making process.

Optimized pairwise ratio analysis (OPARA) is a ranking method within the MCDM framework designed to produce a more precise order of alternatives through an optimized pairwise ratio approach[15], [16]. This method compares each alternative against the others for each criterion, then calculates performance ratios that directly reflect relative superiority. The optimization process in OPARA aims to stabilize comparison results to be more consistent and sensitive to value differences, thus capable of capturing small advantages that are often overlooked by conventional methods. After the ratio values are calculated and integrated with the criteria weights, an aggregate score is obtained which serves as the basis for determining the final ranking. The advantage of OPARA lies in its ability to process quantitative data systematically while maintaining proportionality among alternatives, so that the ranking results not only reflect absolute performance, but also the relative position of each alternative within the overall evaluation system.

The integration of CRISUS as an objective weighting method and OPARA as a ranking method is driven by the need for an evaluation system that is not only accurate but also consistent and minimally biased. CRISUS plays a role in determining the weight of criteria based on the variation of actual data

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through a sum of squares approach, ensuring that the importance level of each criterion truly reflects its discriminative power in the decision matrix. On the other hand, OPARA processes these weights through an optimized pairwise ratio comparison mechanism to produce the ordering of alternatives more proportionally and sensitively to differences in performance. The combination of the two creates a complementary analytical flow where the weighting stage is carried out objectively based on data, followed by the ranking stage that reinforces the results through structured comparative evaluation. This integrated approach can reduce the dominance of subjectivity in determining priorities while enhancing the stability of decision outcomes, especially in the context of selecting alternatives that involve multiple criteria and constantly changing data.

There is a gap that has not been addressed by previous research, where most prior studies still used conventional MCDM methods with weighting approaches that tend to be subjective or only used a single weighting method, thus potentially producing less stable alternative rankings when there are changes in data or variations in criterion values. In addition, some studies focused more on the process of evaluating alternatives without optimally utilizing actual data variations in the process of determining criterion weights, so the level of decision objectivity is still limited. The difference between this research and previous studies is that this research develops a multi-criteria decision-making model for ranking the best marketplaces by integrating the CRISUS method as a weighting technique based on actual data variation and the OPARA method as an alternative evaluation approach based on optimized pairwise ratio. The integration of these two methods is expected to produce a marketplace ranking process that is more objective, consistent, and data-driven, thereby increasing the reliability of decision results in determining the best marketplace based on various key performance indicators.

This study aims to design a marketplace evaluation model that can produce decisions more objectively, consistently, and measurably based on quantitative data. The main focus of the research is on developing an analytical framework that minimizes subjectivity in determining the weighting of criteria, while ensuring that the process of ranking alternatives is carried out systematically and proportionally. The primary contribution of the study lies in the development of a marketplace evaluation model based on data objectivity through the application of the CRISUS weighting method, which utilizes numerical variations among alternatives as the basis for determining the importance level of criteria. Furthermore, this study integrates CRISUS with OPARA as a ranking method to enhance the stability of the ranking results, so that the order of alternatives produced is not easily changed due to small fluctuations in the data. In addition, a sensitivity analysis is conducted to test the robustness of the model against changes in weights as well as variations in criterion values, thereby determining the extent of consistency and reliability of the system in various testing scenarios.

## **2. RESEARCH METHODOLOGY**

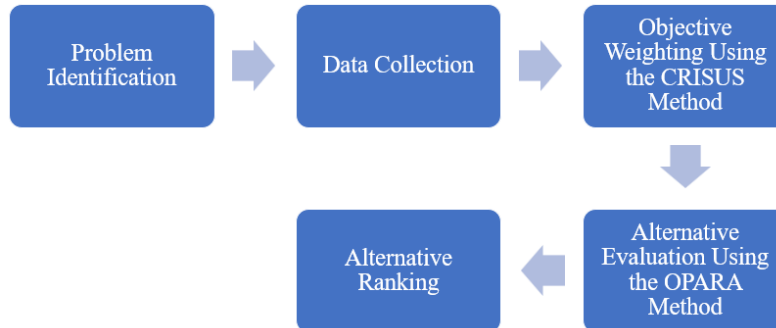
Research method is a systematic approach used by researchers to design, implement, and control the entire research process so that the set objectives can be achieved in a directed and accountable manner[17], [18]. It includes determining the type of research, data collection techniques, analysis procedures, and ways of drawing conclusions that are appropriate to the issues being studied. The research method serves as a framework that ensures each step is carried out logically, structurally, and consistently, so that the results obtained are not only relevant but also possess adequate validity and reliability. Through the application of appropriate methods, research can produce findings that are objective, transparent, and can be tested again by other researchers in a similar context.

### **Research Framework**

A research framework is a conceptual framework that illustrates the flow of thinking and the structure of relationships between variables in a study[19], [20]. This framework serves as a map that shows how the research problem is identified, how the main concepts are interconnected, and how the analysis process is directed to address the research objectives. In a research framework, the research stages are usually explained systematically, starting from the determination of variables, data collection, analysis methods, to the interpretation of results, ensuring that the entire process runs in an integrated manner rather than in a fragmented way. With a clear framework, the research becomes more focused,



consistent, and has a strong logical basis in explaining the relationships between theory, data, and the conclusions drawn. The research framework in this study is shown in Figure 1.



**Figure 1.** Research framework

The research framework in this study begins with the problem identification stage, which involves formulating the need for a decision-making model capable of determining the best marketplace objectively based on multiple criteria. Once the problem is clearly defined, the next stage is data collection, which includes identifying marketplace alternatives and relevant evaluation criteria, then organizing them into a decision matrix. The collected data is then processed through objective weighting using the CRISUS method to obtain the importance level of each criterion based on the variation in values. These weights are subsequently used in the alternative assessment stage with the OPARA method, where each alternative is compared in pairwise ratios to produce preference scores and ranking order. The final stage is a sensitivity analysis aimed at testing the stability and robustness of the model against changes in weights or data fluctuations, so that the extent of the consistency of the alternative ranking results produced by the developed model can be determined.

This study adopts a quantitative research approach within the framework of MCDM to evaluate and rank several major marketplaces in Indonesia. The research design is structured to ensure that the entire process is systematic, transparent, and logically connected, starting from the formulation of variables, data collection, data processing, and interpretation of results. The data used in this study consist of secondary data representing marketplace performance indicators, including monthly visits, annual visits, application ratings, number of downloads, and the number of active sellers. These data were collected from publicly available digital statistics platforms and official marketplace analytics reports during a specific observation period, ensuring that the dataset reflects recent marketplace performance conditions. In this study, five major marketplaces operating in Indonesia are selected as alternatives because they represent the most widely used platforms and have relatively complete and comparable performance data. Although the number of alternatives is limited, the selected marketplaces capture the dominant share of the Indonesian e-commerce market, making them relevant for comparative analysis. The analysis process begins with determining criterion weights using the CRISUS method, followed by alternative evaluation using the OPARA method to obtain the final ranking results. To strengthen the robustness of the findings, sensitivity analysis is conducted by modifying the criterion weights across several scenarios to observe the stability of the resulting rankings. This procedure allows the study to assess how changes in the importance of criteria may influence the decision outcomes and provides additional validation for the reliability of the proposed decision-making model. With this structured framework, the research ensures that the relationship between theoretical concepts, data sources, analytical methods, and conclusions is clearly explained and systematically integrated.

### CRISUS Weighting Method

The CRISUS weighting method is an objective approach in MCDM used to determine the importance level of each criterion based on the variation of numerical data in the decision matrix. Its basic principle is to calculate the sum of squares of the values of each criterion across all alternatives, so that criteria with greater data dispersion will receive higher weights because they are considered to have a stronger discriminative ability in differentiating the performance of alternatives. The main advantage of this



method lies in its objectivity, ease of calculation, and its ability to reduce human bias in the evaluation process. Additionally, CRISUS is also adaptive to dynamic data because the weights will automatically adjust according to changes in the value variation of each criterion, making it relevant for application in complex, data-driven decision environments.

The procedure for assigning criterion weights using the CRISUS approach starts with constructing a decision matrix that contains the performance scores of each alternative across all criteria, as formulated in equation (1). This matrix is subsequently subjected to vector normalization to remove differences in measurement scales among criteria, ensuring that all data become comparable, as shown in equation (2). The next step involves performing sum normalization by calculating the total of normalized values for each criterion, which serves as the foundation for further computations, as indicated in equation (3). Following this, the sum of squares for each criterion is computed to capture the degree of variability within the data, as expressed in equation (4). The standard deviation for each criterion is then derived to reflect the dispersion level and its discriminative power in distinguishing among alternatives, as presented in equation (5). In the final stage, the criterion weights are established by normalizing the standard deviation values so that the aggregate of all weights equals one, making them suitable for subsequent evaluation or alternative ranking processes, as described in equation (6).

$$X = [x_{ij}]_{m \times n} \quad (1)$$

$$r_{ij} = \begin{cases} \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}; \text{benefit criteria} \\ 1 - \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}}; \text{cost criteria} \end{cases} \quad (2)$$

$$s_{ij} = \frac{r_{ij}}{\sum_{i=1}^m r_{ij}} \quad (3)$$

$$\rho_j = \sum_{i=1}^m s_{ij}^2 \quad (4)$$

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^m (s_{ij} - \bar{s}_j)^2}{m}} \quad (5)$$

$$w_j = \frac{\rho_j * \sigma_j}{\sum_{j=1}^n \rho_j * \sigma_j} \quad (6)$$

The CRISUS method offers a weighting approach that emphasizes the strength of data variation as the basis for determining the level of importance of criteria. Its objective, structured, and responsive characteristics to data changes make CRISUS a suitable choice in multi-criteria decision-making models, especially when consistency and transparency of results are the top priorities.

### OPARA Ranking Method

The OPARA Ranking Method is an approach in MCDM used to determine the order of alternatives through optimized pairwise ratio comparisons. This method works by comparing the performance of each alternative against the others for each criterion, and then integrating these comparison results with the criterion weights to produce a final preference score. The main advantage of OPARA lies in its ability to directly capture the relative superiority among alternatives, not just based on absolute values, so that the position of each alternative truly reflects its competitiveness within the overall evaluation system. Furthermore, this method can reduce ranking distortions caused by small value differences and provide more consistent results when dealing with complex and differently scaled data.

The stages of the OPARA method begin with the preparation of a decision matrix that represents the value of each alternative against all criteria using (1). After that, matrix normalization is carried out to equalize the scale between criteria so that they can be compared proportionally using (7). Next, a range-based pairwise adjustment ratio is calculated to normalize comparisons between alternatives, taking into account the maximum and minimum values for each criterion using (8). The next stage is determining the pairwise adjustment ratio based on linearity to maintain consistency in the proportional relationships among alternative values using (9) and (10). The results of this process are then combined to obtain the pairwise adjusted ratio that reflects the relative level of superiority more stably using (11).



In the final stage, all ratio values are integrated with the criteria weights to produce a final score that serves as the basis for determining the ranking of alternatives using (12).

$$r_{ij} = \begin{cases} \frac{x_{ij}}{\max_j x_{ij}}; J \in B \\ \frac{\max_j x_{ij}}{x_{ij}}; J \in C \end{cases} \quad (7)$$

$$\rho_j = \begin{cases} \frac{(\alpha-1) \max_i x_{ij} + \min_i x_{ij}}{\alpha \max_i x_{ij}} & \text{if } \frac{\max_i x_{ij} + \min_i x_{ij}}{\max_i x_{ij} + \min_i x_{ij}} > \beta \\ 1 & \text{otherwise} \end{cases} \quad (8)$$

(9)

$$LPAR_{ij} = \sum_{i=1}^m w_j * (r_{ij})^{\tau_j} \quad (10)$$

$$APAR_{ij} = \omega RPAR_{ij} + (1 - \omega) LPAR_{ij} \quad (11)$$

$$S_i = \frac{1}{n} \left( \sum_{j=1}^n \left( \frac{APAR_{ij}}{\sum APAR_{ij}} \right) \right) \quad (12)$$

The OPARA method provides a systematic ranking approach through adjusted and optimized pairwise ratio comparisons. Its step-by-step process, from normalization to the calculation of final scores, allows each alternative to be evaluated proportionally based on its relative advantage over other alternatives. This approach makes OPARA relevant for use in multi-criteria decision-making models that require accuracy and robustness of evaluation results.

### 3. RESULT AND DISCUSSIONS

The multi-criteria decision model for ranking the best marketplace using CRISUS weighting and OPARA ranking is a decision-making framework designed to evaluate and determine the best marketplace objectively and in a structured manner based on various relevant criteria. This model integrates the CRISUS weighting method, which calculates the importance level of criteria based on variations in numerical data using a sum of squares approach, with the OPARA ranking method, which performs optimized pairwise ratio comparisons to produce a stable and proportional ranking of alternatives. Through this combination, the evaluation process not only considers the weight of the criteria based on data but also analyzes the relative advantages of each marketplace compared to other alternatives comprehensively. With a systematic analysis flow starting from the preparation of the decision matrix, objective weighting, optimized ratio calculation, to the determination of the final score, this model is able to produce ranking recommendations that are more consistent, transparent, and resilient to data fluctuations compared to conventional approaches that rely on a single method.

#### Problem Identification

The identification of problems in this research stems from the rapid development of digital marketplaces that offer many alternatives with different characteristics. Each platform provides its own advantages, whether in terms of price, product variety, promotional systems, or service quality, making the selection process no longer simple. Consumers and business actors are often faced with numerous criteria that must be considered simultaneously, such as user ratings, sales volume, return rates, and seller reputation. The identification of problems in this study arises from the rapid development of digital marketplaces that offer many alternatives with different characteristics. Each platform provides its own advantages, whether in terms of price, product variety, promotional systems, or service quality, making the selection process no longer simple. Consumers and business actors are often faced with numerous criteria that must be considered simultaneously, such as user ratings, sales volume, return rates, and seller reputation.

On the other hand, the dynamics of data in the marketplace also become a significant source of problems in the evaluation process. Prices, ratings, and the number of reviews can change in a relatively short period, so the assessment results are prone to shift if stable methods are not used. When data is volatile, methods that do not account for variation and relationships among alternatives risk producing



inconsistent rankings. The complexity increases further because each criterion has different scales and characteristics, requiring proper normalization and weighting processes. Without an objective weighting mechanism, determining the importance level of criteria can become disproportionate. In addition, ranking methods that are less sensitive to small differences in values can obscure the relative advantages among alternatives. This issue underscores the need for a decision model capable of systematically managing multiple criteria, minimizing subjectivity, and maintaining the stability of ranking results even when data changes. Therefore, the problem identification stage becomes an important foundation in designing a more structured and reliable evaluation approach.

### Data Collection

Data collection is a crucial stage in this research because the quality of the data will greatly affect the accuracy and reliability of the marketplace evaluation. The process begins with determining relevant data sources and types, including quantitative data such as website visit counts, sales volume, product ratings, number of reviews, and other transactional metrics that reflect the performance of each marketplace. This data can be obtained from trusted secondary sources such as industry reports, visitor statistics, business surveys, as well as digital analytics databases that record consumer and seller behavior across various platforms. Data collection must also take into account a consistent time period so that comparisons between alternatives can be made fairly, as well as ensure that all data is in a format that can be quantitatively processed in decision-making models. During this process, the data is checked for completeness, invalid values are removed, and it is ensured that there are no recording errors so that the resulting decision matrix truly reflects the actual performance of the marketplace in the context of multi-criteria evaluation.

The data collection stage in the context of this research also includes determining the marketplaces to be analyzed as well as the appropriate evaluation metrics for each platform, such as the annual number of visitors, growth rate of visits, and the proportion of usage by SMEs and consumers. Table 1 presents the assessment data of the marketplaces obtained from various sources.

Table 1. Data Collection

Marketplace Name	Monthly Visits	Annual Visits	App Rating	Number of Downloads	Active Sellers
Shopee	235	2 349,9	4.6	380	7
Tokopedia	125	1 254,7	4.5	160	6.5
Lazada	85	762,4	4.4	570	4
Blibli	35	337,4	4.6	40	2
Bukalapak	25	168,2	4.3	50	1.5

The assessment data presented provides a quantitative overview of the popularity and adoption levels of each marketplace in Indonesia, particularly from the perspective of application download numbers as an indicator of market penetration and user trust. High download numbers reflect the platform's appeal and consistent use by the public, while differences in values between marketplaces indicate variations in competitive levels in the national digital market. This information serves as an important foundation in preparing a decision matrix because it can represent the actual performance of each alternative in a measurable way. By utilizing numerical and verified data, the subsequent evaluation process can be carried out more objectively, transparently, and systematically within a multi-criteria decision-making framework.

### Objective Weighting Using the CRISUS Method

Objective Weighting Using the CRISUS Method is a stage in the multi-criteria decision-making model aimed at determining the weight of each criterion objectively based on the characteristics of the available numerical data. The CRISUS method works by calculating the sum of the squares of the values for each criterion across all alternatives, so criteria with greater variation or data dispersion will receive higher weights. This approach is based on the assumption that the greater the variation of a criterion,



the greater its ability to distinguish performance among alternatives. The advantage of this approach lies in its ability to reduce subjectivity because it does not depend on expert preferences but fully utilizes the structure of the actual data. Thus, the resulting weights reflect the relative contribution of each criterion proportionally within the evaluation system.

The procedure for determining the weights of criteria using the CRISUS approach begins with constructing a decision matrix that contains the performance scores of each alternative across all criteria using (1). The resulting decision matrix based on the assessment data is presented as follows.

$$X = \begin{bmatrix} x_{11} & x_{12} & x_{13} & x_{14} & x_{15} \\ x_{21} & x_{22} & x_{23} & x_{24} & x_{25} \\ x_{31} & x_{32} & x_{33} & x_{34} & x_{35} \\ x_{41} & x_{42} & x_{43} & x_{44} & x_{45} \\ x_{51} & x_{52} & x_{53} & x_{54} & x_{55} \end{bmatrix} \longrightarrow X = \begin{bmatrix} 235 & 2349.9 & 4.6 & 380 & 7 \\ 125 & 1245.7 & 4.5 & 160 & 6.5 \\ 85 & 762.4 & 4.4 & 570 & 4 \\ 35 & 337.4 & 4.6 & 40 & 2 \\ 25 & 168.2 & 4.3 & 50 & 1.5 \end{bmatrix}$$

This matrix is then subjected to vector normalization to eliminate differences in measurement scales between criteria, calculated using (2) with the following results.

$$r_{11} = \frac{x_{11}}{\sqrt{\sum_{i=1}^5 x_{ij}^2}} = \frac{235}{\sqrt{235^2 + 125^2 + 85^2 + 35^2 + 25^2}} = \frac{235}{\sqrt{79925}} = \frac{235}{282.71010} = 0.83125$$

The overall normalization calculation results in the CRISUS weighting method are presented in Table 2.

Table 2. Sum Normalization Results Using the CRISUS Method

Marketplace Name	Monthly Visits	Annual Visits	App Rating	Number of Downloads	Active Sellers
Shopee	0.83124	0.84034	0.45904	0.53794	0.65705
Tokopedia	0.44215	0.44869	0.44906	0.22650	0.61012
Lazada	0.30066	0.27264	0.43908	0.80691	0.37546
Blibli	0.12380	0.12066	0.45904	0.05663	0.18773
Bukalapak	0.08843	0.06015	0.42910	0.07078	0.14080

The next step involves normalizing the sums by calculating the total normalized values for each criterion, which serves as the basis for further calculations, calculated using (3), the sum normalization results are as follows.

$$S_{11} = \frac{r_{11}}{\sum_{i=1}^5 r_{ij}} = \frac{0.83124}{0.83124 + 0.44215 + 0.30066 + 0.12380 + 0.08843} = \frac{0.83124}{1.78628} = 0.46535$$

The results of the total value calculation in the CRISUS weighting method are presented in Table 3.

Table 3. Total Value Results Using the CRISUS Method

Marketplace Name	Monthly Visits	Annual Visits	App Rating	Number of Downloads	Active Sellers
Shopee	0.46535	0.48227	0.20536	0.31667	0.33333
Tokopedia	0.24752	0.25750	0.20089	0.13333	0.30952
Lazada	0.16832	0.15647	0.19643	0.47500	0.19048
Blibli	0.06931	0.06924	0.20536	0.03333	0.09524
Bukalapak	0.04950	0.03452	0.19196	0.04167	0.07143

After that, the sum of squares for each criterion is calculated to capture the level of variability in the data, as stated in equation (4), with the sum of squares calculated as follows.

$$\rho_1 = \sum_{i=1}^5 s_{i1}^2 = 0.46535^2 + 0.24752^2 + 0.16832^2 + 0.06931^2 + 0.04950^2 = 0.46535 \cdot 31340$$

The result of the total square calculation in the CRISUS weighting method is presented in Table 4.



Table 4. Sum Square Results Using the CRISUS Method

Monthly Visits	Annual Visits	App Rating	Number of Downloads	Active Sellers
0.31340	0.32936	0.20014	0.34653	0.25737

The standard deviation for each criterion is then derived to reflect the level of dispersion and its discriminative power in differentiating between alternatives, calculated using (5), the standard deviation calculation results are as follows.

$$\sigma_1 = \sqrt{\frac{\sum_{i=1}^5 (s_{i1} - \bar{s}_j)^2}{5}} = \sqrt{\frac{0.113400647}{5}} = 0.15060$$

The results of the standard deviation calculations for each criterion overall in the CRISUS weighting method are presented in Table 5.

Table 5. Standard Deviation Results Using the CRISUS Method

Monthly Visits	Annual Visits	App Rating	Number of Downloads	Active Sellers
0.15060	0.16085	0.00521	0.17119	0.10712

At the final stage, the criterion weights are determined by normalizing the standard deviation values so that the aggregate of all weights equals one, making it suitable for further evaluation or the alternative ranking process, calculated using (6), with the resulting weights for each criterion as follows.

$$w_1 = \frac{\rho_1 * \sigma_1}{\sum_{j=1}^5 \rho_j * \sigma_j} = \frac{0.31340 * 0.15060}{(0.31340 * 0.15060) + (0.32936 * 0.16085) + (0.20014 * 0.00521) + (0.34653 * 0.17119) + (0.25737 * 0.10712)} = \frac{0.04720}{0.18811} = 0.25091$$

The calculation results of the weights for each criterion overall in the CRISUS weighting method are presented in Table 6.

Table 6. Criteria Weight Results Using the CRISUS Method

Monthly Visits	Annual Visits	App Rating	Number of Downloads	Active Sellers
0.25091	0.28163	0.00554	0.31536	0.14656

The results of calculating criterion weights using the CRISUS method show that the Number of Downloads criterion received the highest weight of 0.31536, indicating that the download rate has the greatest contribution in distinguishing marketplace performance compared to other criteria. The second position is held by Annual Visits with a weight of 0.28163, followed by Monthly Visits at 0.25091, indicating that traffic indicators, both annual and monthly, have a significant influence in the evaluation process. Meanwhile, Active Sellers received a weight of 0.14656, meaning that the presence and participation of sellers still play an important role although not as much as user popularity indicators. On the other hand, App Rating only has a weight of 0.00554, indicating that the variation in rating values across marketplaces is relatively small, making its contribution to differentiating alternatives very limited according to the CRISUS method calculations. This weight distribution reflects that criteria based on market volume and usage scale have a stronger discriminatory power compared to app quality perception indicators.

The criterion weights obtained from the CRISUS calculation method are then used as the main input in the ranking stage using the OPARA method. These weight values serve as multipliers representing the relative importance of each criterion in the pairwise ratio comparison process among alternatives. By integrating these objective weights, each ratio calculation in OPARA not only reflects the relative advantages between marketplaces but also takes into account the proportional contribution of each criterion according to its level of significance. This process ensures that alternatives with high



performance in more dominant criteria will have a greater influence on the final score. Through this stage, the continuity between the weighting and ranking processes can be maintained, making the evaluation results more consistent, structured, and data-driven.

### Alternative Evaluation Using the OPARA Method

Alternative evaluation using the OPARA Method is an advanced stage in the decision-making model aimed at determining the best ranking of all marketplaces based on the criterion weights that have been calculated previously. At this stage, the normalized decision matrix is used to compare each alternative pairwise for each criterion through adjusted ratio calculations. The process begins with calculating range-based ratios to maintain proportionality of values among alternatives, followed by linearity-based adjustments to ensure the consistency of mathematical relationships between values. The results of these two processes are combined into an optimized ratio that reflects the relative superiority of each marketplace compared to its competitors. The adjusted ratios are then multiplied by the criteria weights from the CRISUS method, resulting in an aggregate preference score for each alternative. This final score serves as the basis for determining the overall ranking of the best marketplaces. Through the mechanism of direct comparison between alternatives and the integration of objective weights, the OPARA method is able to produce rankings that are more stable, sensitive to performance differences, and reflective of relative competitiveness in a multi-criteria evaluation system.

The first stage of the OPARA method begins with the preparation of the decision matrix using (1) based on the assessment data obtained from Table 1, the resulting decision matrix of the OPARA method is the same as the decision matrix from the CRISUS method. The second stage of the OPARA method calculates normalization based on the decision matrix using (7), and the resulting decision matrix as follows.

$$r_{11} = \frac{x_{11}}{\max_j x_{1j}} = \frac{235}{235} = 1.0000$$

The overall normalization calculation results in the OPARA method method are presented in Table 7.

Table 7. Normalization Results Using the OPARA Method

Marketplace Name	Monthly Visits	Annual Visits	App Rating	Number of Downloads	Active Sellers
Shopee	1.0000	1.0000	1.0000	0.6667	1.0000
Tokopedia	0.5319	0.5339	0.9783	0.2807	0.9286
Lazada	0.3617	0.3244	0.9565	1.0000	0.5714
Blibli	0.1489	0.1436	1.0000	0.0702	0.2857
Bukalapak	0.1064	0.0716	0.9348	0.0877	0.2143

The third stage of the OPARA method calculates the scale between criteria using (8), and the calculation results of the scale between criteria are as follows.

$$\rho_1 = \frac{(4 - 1) \max_j x_{i1} + \min_j x_{i1}}{\alpha \max_j x_{ij}} = \frac{(5 - 1)235 + 25}{5 * 235} = \frac{840}{1175} = 0.7149$$

The overall resulting scale between criteria results in the OPARA method method are presented in Table 8.

Table 8. Scale Between Criteria Results Using the OPARA Method

Monthly Visits	Annual Visits	App Rating	Number of Downloads	Active Sellers
0.7149	0.7427	0.0522	0.7439	0.6286



The third stage of the OPARA method calculates the pairwise adjustment ratio based on the range using (9), and the results of the pairwise adjustment ratio calculation based on the range are as follows.

$$RPAR_{11} = (w_1 * (r_{11})^{\rho_1}) + (w_2 * (r_{12})^{\rho_2}) + (w_3 * (r_{13})^{\rho_3}) + (w_4 * (r_{14})^{\rho_4}) + (w_5 * (r_{15})^{\rho_5})$$
$$RPAR_{11} = (0.25091 * (1.0000)^{0.7149}) + (0.28163 * (1.0000)^{0.7427}) + (0.00554 * (1.0000)^{0.0522})$$
$$+ (0.31536 * (0.66667)^{0.7439}) + (0.14656 * (1.0000)^{0.6286})$$
$$RPAR_{11} = 1.0000$$

The overall resulting pairwise adjustment ratio based on the range results in the OPARA method are presented in Table 9.

Table 8. Pairwise Adjustment Ratio based on the Range Results Using the OPARA Method

Marketplace Name	Shopee	Tokopedia	Lazada	Blibli	Bukalapak
Shopee	1.0000	1.6021	1.6160	4.1801	5.0588
Tokopedia	0.6476	1.0000	1.0653	2.5678	3.1688
Lazada	0.7783	1.3099	1.0000	3.4968	3.6717
Blibli	0.2623	0.0000	0.4308	1.0000	1.2397
Bukalapak	0.2212	0.3393	0.3325	0.8653	1.0000

The fourth stage of the OPARA method calculates the pairwise adjustment ratio based on linearity using (10), and the results of the pairwise adjustment ratio calculation based on the range are as follows.

$$LPAR_{ij} = \sum_{i=1}^m w_j * (r_{ij})^{\tau_j}$$
$$LPAR_{11} = (w_1 * (r_{11})^{\tau_1}) + (w_2 * (r_{12})^{\tau_2}) + (w_3 * (r_{13})^{\tau_3}) + (w_4 * (r_{14})^{\tau_4}) + (w_5 * (r_{15})^{\tau_5})$$
$$LPAR_{11} = (0.25091 * (1.0000)^{0.25}) + (0.28163 * (1.0000)^{0.25}) + (0.00554 * (1.0000)^{0.25})$$
$$+ (0.31536 * (0.66667)^{0.25}) + (0.14656 * (1.0000)^{0.25})$$
$$LPAR_{11} = 1.0000$$

The overall resulting pairwise adjustment ratio based on the linearity results in the OPARA method are presented in Table 10.

Table 10. Pairwise Adjustment Ratio based on the Linearity Results Using the OPARA Method

Marketplace Name	Shopee	Tokopedia	Lazada	Blibli	Bukalapak
Shopee	1.0000	1.1696	1.1558	1.6211	1.7285
Tokopedia	0.7189	1.0000	1.0344	2.0470	2.3905
Lazada	0.8890	1.0451	1.0000	1.4510	1.5240
Blibli	0.6216	0.7230	0.7219	1.0000	1.0695
Bukalapak	0.5841	0.5841	0.6696	0.9426	0.6216

The fifth stage of the OPARA method calculates the pairwise-adjusted compound ratios using (11), and the results of the compound ratios as follows.

$$APAR_{11} = 0.5 * RPAR_{11} + (1 - 0.5)LPAR_{11} = 0.5 * 1.0000 + (1 - 0.5)1.0000 = 1.0000$$

The overall resulting pairwise-adjusted compound ratios results in the OPARA method are presented in Table 11.

Table 11. Pairwise-adjusted Compound Ratios Results Using the OPARA Method





Marketplace Name	Shopee	Tokopedia	Lazada	Blibli	Bukalapak
Shopee	1.0000	1.3859	1.3859	2.9006	3.3936
Tokopedia	0.6833	1.0000	1.0498	2.3074	2.7796
Lazada	0.8337	1.1775	1.0000	2.4739	2.5978
Blibli	0.4419	0.3615	0.5763	1.0000	1.1546
Bukalapak	0.4026	0.4617	0.5011	0.9040	0.8108

The sixth stage of the OPARA method calculates the final score with the aggregated preference values, which serve as the basis for determining the final ranking of each alternative using (12), and the results of the final score as follows.

$$S_1 = \frac{1}{5} \left( \sum_{j=1}^5 \left( \frac{APAR_{i1}}{\sum APAR_{i1}} \right) \right) = \frac{1}{5} (1.5392) = 0.3078$$

The overall the final score with the aggregated preference values in the OPARA method method are presented in Table 12.

Table 12. Final Value Results Using the OPARA Method

Marketplace Name	Final Value
Shopee	0.3078
Tokopedia	0.2327
Lazada	0.2476
Blibli	0.1107
Bukalapak	0.1012

The final scores obtained through the OPARA method show variations in preference scores among the different marketplaces. Shopee has a final score of 0.3078, reflecting its relative performance contribution after considering all predetermined criteria and weights. Lazada obtained a score of 0.2476, while Tokopedia stands at 0.2327, indicating close performance among the three in the context of multi-criteria evaluation. On the other hand, Blibli and Bukalapak recorded scores of 0.1107 and 0.1012, respectively, illustrating differences in aggregate contribution compared to the other alternatives. These scores are the result of integrating pairwise comparison ratios optimized with CRISUS objective weights, so each score represents the relative performance level based on all the indicators used in the model.

### Ranking Alternative

Alternative ranking is an important stage in the multi-criteria decision-making process because it is at this phase that all quantitative evaluation results are translated into a systematic order of preference. After each alternative is assessed based on a number of criteria and integrated with weights that reflect their level of importance, the next step is to arrange the relative positions of each alternative based on the final scores obtained. This process aims to show the degree of comparative advantage of each option within a consistent evaluation framework. Ranking not only highlights the alternatives with the highest performance but also provides a comprehensive view of the value gaps between alternatives, allowing performance differences to be analyzed in greater depth. With a structured approach, ranking results can serve as a basis for rational and transparent recommendations to support strategic decision-making.

The ranking of alternatives generated from the integration of the CRISUS and OPARA methods represents a comprehensive evaluation that combines objective weighting and optimized pairwise ratio comparisons. In this approach, CRISUS first determines the importance level of each criterion based on variations in actual data, ensuring that the weights used truly reflect the differentiating power of each indicator. These weights are then processed using the OPARA method to assess the relative superiority of each alternative through a systematic and proportional ratio mechanism. The integration of these



two methods ensures that the ranking process not only considers the absolute values but also the relative positions of alternatives within the overall evaluation system. The result is a ranking of alternatives that is more stable, consistent, and data-driven, providing a more comprehensive picture of performance in the context of multi-criteria decision-making. The results of the alternative ranking are shown in Figure 2.

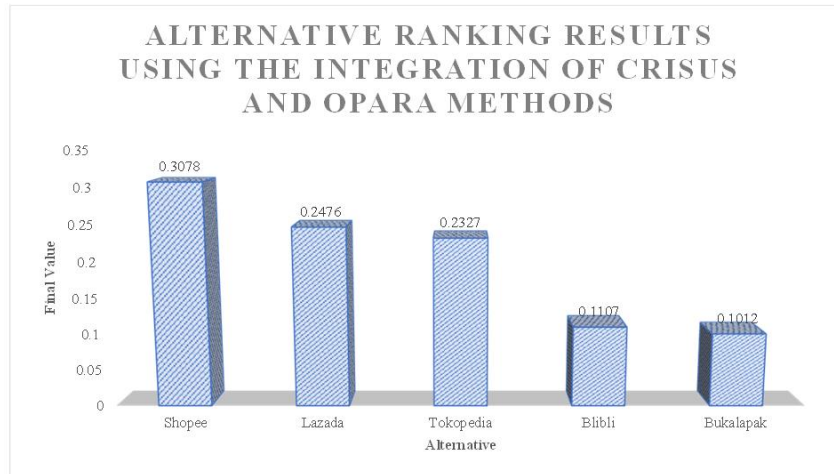


Figure 2. Ranking alternative

The findings of this study are that Shopee ranks first with a final score of 0.3078, indicating the highest aggregate performance based on the integration of CRISUS weighting and OPARA calculation. The second position is held by Lazada with a score of 0.2476, followed by Tokopedia in third place with a score of 0.2327, which indicates that the two platforms have a relatively small score difference in the overall evaluation. Meanwhile, Bibli is in fourth place with a score of 0.1107 and Bukalapak in fifth place with a score of 0.1012, reflecting a fairly significant performance difference between the top three platforms and the other two platforms. The results of this study are in line with or supported by several previous studies from [21] which show that marketplace platforms with a high level of user visits, a large number of application downloads, as well as a high number of active sellers tend to achieve a superior position in Multi-Criteria Decision-Making based evaluations because these indicators represent the level of user trust and the strength of the digital ecosystem on a marketplace.

## 4. CONCLUSION

Choosing the best marketplace requires a decision-making approach that can evaluate multiple criteria systematically and in a data-driven manner, especially amid the intense competition among major platforms such as Tokopedia, Shopee, Lazada, Bibli, and Bukalapak. This study demonstrates that the integration of CRISUS for objective criterion weighting and OPARA for alternative evaluation can provide a structured framework for analyzing marketplace performance based on indicators such as monthly visits, annual visits, app ratings, number of downloads, and number of active sellers. The results indicate that Shopee occupies the first position, followed by Lazada and Tokopedia, which reflects the strong influence of platform usage scale and market activity on the overall evaluation. Beyond simply presenting the ranking results, the study contributes methodologically by showing that combining data-driven weighting with a pairwise ratio evaluation mechanism can improve the objectivity and stability of ranking outcomes in multi-criteria decision models. From a practical perspective, the proposed model can support stakeholders, including sellers, consumers, and digital business analysts, in making more informed decisions when selecting a marketplace platform. However, this study also has several limitations. The analysis only involves five major marketplaces and relies on a limited set of performance indicators derived from secondary data, which may not fully capture other relevant aspects such as service quality, logistics performance, or user experience. In addition, the study focuses on a single



decision model without extensive comparison with other MCDM approaches. Therefore, future research is recommended to include a larger set of marketplace alternatives, incorporate additional qualitative and behavioral criteria, and perform comparative analyses with other MCDM methods or hybrid models to further validate and enhance the robustness of marketplace evaluation frameworks.

## 5. REFERENCES

- [1] Vijay Mallik Reddy and Lakshmi Nivas Nalla, "Leveraging Big Data Analytics to Enhance Customer Experience in E-commerce," *Rev. Esp. Doc. Cient.*, vol. 18, no. 02 SE-Articles, pp. 295–324, Dec. 2023, doi: 10.3989/redc/v18i2.221.
- [2] M. Krstić, G. P. Agnusdei, P. P. Miglietta, S. Tadić, and V. Roso, "Applicability of Industry 4.0 Technologies in the Reverse Logistics: A Circular Economy Approach Based on Comprehensive Distance Based RANKING (COBRA) Method," *Sustainability*, vol. 14, no. 9. 2022. doi: 10.3390/su14095632.
- [3] F. E. Francisco, A. C. F. Costa, P. Alexandre Costa Araújo Sampaio, P. Domingues, and O. J. de Oliveira, "Implementation and improvement of Integrated Management Systems: recommendations for their adaptation to the ISO High-Level structure," *Clean. Environ. Syst.*, vol. 15, p. 100227, 2024, doi: <https://doi.org/10.1016/j.cesys.2024.100227>.
- [4] K. Aliyeva, A. Aliyeva, R. Aliyev, and M. Özdeşer, "Application of Fuzzy Simple Additive Weighting Method in Group Decision-Making for Capital Investment," *Axioms*, vol. 12, no. 8. 2023. doi: 10.3390/axioms12080797.
- [5] B. Efe, B. Yelbey, and L. Efe, "Unmanned aerial vehicle selection using interval valued q rung orthopair fuzzy number based MAIRCA method TT - Aralık değerli q seviyeli bulanık sayı temelli MAIRCA yöntemiyle insansız hava aracı seçimi," *Pamukkale Üniversitesi Mühendislik Bilim. Derg.*, vol. 31, no. 1, pp. 37–46, 2025, [Online]. Available: <https://dergipark.org.tr/tr/pub/pajes/issue/90500/1644156>
- [6] V. Simic, A. Ebadi Torkayesh, and A. Ijadi Maghsoodi, "Locating a disinfection facility for hazardous healthcare waste in the COVID-19 era: a novel approach based on Fermatean fuzzy ITARA-MARCOS and random forest recursive feature elimination algorithm," *Ann. Oper. Res.*, vol. 328, no. 1, pp. 1105–1150, 2023, doi: 10.1007/s10479-022-04822-0.
- [7] M. Vijay *et al.*, "Sustainable assessment of renewable energy microgrid architectures using a probabilistic hesitant fuzzy MCDM approach," *Sci. Rep.*, 2026, doi: 10.1038/s41598-026-39733-8.
- [8] K. Rudnik, G. Bocewicz, A. Kucińska-Landwójtowicz, and I. D. Czabak-Górska, "Ordered fuzzy WASPAS method for selection of improvement projects," *Expert Syst. Appl.*, vol. 169, p. 114471, 2021, doi: <https://doi.org/10.1016/j.eswa.2020.114471>.
- [9] Z. Turskis and V. Keršulienė, "SHARDA-ARAS: A Methodology for Prioritising Project Managers in Sustainable Development," *Mathematics*, vol. 12, no. 2, p. 219, Jan. 2024, doi: 10.3390/math12020219.
- [10] D. D. Trung, N. T. P. Giang, D. Van Duc, T. Van Dua, and H. X. Thinh, "The Use of SAW, RAM and PIV Decision Methods in Determining the Optimal Choice of Materials for the Manufacture of Screw Gearbox Acceleration Boxes," *Int. J. Mech. Eng. Robot. Res.*, vol. 13, no. 3, pp. 338–347, 2024, doi: 10.18178/ijmerr.13.3.338-347.
- [11] D. Tešić, D. Božanić, S. P. Mondal, and A. Puška, "Modification of the Ranking of Alternatives with Weights of Criterion (RAWEC) Method and Improvement with Fermatean Fuzzy numbers," *J. Soft Comput. Decis. Anal.*, vol. 3, no. 1 SE-Articles, pp. 146–157, Aug. 2025, doi: 10.31181/jscda31202570.
- [12] S. Bektaş, "Financial Performance Ranking With A New Hybrid Decision Making Model: Application Of The CRISUS-RAWEC Hybrid Model For The Reinsurance Industry," *Gümüşhane Univ. J. Soc. Sci.*, vol. 17, no. 1, pp. 233–249, 2026, [Online]. Available: <https://dergipark.org.tr/en/pub/gumus/article/1721934>
- [13] S. GÜL and S. BEKTAŞ, "ESG Performance Ranking with a Novel Hybrid Decision-Making Model: Application of the CRISUS-PIV Hybrid Model for the Banking Sector," *Üçüncü Sektör Sos. Ekon. Derg.*, vol. 60, no. 4, pp. 3557–3579, 2025, doi: 10.63556/tisej.2025.1582.
- [14] I. Adalar and Ö. IŞIK, "CRiterion Importance Based on SUM of Squares (CRISUS): A Novel Objective Weighting Method and Its Implementation in Multidimensional Sustainability Performance Measurement.," *Econ. Comput. Econ. Cybern. Stud. Res.*, vol. 59, no. 2, 2025, doi: 10.24818/18423264/59.2.25.13.
- [15] Do Duc Trung, Nazli Ersoy, Tran Van Dua, Duong Van Duc, and Manh Thi Diep, "M-OPARA: A Modified Approach to the OPARA Method," *Decis. Mak. Appl. Manag. Eng.*, vol. 8, no. 1 SE-Regular articles, pp. 256–275, Feb. 2025, doi: 10.31181/dmame8120251334.
- [16] T. N. U. Vo, "Integrating FUCA, SRP, and OPARA Methods to Assess Faculty's Scientific Research Capacity," *Eng. Technol. Appl. Sci. Res.*, vol. 14, no. 6 SE-, pp. 17870–17875, Dec. 2024, doi: 10.48084/etasr.8659.
- [17] S. Setiawansyah, "Comparative Analysis of CODAS, TOPSIS, and COCOSO Methods Using Objective Weighting in Multi-Criteria Decision Support Systems," *J. Ilm. Inform. dan Ilmu Komput.*, vol. 5, no. 1 SE-





- Articles, pp. 25–45, Mar. 2026, doi: 10.58602/jima-ilkom.v5i1.78.
- [18] J. Wang, S. Setiawansyah, and S. Sumanto, "Comparison of Objective Weighting Methods in SAW and Their Effect on Alternative Ranking Results," *J. Masy. Inform.*, vol. 17, no. 1, pp. 89–112, Feb. 2026, doi: 10.14710/jmasif.17.1.78414.
- [19] R. Aryanti, J. Wang, A. D. Wahyudi, S. Setiawansyah, and D. Darwis, "Decision Support System for Selecting the Best Restaurant Waiter Using a Combination of WENSLO Weighting and AROMAN Methods," *JEECS (Journal Electr. Eng. Comput. Sci.)*, vol. 10, no. 2 SE-Articles, pp. 128–141, Dec. 2025, doi: 10.54732/jeeecs.v10i2.4.
- [20] R. R. Oprasto, J. Wang, A. F. O. Pasaribu, S. Setiawansyah, R. Aryanti, and Sumanto, "An Entropy-Assisted COBRA Framework to Support Complex Bounded Rationality in Employee Recruitment," *Bull. Comput. Sci. Res.*, vol. 5, no. 3 SE-, pp. 207–218, Apr. 2025, doi: 10.47065/bulletincsr.v5i3.505.
- [21] E. Hadistra and R. Supriyanto, "Selection of the Best Marketplace using SAW and WP Methods: A Case Study of Bekasi City," *Sist. J. Sist. Inf.*, vol. 15, no. 2, 2026, doi: 10.32520/stmsi.v15i2.4846.

