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Decision Support System for Selecting the Best Outsourcing Employee Using CRISUS and WASPAS

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Abstract

The outsourcing employee selection process often faces problems such as high subjectivity in assessments, the involvement of multiple criteria with varying levels of importance, and inconsistencies in decision outcomes when using conventional methods. However, most previous studies still use weighting approaches that are subjective or have not integrated methods capable of optimally improving the objectivity and stability of decision results. These conditions have the potential to result in suboptimal employee selection that does not fully reflect the organization's needs. Based on these issues, this study proposes a Decision Support System for selecting the best outsourcing employees by combining the CRISUS method to objectively determine the criteria weights and the WASPAS method as a tool for evaluating and ranking alternatives. Data is collected through performance assessments based on a number of relevant criteria, and then the criteria weights are calculated using the CRISUS method to proportionally reflect the importance level of each criterion. Next, the WASPAS method is used to calculate the final preference values and generate the employee ranking order. The study results show that Employee A8 ranks first with a preference value of 1.00000, followed by Employee A3 in second place with a value of 0.96951, and Employee A5 in third place with a value of 0.94115. These findings indicate that the integration of CRISUS and WASPAS can produce rankings that are objective, consistent, and easy to interpret, so the proposed system can serve as an effective and reliable decision support tool in the outsourcing employee selection process.

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1. Introduction

Choosing the right outsourcing employees is very important for the performance and efficiency of an organization because they play a direct role in carrying out daily operational activities [1]. Outsourcing employees who have the appropriate competencies, experience, and work attitude according to the organization's needs are able to complete tasks effectively, maintain service quality, and minimize work errors. This impacts the smoothness of operational processes and saves time and costs that would otherwise be spent on corrections or excessive supervision. In addition, disciplined and adaptable outsourcing employees can work in harmony with internal staff, creating good coordination and a productive work environment. The right selection also helps organizations increase workforce flexibility without compromising performance standards. Conversely, selecting unsuitable outsourced employees has the potential to reduce productivity, slow down target achievement, and cause inefficiencies. The process of selecting outsourced employees needs to be carried out carefully and objectively so that their presence truly supports the achievement of performance and organizational efficiency on a sustainable basis.

Common problems in outsourcing employee selection are often related to high subjectivity in evaluations, the complexity of multiple criteria, and inconsistency in the evaluation process [2]. Subjectivity arises when selection decisions are more influenced by the evaluator's personal perceptions [3], [4], previous experiences, or non-technical considerations that are difficult to measure, resulting in less objective assessment outcomes. On the other hand, outsourcing employee selection usually involves many criteria such as technical competence, work experience, attitude, discipline, communication skills, and fit with the organization's work culture, making the evaluation process complex and prone to bias if not managed with a clear method. When each assessor has a different understanding and weight of criteria, assessment inconsistencies are difficult to avoid and can result in unstable decisions over time[5]. This condition not only makes it difficult for organizations to determine the best employees, but also has the potential to reduce the quality of decisions and the efficiency of the selection process. Therefore, the problems of subjectivity, multi-criteria, and inconsistency of assessment are the main challenges that need to be overcome so that the selection of outsourcing employees can be carried out more fairly, systematically, and accountably [6], [7].

A Multi-Criteria Decision Making (MCDM)-based Decision Support System (DSS) plays an important role in helping organizations make more objective and rational decisions when faced with problems involving multiple criteria and alternatives [8], [9]. In the context of outsourcing employee selection, an MCDM-based DSS can integrate various quantitative and qualitative assessment criteria into a single structured evaluation framework. This system helps reduce evaluator subjectivity by applying consistent calculation rules, so that each alternative is evaluated based on the same weights and criteria. In addition, DSS enables the evaluation process to be carried out more transparently, easily traceable, and replicable, which ultimately increases confidence in the decision outcomes [10]–[12]. With the support of MCDM, organizations can systematically compare alternatives, produce more accurate rankings, and improve time and resource efficiency in the decision-making process.

Conventional methods for determining the best outsourcing employees have several limitations that can affect the quality of decisions. Approaches such as manual assessments, informal discussions, or simple average scores tend to rely heavily on the evaluator's intuition and experience, making them susceptible to subjectivity and bias. These methods are also less capable of handling multiple assessment criteria simultaneously, especially when the criteria have different levels of importance. As a result, the contribution of each criterion to the final outcome is often disproportionate and difficult to justify. In addition, conventional methods generally lack a clear mechanism to maintain consistency in assessments among evaluators or across selection periods, causing decision outcomes to change without a solid basis. Another limitation is the low transparency and documentation of the decision-making process, which makes it difficult to re-evaluate and improve in the future. This condition indicates that conventional methods are less effective in producing objective, consistent, and efficient decisions for outsourcing employee selection.

The criterion importance based on sum of squares (CRISUS) method is an objective weighting approach used within the framework of MCDM to determine the importance level of each criterion based on data characteristics [13], [14]. The main principle of CRISUS lies in utilizing the variation values of data through the calculation of the sum of squares, where criteria with higher levels of variation are considered to play a more significant role in differentiating alternatives. With this approach, criterion weights are not determined based on the subjective judgment of decision-makers but are calculated directly from the available evaluation data. This makes CRISUS capable of reducing subjective bias and enhancing objectivity in the decision-making process. In addition, this method is relatively simple computationally and easy to integrate with other MCDM methods for the alternative ranking process [15], [16]. Therefore, CRISUS is considered effective in supporting more consistent, transparent, and data-driven decision-making, particularly in selection problems involving multiple criteria with different levels of importance[17].

The weighted aggregated sum product assessment (WASPAS) method is one of the MCDM methods that combines the advantages of weighted sum and weighted product approaches within a single evaluation framework [18]–[20]. WASPAS works by calculating the preference values of alternatives through a combination of the weighted sum model (WSM) and the weighted product model (WPM), thus providing more stable and representative assessment results. This approach allows each criterion to be evaluated proportionally according to its importance weight, both in additive and multiplicative forms. With this mechanism, WASPAS is able to capture performance differences among alternatives more comprehensively compared to a single method. In addition, its calculation process is relatively simple and easy to understand, making it practical to apply in various decision-making problems, including outsourcing employee selection. Another advantage of WASPAS is its ability to produce consistent and transparent rankings of alternatives, thereby supporting more objective and accountable decision-making [21], [22].

The motivation for integrating CRISUS as a weighting method and WASPAS as a ranking method is based on the need for a more objective, consistent decision-making process that can effectively handle multi-criteria complexity. CRISUS is used to determine the weights of criteria objectively by utilizing data variation through the sum of squares approach, thus reducing reliance on the subjective assessments of decision-makers. Meanwhile, WASPAS serves as a ranking method that combines weighted sum and multiplication approaches, providing ranking results that are more stable and representative of the performance of alternatives. The integration of these two methods allows the resulting criteria weights to truly reflect the characteristics of the data, which are then processed comprehensively in the alternative evaluation process. Thus, the decisions made are not only fairer and more transparent but also have a higher level of reliability, especially in the context of selecting outsourced employees involving many criteria with different levels of importance.

Research results related to DSS in employee selection and evaluation show that the implementation of MCDM methods can significantly improve the quality of decision-making. Research by [23] using the Fuzzy TOPSIS method in outsourcing employee recruitment proves that the system is able to accommodate various criteria such as interviews, skills, CV, and salary more comprehensively, as well as handle uncertainty in assessments, resulting in more accurate and efficient decisions, especially with the support of REST API integration that enhances system flexibility. Furthermore, research by [24] applying the SMART method in contract employee selection shows that the developed DSS can simplify the selection process, which was previously manual, making it faster, more structured, and easier to understand, with the ability to proportionally weight criteria according to their level of importance. Meanwhile, research from [25] using the WASPAS method in assessing the best employees shows that the combination of weighted sum and multiplication approaches is able to improve the objectivity and consistency of evaluation results compared to conventional methods that tend to be subjective. Overall, these three studies confirm that the integration of MCDM methods in DSS not only accelerates the decision-making process but also enhances the accuracy, transparency, and reliability of results in the context of employee selection and evaluation. However, there has not been any research that specifically integrates the CRISUS and WASPAS methods in a Decision Support System for Selecting the Best Outsourcing Employee in order to produce more objective weighting of criteria as well as more stable and accurate ranking of alternatives.

Therefore, the aim of this study is to apply an MCDM-based DSS approach to assist the outsourcing employee selection process in a more objective, consistent, and efficient manner. Specifically, this study aims to integrate the CRISUS method as an objective-criteria weighting technique with the WASPAS method as an alternative ranking mechanism. The main contribution of this research lies in providing an evaluation framework that can reduce subjectivity in assessments, handle multiple criteria in a structured way, and produce more accountable employee rankings. In addition, this research provides a practical contribution in the form of a decision support model that can be easily applied by organizations in the outsourcing employee selection process. From an academic perspective, this study enriches MCDM research by demonstrating the effectiveness of integrating objective weighting methods and hybrid ranking methods in the context of human resource selection.

2. Research Methodology

Research methodology can generally be defined as a systematic framework used to plan, conduct, and evaluate a study so that the predetermined objectives can be achieved in a guided manner. This methodology includes the selection of research approaches, data collection techniques, analysis methods, and procedures used to ensure the accuracy and reliability of research results. With a research methodology, researchers have clear guidelines for addressing research problems logically and consistently. In addition, research methodology plays an important role in ensuring that the research process can be understood, replicated, and scientifically accountable, so that the findings obtained have strong academic and practical value.

2.1. General System Framework

The general framework of a system describes the workflow and the relationships between the components involved in a system to achieve the established objectives[26]–[28]. In general, this framework shows how data or inputs are collected, processed, and processed through certain stages until they produce outputs in the form of information or recommendations. In the context of decision support systems, the general system framework serves as a conceptual guide that explains the integration between users, data, processing methods, and decision results [12], [29]–[31]. With the existence of a general system framework, complex processes can be understood more structurally, making it easier to develop, implement, and evaluate systems comprehensively and consistently. The general system framework applied in this study is shown in Figure 1.

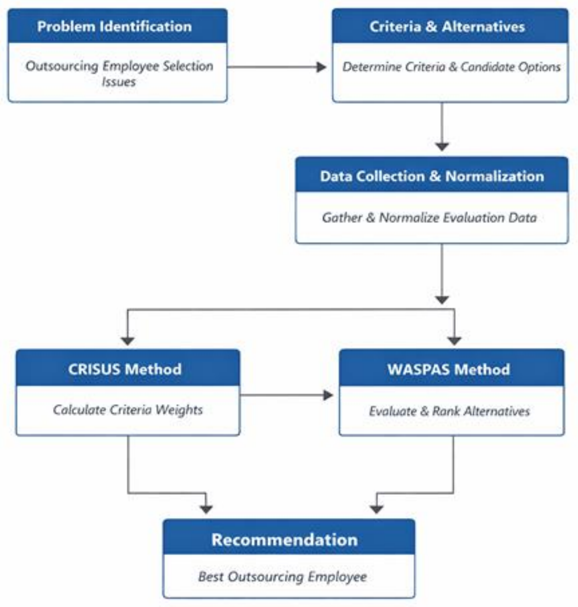

Figure 1. General System Framework

The general system framework describes the research flow systematically, starting from problem formulation to obtaining decision recommendations. The research begins with identifying issues in the selection of outsourcing employees, which involve many criteria and are still subjective, then continues with determining the criteria and employee alternatives based on organizational needs. The next stage is the collection and normalization of assessment data as the basis for calculation. Next, the CRISUS method is used to determine the weights of criteria objectively based on data variation, which then becomes the input for the WASPAS method to evaluate and rank outsourced employee alternatives. The ranking results provide recommendations for the best employees as the output of the decision support system. All these stages are summarized in an integrated research framework to ensure that the selection process is carried out objectively, consistently, and accountably.

2.2. CRISUS Method

The CRISUS method is an objective weighting method in MCDM that determines the importance level of each criterion based on the magnitude of data variation through the calculation of the sum of squares. The basic concept of CRISUS is that criteria with higher value variation have a greater ability to differentiate performance among alternatives, making them deserving of higher weights. The main advantage of this method is its ability to generate criterion weights objectively without relying on the subjective judgment of decision-makers. In addition, CRISUS can enhance the consistency and transparency of the weighting process, is easy to apply because its calculation steps are simple, and is effective for decision-making problems that involve many criteria with diverse data characteristics.

The process of determining the weights of criteria using the CRISUS method begins with the preparation of a decision matrix that represents the values of each alternative against all criteria using (1). This matrix is then processed through vector normalization to eliminate scale differences between criteria, making the data comparable using (2). After that, sum normalization is performed by summing the normalized values for each criterion as the basis for the next calculation using (3). Based on these results, the sum of squares for each criterion is calculated to determine the level of data variation for each criterion using (4). Next, the standard deviation of each criterion is determined as a measure of data dispersion, which indicates the criterion's ability to differentiate between alternatives using (5). The final stage of this process is determining the weights of the criteria, where the weights are obtained by normalizing the standard deviation values so that the total weight of all criteria equals one and is ready to be used in the evaluation or ranking of alternatives using (6).

$$X = [x_{ij}]_{mxn} \tag{1}$$

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\sqrt{\sum_{i=1}^{m} {x_{ij}}^2}} ; benefit\ criteria \\ 1 - \dfrac{x_{ij}}{\sqrt{\sum_{i=1}^{m} {x_{ij}}^2}} ; cost\ criteria \end{cases} \tag{2}$$

$$s_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} \tag{3}$$

$$\rho_j = \sum_{i=1}^{m} {s_{ij}}^2 \tag{4}$$

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m} \left(s_{ij} - \overline{s_j}\right)^2}{m}} \tag{5}$$

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

The symbol x_{ij} represents the value of the i[th] alternative for the j[th] criterion, m denotes the number of alternatives, and n denotes the number of criteria. The symbol r_{ij} indicates the normalized vector value from the decision matrix, which is calculated differently for benefit-type and cost-type criteria, with the aim of equalizing the evaluation scale. Furthermore, s_{ij} represents the sum normalization value obtained by dividing r_{ij} by the total normalization value for the same criterion. The symbol ρ_j represents the sum of squares value for the j[th] criterion, which reflects the level of data variation based on the square of s_{ij} values. The symbol σ_j is the standard deviation of the j[th] criterion used to measure the spread of s_{ij} values around their mean $\overline{s_j}$. Finally, w_j is the weight of the j[th] criterion obtained from the normalized product of the sum of squares and the standard deviation, so that the total weight of all criteria equals one.

2.3. WASPAS Method

The WASPAS method is an MCDM method that combines the WSM and WPM approaches within a single evaluation framework to determine the ranking of alternatives. WASPAS calculates the preference value of alternatives based on the additive and multiplicative contributions of each weighted criterion, thus being able to represent the performance of alternatives more comprehensively. The main advantage of the WASPAS method lies in its ability to produce more stable and accurate rankings compared to using a single method alone, as it leverages the strengths of both approaches simultaneously. In addition, WASPAS has a relatively simple, easy-to-understand, and transparent calculation process, making it effectively applicable to various decision-making problems.

The assessment process using the WASPAS method begins with the preparation of a decision matrix containing the values of each alternative for all criteria used as the basis for evaluation, using (1). The next stage is normalization, which aims to standardize the evaluation scale across criteria so that they can be compared fairly, both for benefit-type and cost-type criteria, using (7). Once the normalized values are obtained, the final value is calculated by combining the results of the weighted sum model and weighted product model calculations according to the predetermined criteria weights, using (8). This final value is then used to determine the ranking of alternatives, where the alternative with the highest value is considered the best choice.

$$n_{ij} = \begin{cases} \dfrac{x_{ij}}{\max\limits_{j} x_{ij}}; benefit\ criteria \\ \dfrac{\min\limits_{j} x_{ij}}{x_{ij}}; cost\ criteria \end{cases} \tag{7}$$

$$Q_i = 0.5 \sum_{j=1}^{n} w_j * n_{ij} + 0.5 \prod_{j=1}^{n} {n_{ij}}^{w_j} \tag{8}$$

The symbol n_{ij} represents the normalized value of x_{ij}, which is calculated differently depending on the type of criterion: by dividing x_{ij} by the maximum value of the j[th] criterion for benefit-type criteria, and by dividing the minimum value of the j-th criterion by x_{ij} for cost-type criteria. The symbols $\max\limits_{j} x_{ij}$ and $\min\limits_{j} x_{ij}$ represent the maximum and minimum values for the j-th criterion, respectively. The symbol w_j denotes the weight of the j[th] criterion, reflecting the relative importance of each criterion. Furthermore, Q_i is the final preference value of the i[th] alternative obtained from a combination of the weighted sum and weighted product models, with a coefficient of 0.5 indicating an equal contribution from both models. It is this Q_i value that is used as the basis for ranking alternatives, where a higher value indicates a better alternative.

2.4. Problem Identification

The problem identification in this study focuses on the issues of selecting outsourcing employees, which still face various challenges in practice. The selection process often involves many evaluation criteria such as technical competence, work experience, discipline, responsibility, and adaptability, each with different levels of importance. However, in many organizations, the assessment of these criteria is still conducted manually and relies on the subjective judgment of decision-makers. This situation causes selection results to tend to be inconsistent, difficult to account for, and potentially lead to suboptimal decisions. In addition, the increasing number of outsourcing employee candidates makes the evaluation process more complex and time-consuming, thereby reducing the efficiency of decision-making.

Another issue identified is the limitation of conventional methods in processing multi-criteria assessment data in a structured manner. Without a clear method for determining the weight of each criterion, each assessment aspect is often treated equally or decided based on intuition, even though their contributions to organizational performance vary. This can lead to less suitable employees being selected while more competent candidates are overlooked. Therefore, a decision support system approach is needed that can reduce subjectivity, systematically manage multiple criteria, and produce a more objective and consistent ranking of outsourced employees as a basis for better decision-making.

2.5. Dataset

The dataset used in this study was systematically compiled through the process of collecting internal organizational data aimed at ensuring the accuracy and relevance of information in the selection of outsourcing employees. The data collected includes two main components, namely criteria data and alternative assessment data, which are integrated to support the decision-making process. The criteria data represents important aspects used as the basis for evaluation, namely competence, work experience, discipline, work performance, as well as attitude and work ethics. Each criterion is formulated clearly and measurably so that it can depict the real needs of the organization in assessing the quality of outsourcing employees. The process of determining criteria is conducted in a structured manner, taking into account organizational policies and applicable evaluation standards, thereby minimizing subjectivity in the evaluation. In addition, each criterion is accompanied by a detailed description to ensure uniform understanding in the assessment process. The clarity of the criterion definitions is an important factor in maintaining consistency of evaluation results across alternatives. With a structured criteria dataset, the weighting process using the CRISUS method can be carried out more objectively and reflect the importance level of each assessment aspect.

Meanwhile, the alternative assessment data represents a quantitative representation of the performance of each outsourced employee against all the criteria that have been determined. This dataset consists of nine employee alternatives, namely A1 to A9, each evaluated using a uniform numerical scale to ensure fairness in comparison. The scores given for each criterion reflect the actual performance conditions of the employees based on evaluations from authorized parties within the organization. The data is organized in a structured manner in the form of a decision matrix to facilitate processing using the MCDM method. The consistency of the rating scale allows each alternative to be compared directly without bias due to differences in value interpretation. This dataset is then used as the main input in the calculation process of the CRISUS method to determine the criteria weights and the WASPAS method to generate employee rankings. With complete and organized data structure, the evaluation results obtained become more accurate, transparent, and accountable. Overall, a good-quality dataset serves as the main foundation for producing optimal decisions in selecting outsourcing employees according to the organization's needs.

2.6. Data Collection

Data collection in this research is conducted to obtain accurate and relevant information as a basis for the outsourcing employee selection process. The data collected includes information on alternative outsourcing employees to be evaluated as well as the evaluation criteria used by the organization. Each employee is assessed based on several predetermined criteria. Data collection is carried out through internal organizational sources, which may include performance appraisal documents, administrative records, and evaluation results from authorized personnel. This stage is very important because the quality and completeness of the data obtained will greatly affect the accuracy of the decision-making results.

Criteria data is an important component in this research because it serves as the basis for assessment to evaluate the performance of each outsourcing employee systematically. The criteria used represent the main aspects considered relevant by the organization in determining the quality and suitability of outsourcing employees. The determination of criteria data is carried out in a structured manner to accurately reflect the actual needs of the organization and support an objective evaluation process. With clear and measurable criteria, decision-making can be conducted more consistently, transparently, and responsibly. Table 1 contains the criteria data used in this study.

Table 1. Criteria Data

Criteria Code	Criteria Name	Description
CA	Competence	The level of employees' abilities and skills in carrying out the tasks assigned
CB	Work Experience	Length and relevance of the employee's work experience
CC	Discipline	Employee compliance with rules, working hours, and responsibilities
CD	Work Performance	Employee performance based on targets and work quality
CE	Attitude and Work Ethic	Behavior, motivation, and the ability to cooperate in the workplace

Table 2. Alternative Assessment Data

Alternative	CA	CB	CC	CD	CE
Employee A1	85	80	90	88	87
Employee A2	78	75	85	82	80
Employee A3	90	88	92	91	89
Employee A4	70	72	78	75	74
Employee A5	88	85	87	86	90
Employee A6	82	78	80	83	81
Employee A7	75	70	82	78	76
Employee A8	92	90	94	93	95
Employee A9	80	77	84	81	83

Alternative assessment data is information used to describe the performance of each outsourcing employee against all the established criteria. This data serves as a quantitative representation of employee evaluation results based on aspects of competence, experience, discipline, performance, and work attitude. The preparation of alternative assessment data is conducted in a structured manner using a uniform rating scale so that each employee can be compared fairly. With clear and measurable alternative assessment data, the evaluation and ranking process of outsourcing employees can be carried out systematically, objectively, and support more accurate decision-making. Table 2 presents the alternative assessment data used in this study.

The assessment data in Table 2 serves as the main basis for systematically and objectively evaluating outsourcing employees. Each value for the alternatives and criteria represents the actual performance condition of the employees, so it can be used directly in the CRISUS method calculations for determining the criteria weights and the WASPAS method for ranking the alternatives. With structured and consistent assessment data, the decision-making process can be carried out more accurately, transparently, and traceably, and it supports the selection of outsourcing employees that meet organizational needs and standards.

3. Results and Discussions

DSS for Selecting the Best Outsourcing Employee Using CRISUS and WASPAS is a systematic approach designed to help organizations determine the best outsourcing employees objectively and consistently under decision-making conditions that involve multiple criteria. This system utilizes the CRISUS method to determine the weights of criteria based on the variation in assessment data, so that the importance level of each criterion is set objectively without relying on the subjective preferences of decision-makers. The criterion weights obtained are then used in the WASPAS method to evaluate and rank outsourcing employees through a combination of weighted summation and weighted multiplication. The integration of these two methods allows the system to produce recommendations that are more accurate, transparent, and accountable. With this DSS, the outsourcing staff selection process can be carried out more efficiently, reducing assessment bias, and assisting management in making decisions that align with organizational needs and performance standards.

3.1. Calculation of Criteria Weights Using the CRISUS Method

Calculation of Criteria Weights Using the CRISUS Method is an important stage in this research because it serves to determine the level of importance of each criterion objectively before the process of ranking alternatives is carried out. At this stage, the assessment data that has been compiled in the decision matrix is processed using the CRISUS approach by utilizing data variations between alternatives. The calculation of criteria weights is carried out through a series of steps that include data normalization, calculation of the sum of squares values, and measurement of the standard deviation for each criterion. This approach allows the criteria weights to be determined based on the actual characteristics of the data, rather than based on the subjective perceptions of decision-makers. The resulting weights are expected to reflect the real contribution of each criterion in differentiating the performance of outsourcing employees, thereby supporting a more consistent and accountable evaluation and decision-making process.

The process of determining criteria weights using the CRISUS method begins with the preparation of a decision matrix that represents the value of each alternative against all criteria using (1) based on the assessment data in Table 2. The general form of the decision matrix and the results of the decision matrix are as follows.

$$X = \begin{bmatrix} x_{11} & x_{12} & x_{13} & x_{14} & x_{15} \\ x_{21} & x_{22} & x_{23} & x_{24} & x_{25} \\ x_{31} & x_{32} & x_{33} & x_{34} & x_{35} \\ x_{41} & x_{42} & x_{43} & x_{44} & x_{45} \\ x_{51} & x_{52} & x_{53} & x_{54} & x_{55} \\ x_{61} & x_{62} & x_{63} & x_{64} & x_{65} \\ x_{71} & x_{72} & x_{73} & x_{74} & x_{75} \\ x_{81} & x_{82} & x_{83} & x_{84} & x_{85} \\ x_{91} & x_{92} & x_{93} & x_{94} & x_{95} \end{bmatrix} \qquad X = \begin{bmatrix} 85 & 80 & 90 & 88 & 87 \\ 78 & 75 & 85 & 82 & 80 \\ 90 & 88 & 92 & 91 & 89 \\ 70 & 72 & 78 & 75 & 74 \\ 88 & 85 & 87 & 86 & 90 \\ 82 & 78 & 80 & 83 & 81 \\ 75 & 70 & 82 & 78 & 76 \\ 92 & 90 & 94 & 92 & 95 \\ 80 & 77 & 84 & 81 & 83 \end{bmatrix}$$

The next process is to perform vector normalization to eliminate differences in scale between criteria, so that the data becomes comparable using (2). The complete results of the vector normalization calculations are presented in Table 3. The next process is to perform sum normalization by adding up the normalized values for each criterion as the basis for the next calculation using (3). The complete results of the sum normalization calculations are presented in Table 4. The next process involves calculating the sum of squares value for each criterion to determine the level of data variation possessed by each criterion, using (4). The complete results of the sum of squares calculation are presented in Table 5. The next process involves calculating the standard deviation value of the criteria, which is determined as a measure of data dispersion that shows the ability of the criteria to differentiate alternatives, using (5). The complete results of the standard deviation calculation for the criteria are presented in Table 6. The final stage of this process is the determination of the criteria weights, where the weights are obtained by normalizing the standard deviation values so that the total weight of all criteria equals one, using (6). The complete results of the criteria weight calculations are presented in Table 7.

Table 3. Vector Normalization Calculation Results

Alternative	CA	CB	CC	CD	CE
Employee A1	0.34341	0.33452	0.34912	0.34798	0.34466
Employee A2	0.31513	0.31362	0.32972	0.32425	0.31693
Employee A3	0.36361	0.36798	0.35687	0.35984	0.35258
Employee A4	0.28281	0.30107	0.30257	0.29657	0.29316
Employee A5	0.35553	0.35543	0.33748	0.34007	0.35655
Employee A6	0.33129	0.32616	0.31032	0.32821	0.32089
Employee A7	0.30301	0.29271	0.31808	0.30844	0.30108
Employee A8	0.37169	0.37634	0.36463	0.36775	0.37635
Employee A9	0.32321	0.32198	0.32584	0.32030	0.32881

Table 4. Sum Normalization Calculation Results

Alternative	CA	CB	CC	CD	CE
Employee A1	0.11486	0.11189	0.11658	0.11625	0.11523
Employee A2	0.10541	0.10490	0.11010	0.10832	0.10596
Employee A3	0.12162	0.12308	0.11917	0.12021	0.11788
Employee A4	0.09459	0.10070	0.10104	0.09908	0.09801
Employee A5	0.11892	0.11888	0.11269	0.11361	0.11921
Employee A6	0.11081	0.10909	0.10363	0.10964	0.10728
Employee A7	0.10135	0.09790	0.10622	0.10304	0.10066
Employee A8	0.12432	0.12587	0.12176	0.12285	0.12583
Employee A9	0.10811	0.10769	0.10881	0.10700	0.10993

Table 5. Sum of Square Calculation Results

CA	CB	CC	CD	CE
0.11188	0.11187	0.11151	0.11160	0.11178

Table 6. Standard Deviation Calculation Results

CA	CB	CC	CD	CE
0.00925	0.00919	0.00665	0.00738	0.00862

Table 7. Criteria Weight Calculation Results

CA	CB	CC	CD	CE
0.22537	0.22382	0.16163	0.17939	0.20978

The calculation of criteria weights shows that CA has the highest weight at 0.22537, indicating that this criterion is the most influential factor in the evaluation process of outsourced employees. Next, CB has an almost equal weight of 0.22382, signifying a very high level of importance and playing a significant role in differentiating performance among alternatives. CE comes next with a weight of 0.20978, indicating a fairly strong contribution to the evaluation process. Meanwhile, CD has a weight of 0.17939, and CC has the lowest weight at 0.16163, which means that these two criteria are still influential but relatively less so compared to the others. Overall, this weight distribution shows that all criteria play important roles, albeit with different levels of significance, allowing the evaluation process to be carried out in a balanced and proportional manner.

3.2. Alternative Assessment Using the WASPAS Method

Alternative assessment using the WASPAS method is a follow-up stage after the criteria weights have been obtained, aimed at evaluating and comparing the performance of each outsourcing employee alternative comprehensively. At this stage, the normalized alternative assessment data are processed using the WASPAS method by combining the weighted sum and weighted product approaches. The use of both approaches allows for a more balanced evaluation, as it can capture the contribution of each criterion both additively and multiplicatively. By utilizing the criteria weights generated from the CRISUS method, the process of evaluating alternatives in WASPAS can be carried out consistently and objectively. The result of this stage is a final preference score used as the basis for ranking outsourcing employees, thereby supporting more accurate, transparent, and accountable decision-making.

The evaluation process using the WASPAS method begins with the preparation of a decision matrix containing the values of each alternative for all criteria used as the basis for evaluation using (1). The results of the WASPAS decision matrix are the same as the results of the CRISUS decision matrix. The next stage is normalization, which aims to equalize the evaluation scale among criteria so that they can be compared fairly, both for benefit-type and cost-type criteria using (7). The complete normalization calculation results are presented in Table 8. After the normalized values are obtained, the calculation of the final score is carried out by combining the results of the weighted sum model and weighted product model calculations according to the predetermined criteria weights using (8). The complete results of the final score calculation is presented in Table 9.

Table 8. Normalization Calculation Results

Alternative	CA	CB	CC	CD	CE
Employee A1	0.92391	0.88889	0.95745	0.94624	0.91579
Employee A2	0.84783	0.83333	0.90426	0.88172	0.84211
Employee A3	0.97826	0.97778	0.97872	0.97849	0.93684
Employee A4	0.76087	0.80000	0.82979	0.80645	0.77895
Employee A5	0.95652	0.94444	0.92553	0.92473	0.94737
Employee A6	0.89130	0.86667	0.85106	0.89247	0.85263
Employee A7	0.81522	0.77778	0.87234	0.83871	0.80000
Employee A8	1.00000	1.00000	1.00000	1.00000	1.00000
Employee A9	0.86957	0.85556	0.89362	0.87097	0.87368

Table 9. Normalization Calculation Results

Alternative	Final Score
Employee A1	0.92364
Employee A2	0.85839
Employee A3	0.96951
Employee A4	0.79257
Employee A5	0.94115
Employee A6	0.87129
Employee A7	0.81679
Employee A8	1.00000
Employee A9	0.87139

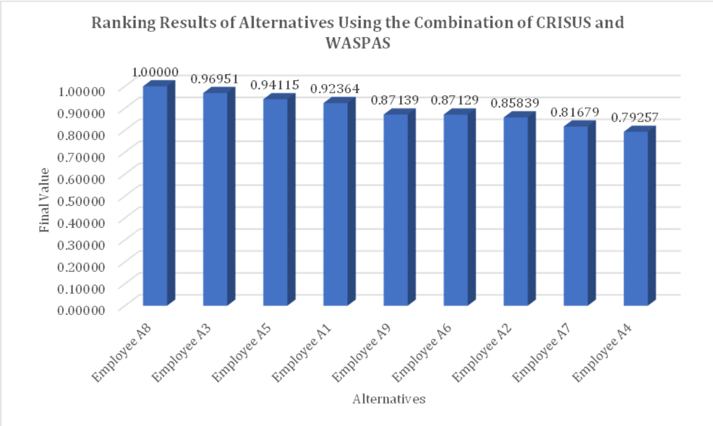

Figure 2. Alternative Ranking Results

The final results of the calculations using the WASPAS method produce preference values for each outsourcing employee alternative that reflect their relative performance levels based on all established criteria. These preference values serve as the main basis in the ranking process, where each alternative is compared comprehensively, taking into account the weight and contribution of each criterion. Through the ranking process, the alternative with the highest WASPAS value is placed at the top rank as the best outsourcing employee. This stage provides a clear and structured overview of the position of each alternative, making it easier for decision-makers to determine their choice objectively, transparently, and consistently. The results of the alternative rankings are shown in Figure 2.

The ranking results of alternatives using a combination of the CRISUS and WASPAS methods show a clear difference in performance levels among outsourcing employees. Based on the final WASPAS scores, Employee A8 ranks first with the highest score of 1.00000, indicating the best performance compared to other alternatives. The next position is held by Employee A3 with a score of 0.96951, followed by Employee A5 with a score of 0.94115 and Employee A1 with a score of 0.92364, reflecting high and relatively competitive performance. Furthermore, Employee A9 and Employee A6 have almost identical scores of 0.87139 and 0.87129, followed by Employee A2 with a score of 0.85839. Meanwhile, Employee A7 with a score of 0.81679 and Employee A4 with a score of 0.79257 are at the bottom ranks, indicating relatively lower performance compared to other alternatives. These results indicate that the combination of the CRISUS and WASPAS methods is capable of producing rankings that are objective, consistent, and easy to understand as a basis for decision making.

3.3. Sensitivity Analysis

Sensitivity analysis is an approach used to evaluate the extent to which changes in parameters, assumptions, or criteria weights can affect the final results of a model or decision-making method. This analysis aims to test the stability and reliability of decision outcomes by observing the system's response to variations in certain input values. In the context of multi-criteria decision support systems, sensitivity analysis helps identify the most influential criteria and determine whether small changes in weights or evaluation values can alter the ranking order of alternatives. Sensitivity analysis provides a deeper understanding of the strengths and weaknesses of the model used and increases decision-makers' confidence in the results obtained, as decisions are not only dependent on a single condition but have been tested across various possible scenarios.

Sensitivity analysis of changes in the initial criteria weights in the CRISUS method is an evaluation process carried out to determine to what extent changes in the criteria weights generated by CRISUS can affect the final decision-making results. This analysis is conducted by modifying the criteria weight values in certain scenarios, then observing their impact on the preference values and the ranking of alternatives. The main purpose of this analysis is to test the stability and consistency of decision results when there are changes in the level of importance of the criteria. Through sensitivity analysis, it can be identified which criteria most dominantly influence changes in rankings and whether the decision-making model still produces relatively the same recommendations even if the initial weights are adjusted. The scenarios of criteria weight changes are presented in Table 10.

Table 10. Scenario of Criteria Weight Changes

Weight Change Scenario	CA	CB	CC	CD	CE
Initial Weight of CRISUS	0.22537	0.22382	0.16163	0.17939	0.20978
Scenario 1	0.29579	0.20347	0.14694	0.16308	0.19071
Scenario 2	0.20488	0.29438	0.14694	0.16308	0.19071
Scenario 3	0.20488	0.20347	0.23785	0.16308	0.19071
Scenario 4	0.20488	0.20347	0.14694	0.25399	0.19071
Scenario 5	0.20488	0.20347	0.14694	0.16308	0.28162
Scenario 6	0.26226	0.21316	0.15393	0.17085	0.19979
Scenario 7	0.21464	0.26078	0.15393	0.17085	0.19979
Scenario 8	0.21464	0.21316	0.20155	0.17085	0.19979
Scenario 9	0.21464	0.21316	0.15393	0.21847	0.19979
Scenario 10	0.21464	0.21316	0.15393	0.17085	0.24741
Scenario 11	0.13930	0.24869	0.17959	0.19932	0.23309
Scenario 12	0.25041	0.13758	0.17959	0.19932	0.23309
Scenario 13	0.25041	0.24869	0.06848	0.19932	0.23309
Scenario 14	0.25041	0.24869	0.17959	0.08821	0.23309
Scenario 15	0.25041	0.24869	0.17959	0.19932	0.12198
Scenario 16	0.18460	0.23560	0.17014	0.18883	0.22082
Scenario 17	0.23723	0.18297	0.17014	0.18883	0.22082
Scenario 18	0.23723	0.23560	0.11751	0.18883	0.22082
Scenario 19	0.23723	0.23560	0.17014	0.13620	0.22082
Scenario 20	0.23723	0.23560	0.17014	0.18883	0.16819

In the sensitivity analysis presented in Table 9, changes in criterion weights were arranged into several scenarios to test the stability of decision results while ensuring that the total criterion weight remained 1. Scenarios 1 through 5 were designed by increasing the weight of the tested criterion by 0.1, while the weights of the other criteria were adjusted proportionally so that the total weight remained constant. Next, in scenarios 6 through 10, the criterion weights were increased by 0.05 using the same adjustment mechanism. To observe the impact of weight reduction, scenarios 11 through 15 were conducted by decreasing the criterion weights by 0.1, and scenarios 16 through 20 involved a reduction of 0.05, with the other criterion weights again adjusted proportionally. This approach ensures that every scenario of weight changes, remains in a valid condition and allows the evaluation of the impact of weight changes on ranking results to be conducted fairly and consistently. The ranking results from changes in criterion weights are shown in Figure 3.

The ranking chart in Figure 3 shows the stability of the alternative ranking results under the initial conditions and all sensitivity analysis scenarios from scenario 1 to scenario 20. It can be seen that Employee A8 consistently holds the first rank in all scenarios, followed by Employee A3 in second place, Employee A5 in third, and Employee A1 in fourth without any changes in position. Ranking changes only occur for Employee A9 and Employee A6, who swap positions between fifth and sixth place in several scenarios, indicating that these two alternatives have a higher level of sensitivity to changes in criteria weights. Meanwhile, Employee A2, Employee A7, and Employee A4 remained in seventh, eighth, and ninth place across all scenarios. Overall, this graph indicates that the CRISUS and WASPAS models have a high level of stability, as most alternatives maintain their positions despite changes in criteria weights.

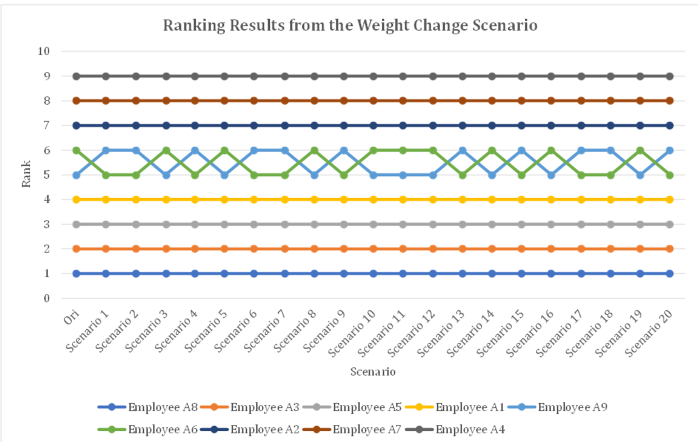

Figure 3. Ranking Results from Sensitivity Analysis

3.4. Discussions

The discussion in this study shows that the application of a DSS based on the integration of the CRISUS and WASPAS methods is able to provide a systematic and objective solution in the outsourcing employee selection process. The results of the criteria weighting using CRISUS indicate that each criterion has a different level of importance, determined based on variations in assessment data. This approach allows the criteria weights to reflect the actual data conditions, so the evaluation process no longer depends on the subjective perception of decision-makers. The developed system is able to reduce assessment bias and improve consistency in the outsourcing employee selection process.

The ranking results of alternatives using WASPAS show a clear difference in preference values among outsourcing employees. The alternative with the best performance can be directly identified based on the final score obtained, making it easier for management to determine the employee who is most suitable for the organization's needs. The stability of the rankings at the top and bottom positions indicates that the WASPAS method is capable of producing robust rankings when combined with objectively weighted criteria. This suggests that the integration of CRISUS and WASPAS is effective in addressing selection issues involving multiple criteria with varying levels of importance.

Sensitivity analysis conducted through various scenarios of changes in criterion weights provides an overview of the reliability of the proposed decision-making model. The analysis results show that most alternatives maintain their ranking positions despite changes in weights, indicating a high level of system stability. Ranking changes only occur for alternatives with similar preference values, which suggests that the performance differences between these alternatives are relatively small. These findings reinforce that the developed decision support system is not sensitive to changes in weights within reasonable limits and continues to produce consistent recommendations.

Overall, the results of this study indicate that a CRISUS and WASPAS-based DSS can serve as a reliable tool in supporting decision-making for outsourcing employee selection. This system not only enhances the objectivity and transparency of the selection process but also provides flexibility through sensitivity testing regarding changes in criteria weights. These findings offer practical contributions for organizations in improving the quality of workforce selection decisions, as well as academic contributions in the development of studies on MCDM methods in the field of human resource management.

4. Conclusion

The integration of the CRISUS and WASPAS methods in a Decision Support System is capable of providing a comprehensive, objective, and consistent approach in the process of selecting outsourcing employees. The weighting of criteria using CRISUS successfully captures the level of importance of each criterion based on the characteristics of the evaluation data, making the resulting weights more representative compared to subjective approaches. Furthermore, the application of WASPAS in evaluating alternatives produces clear and easy-to-interpret rankings, thereby supporting more structured decision-making. The sensitivity analysis results indicate that the proposed model has a good level of stability, as most alternatives maintain their ranking positions despite variations in criterion weights across different scenarios. This confirms that the developed system is not only accurate but also reliable against changes in assessment conditions. Overall, this study demonstrates that the proposed approach is effective in enhancing transparency, reducing bias, and strengthening the quality of decisions in outsourcing employee selection, while also providing a tangible contribution to the development of MCDM method applications in the context of human resource management. Future research can integrate other weighting methods, both objective and hybrid, to compare the stability of criterion weights against CRISUS in the context of employee selection. In addition, the use of alternative ranking methods besides WASPAS, such as distance-based or compromise approaches, can be explored to test the consistency of ranking results under various data conditions.

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