Group decision support system for employee performance evaluation using combined simple additive weighting and Borda

T F A Aziz¹, S Sulistiyono¹, H Harsiti², A Suyawan², A Suhendar¹ and T A Munandar¹,*

¹ Informatics Dept., Faculty of Information Technology, Universitas Serang Raya, Serang, Indonesia
² Information Systems Dept., Faculty of Information Technology, Universitas Serang Raya, Serang, Indonesia

*aafatwa25@gmail.com

Abstract. Subjectivity in performance appraisal is almost inevitable. Subjectivity is defined as a perspective based on personal views or feelings about a thing. Eliminate subjectivity factors so that assessing objectively based on certain criteria is difficult to implement, whereas subjectivity causes unfair competition and giving rise to an uncompetitive environment. This research was conducted to reduce subjectivity in a performance appraisal using the Group Decision Support System with Simple Additive Weighting and Borda methods. Employee performance appraisal at PT. Krakatau Osaka Steel was the object of this research. The Group Decision Support System has selected the best employees from 59 employee samples taken by the Purposive Sampling method resulted the 7 best employees according to the assessors with a Decision Support System, these results are then reselected to become the 3 best employees provided by the Group Decision Support System. The results of Group Decision Support System were found that A2 was in the first place with a Borda score of 0.218336, followed by 2 other employees, namely A52 and A1, with a Borda score of 0.206507 and 0.205753, respectively.

1. Introduction

Human resource management (HRM) has been proven to have an impact on an organization's performance [1]. Proper management of employees will greatly affect the success of a company. If employees can be well organized, then certainly the organization or company can run all business processes properly, as happened at PT. Krakatau Osaka Steel.

PT. Krakatau Osaka Steel is a private company in Indonesia as steel manufacture company, in the management of company development required human resources (HR). In every year the company is always evaluating the performance of its employees, performance evaluation is very useful to motivate employees to work better so that the company will develop continuously from competent human resources [2]. However, employee performance evaluation is difficult to do manually because assessor have their own preferences so that it can cause subjectivity in the evaluation. Subjective judgments often appear because assessors see first-hand and judge what is happening, but the main problem that appear is the inability to balance subjectivity and data analysis to determine the priority in performance evaluation [3]. If subjective elements are more prioritized, it means there will be partiality in the...
evaluation and causes unfair competition and giving rise to an uncompetitive environment. However, performance evaluation must be carried out as fair as possible, so it will have a positive impact on employee’s engagement.

Employee engagement is recognized as one of the main factors leading to the success of organizations in sustaining competitive advantage. Attention given to performance evaluation justice has an implication on employee engagement [4]. This performance evaluation will have an impact on whether or not a company is developing [2], so that a performance evaluation is needed to generate an evaluation that does not contain an assessor preference that results in subjectivity, performance evaluation must be carried out with an approach that can consider evaluations resulting from several preferences and voting mechanism that resulting a good decision, so the evaluation is more solid and objective as possible [5]. Then to resolve this problem the approach taken is to design a group decision support system model by using combination of two methods that is Simple Additive Weighting and Borda, so it can reduce subjectivity in a performance evaluation.

Based on literature studies, one of the methods used for evaluation in making decisions to determine the best employees is to use the Simple Additive Weighting (SAW) method. Implementation of it helps managers to make quicker and more accurate decision making [6]. This method is chosen because it is able to select the best alternative from a number of alternatives that exist based on the criteria specified [7]. Evaluations conducted by several assessors will result in different preferences, so a group decision-making method is needed to determine a number of alternatives from several alternatives. The evaluation results from the SAW method are then processed using the Borda method which is a group decision support method. Borda method is a method of group decision making that can combine the results of the analysis of several assessors to determine a number of alternatives [8]. The weighted Borda is implemented to aggregate the rankings of alternatives regarding different experts [9]. Therefore, Borda method can be used to combine several preferences to determine a number of alternatives.

2. Literature review

2.1. Group decision support system

GDSS is a set of information systems that used to support management teams to resolve problems by analyzing, facilitate conflict resolution, identify priorities and making decisions in a collaborative environment [10]. Currently, the concepts of group decision support have developed rapidly. In addition to its ability to be applied to various affairs, group decision support can also be used as the right tool to optimize the decisions generated [11]. Many studies use group decision support system to determine alternative options for cases such as a multi agent system for group decision support based on conflict resolution styles to help a group of users to find a set of tourist attractions, selected among a huge set of possible alternatives, that meets the preferences of each individual [12], to determine the location of opening a new bank branch [13], requalifying public buildings and utilities [14], to determine regional development priority [3] and to deciding the most appropriate variety to plant in agriculture [15].

2.2. Simple Additive Weighting (SAW)

Simple Additive Weighting (SAW) is one of methods that use in Decision Support Systems and used to find optimal alternatives from a number of alternatives with certain criteria [6]. Selection of criteria for cases to be solved with the help of Decision Support System requires analyzing that is closely related to the problems at hand. The criteria that become references must have compatibility with the problem to be sought solution [16]. The Simple Additive Weighting is a simple assessment method which is the most widely used method to handling MADM (Multiple Attribute Decision Making) situations [17]. The SAW method is often also known as the weighted summation method [18,19]. The basic concept of the SAW method is to find the weighted sum of performance ratings on each alternative on all attributes. The SAW method requires the decision matrix normalization process (X) to a scale that can be compared with all normalized matrix rows with preference weights (W) proper to the matrix column elements (W) [7]. The following is formula from the Simple Additive Weighting (SAW) method:
\[ r_{ij} = \frac{x_{ij}}{\text{Max}(x_{ij})} \]  

(1)

where \( r_{ij} \) is the normalized rating of alternative \( A_i \) on attribute \( C_j \); \( i = 1,2,...,m \) and \( j = 1,2,...,n \).

Value preferences for each alternative \( V_i \) is given the following equation:

\[ V_i = \sum_{j=1}^{n} w_j r_{ij} \]  

(2)

\( V_i \) = Value for each alternative  
\( W_j \) = Weight value of each criterion  
\( r_{ij} \) = Value normalized performance  

Value of \( V_i \) higher indicates that \( A_i \) is the preferred alternative.

2.3. Borda

Borda is a group decision support method that is obtained by multiplying the reference value by the weight of the ranking. The count Borda method is a method of voting by the assessor ranking candidates according to preference. In Borda method, each candidate will be ranked by giving a number of points according to the position of this candidate [20]. Borda determines the best alternative by accumulating at the most points gained. Borda provides a number of points for each candidate depending on the ranking set by the decision maker. The winner will be determined by the number of points each candidate receives [8]. The lowest Borda score are selected to be eliminated [21]. The Borda count works as follow: Every assessors gives \( n \) point for the first choice candidate, \( n-1 \) point for the second choice candidate, so on and 1 point for the last choice candidate. The best alternative is the candidate who has the most points [22].

3. Method

This study was started by conducting observation and analysis on problems that occurred in evaluating employee performance at PT. Krakatau Osaka Steel. Then, a literature study was conducted to support the method used. The next step was designing a group decision support system model, followed by collecting the latest date regarding employee performance evaluation conducted in April 2019. The assessor then was appointed as the authority in evaluating employee performance, and finally, the accuracy of the results of the GDSS method was made by comparing the results between the GDSS method and the current method.

4. Propose model

GDSS Employee Performance Evaluation (EPE) Model that will be developed consists of several stages. The first is an alternative assessment by the assessor with predetermined criteria. Second, data processing by the system using the Simple Additive Weighting method, which will produce an assessment in the form of an alternative ranking of employees, which will then be taken by the 5 best employees according to each assessor. Third, employee performance evaluation will result in different preferences according to each assessor, then selecting alternative data of the selected candidates to progress to the next stage, namely assessment data processing by using the Borda method. The fourth is the ranking stage of the selected candidates at PT. Krakatau Osaka Steel and selecting three of the best employees. EPE Model is shown in figure 1.
Figure 1. GDSS EPE model.

The created GDSS model is a combination between two decision support system methods using Simple Additive Weighting method calculations on the first calculation and Group Decision Support System with Borda method for the result. In the GDSS model, the system consisted of two main actors, namely the assessor to give the value and the operator to process the value into information on the results of employee performance evaluation at PT. Krakatau Osaka Steel. In the first stage, there was an alternative assessment conducted by the assessor and 59 alternative employees and 7 predetermined criteria assessed. The second stage was the data processing by system with the Simple Additive Weighting method by finding the weighted sum of the performance for each alternative. The SAW method requires the decision matrix normalization process \( X \) to a scale that can be compared with all existing alternative ratings, which will result in an assessment in the ranking of employee alternatives and then be taken by the 5 best employees according to each assessor. Third, the employee performance evaluation that produced different preferences according to each assessor. An assessor produced five alternatives selected as candidates to enter the next stage. The maximum number of candidates was 15, and then the selection from all candidates was made according to the assessors by the processed data, so that there was no duplicated data of candidates as selected candidates according to the assessment to enter the next stage, namely by processing of assessment data using the Borda method. Borda point obtained by multiplying the results of the preference value of the SAW with the weighting ranking obtained, then looking for the Borda score as the result of sharing the Borda points of each candidate with the results of the overall Borda point accumulation from all assessors, from which the final evaluation produced the alternative candidates. The fourth was the ranking stage of the selected candidates at PT. Krakatau Osaka Steel then three best employees selected with the highest Borda score.

5. Results and discussion
In the Simple Additive Weighting method, there are criteria and alternatives needed as attributes. Existing criteria have a weight specified for the assessment. The total score for the alternative is obtained by adding up all the multiplication results between the rating (which can be compared across attributes) and the weight of each attribute. The weighting criteria available in this study as shown in table 1.
Table 1. Weighting criteria.

| Criteria                   | Notation | Weight of criteria |
|----------------------------|----------|--------------------|
| Honest and Integrity       | C1       | 10%                |
| Competence and Innovative  | C2       | 10%                |
| Smart Work and High Achievement | C3     | 10%                |
| Loyalty                    | C4       | 10%                |
| Programmable Objective     | C5       | 36%                |
| Non-Programmable Objective | C6       | 12%                |
| Quality of the work        | C7       | 12%                |

(Source: Assessment Form of PT. KOS)

Table 1 is shown specified criteria and their weight. The company in accordance with existing rules has determined the weighting of each criterion.

Based on the total alternative population of employees at PT. Krakatau Osaka Steel, the sample was taken purposively with an error percentage of 5%, and then the number of samples needed was 59 samples. The next step was the collection the value data from each assessor for all alternatives from each of the available criteria. A list of the results from the assessors as shown in table 2.

Table 2. Employee appraisal.

| Alt | 1st Assessor | 2nd Assessor | 3rd Assessor |
|-----|--------------|--------------|--------------|
|     | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C1 | C2 | C3 | C4 | C5 | C6 | C7 |
| A1  | 90 | 86 | 85 | 85 | 90 | 88 | 86 | 85 | 87 | 86 | 80 | 90 | 85 | 85 |
| A2  | 92 | 85 | 85 | 90 | 91 | 88 | 86 | 90 | 84 | 85 | 90 | 88 | 85 | 83 |
| A3  | 85 | 82 | 82 | 85 | 82 | 82 | 80 | 82 | 77 | 79 | 77 | 79 | 77 | 77 |
| A4  | 80 | 84 | 83 | 80 | 80 | 80 | 78 | 80 | 77 | 81 | 79 | 82 | 75 | 77 |
| A5  | 85 | 80 | 78 | 85 | 80 | 78 | 80 | 86 | 80 | 80 | 81 | 81 | 82 | 81 |
| A6  | 78 | 82 | 81 | 78 | 80 | 78 | 77 | 84 | 86 | 81 | 83 | 80 | 82 | 80 |
| A7  | 85 | 82 | 80 | 85 | 83 | 82 | 80 | 86 | 80 | 80 | 81 | 82 | 82 | 81 |
| A8  | 85 | 82 | 82 | 85 | 82 | 85 | 80 | 82 | 79 | 79 | 82 | 79 | 82 | 77 |
| A9  | 79 | 78 | 80 | 80 | 80 | 80 | 80 | 74 | 77 | 77 | 75 | 77 | 76 | 77 |
| A10 | 77 | 80 | 80 | 78 | 80 | 79 | 80 | 75 | 76 | 77 | 77 | 77 | 77 | 77 |
| A11 | 75 | 88 | 79 | 80 | 78 | 76 | 78 | 77 | 89 | 76 | 80 | 72 | 73 | 74 |
| A12 | 77 | 78 | 76 | 75 | 71 | 70 | 73 | 77 | 69 | 74 | 49 | 89 | 76 | 77 |
| A13 | 70 | 71 | 72 | 73 | 71 | 80 | 80 | 81 | 82 | 78 | 77 | 75 | 80 | 79 |
| A14 | 70 | 70 | 71 | 70 | 71 | 76 | 70 | 70 | 71 | 76 | 72 | 73 | 71 | 70 |
| A15 | 71 | 71 | 71 | 72 | 70 | 80 | 71 | 71 | 72 | 71 | 71 | 73 | 77 | 71 |
| A16 | 75 | 75 | 76 | 76 | 70 | 81 | 71 | 71 | 72 | 71 | 76 | 77 | 77 | 77 |
| A17 | 77 | 70 | 81 | 82 | 76 | 71 | 70 | 70 | 70 | 76 | 79 | 70 | 71 | 71 |
| A18 | 69 | 69 | 70 | 76 | 80 | 71 | 71 | 70 | 71 | 72 | 73 | 71 | 71 | 70 |
| A19 | 79 | 70 | 70 | 70 | 76 | 69 | 70 | 69 | 69 | 81 | 71 | 72 | 70 | 71 |
| A20 | 77 | 76 | 76 | 76 | 70 | 69 | 69 | 70 | 70 | 70 | 76 | 76 | 76 | 76 |
| A21 | 70 | 70 | 70 | 71 | 76 | 76 | 76 | 76 | 76 | 76 | 70 | 71 | 71 | 72 |
| A22 | 81 | 81 | 79 | 79 | 79 | 79 | 79 | 77 | 77 | 77 | 70 | 79 | 71 | 71 |
| A23 | 88 | 79 | 80 | 78 | 76 | 78 | 78 | 89 | 76 | 80 | 72 | 73 | 74 | 77 |
| A24 | 78 | 76 | 75 | 72 | 71 | 70 | 73 | 77 | 76 | 49 | 76 | 77 | 78 | 71 |
| A25 | 71 | 72 | 73 | 71 | 80 | 81 | 80 | 72 | 78 | 77 | 75 | 70 | 79 | 81 |
| A26 | 70 | 71 | 70 | 71 | 76 | 70 | 70 | 71 | 76 | 72 | 73 | 71 | 70 | 70 |
| A27 | 71 | 71 | 72 | 80 | 71 | 70 | 71 | 71 | 72 | 71 | 73 | 77 | 71 | 71 |
| A28 | 75 | 76 | 76 | 80 | 71 | 71 | 75 | 71 | 72 | 76 | 77 | 77 | 70 | 71 |
| A29 | 70 | 81 | 82 | 76 | 71 | 70 | 77 | 70 | 76 | 79 | 71 | 71 | 70 | 70 |
| A30 | 69 | 70 | 76 | 80 | 71 | 71 | 69 | 70 | 70 | 71 | 72 | 71 | 70 | 71 |
| A31 | 70 | 70 | 70 | 69 | 70 | 70 | 70 | 69 | 69 | 81 | 72 | 70 | 71 | 69 |
| A32 | 76 | 76 | 76 | 77 | 70 | 69 | 77 | 70 | 70 | 76 | 76 | 76 | 76 | 70 |
| A33 | 70 | 70 | 76 | 71 | 76 | 76 | 76 | 76 | 76 | 76 | 70 | 70 | 70 | 70 |
| A34 | 81 | 79 | 79 | 79 | 79 | 79 | 81 | 77 | 77 | 70 | 70 | 79 | 71 | 71 |
| A35 | 80 | 88 | 80 | 89 | 78 | 83 | 80 | 80 | 81 | 81 | 81 | 81 | 81 | 80 |
| A36 | 69 | 81 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 71 | 76 | 77 | 77 |
| A37 | 70 | 70 | 76 | 75 | 75 | 76 | 75 | 75 | 76 | 79 | 70 | 71 | 71 | 71 |
| A38 | 76 | 76 | 76 | 75 | 77 | 70 | 81 | 77 | 80 | 81 | 72 | 73 | 71 | 71 |
| A39 | 77 | 77 | 70 | 69 | 69 | 70 | 70 | 70 | 70 | 76 | 76 | 76 | 76 | 76 |
| A40 | 89 | 80 | 82 | 79 | 79 | 70 | 70 | 80 | 80 | 81 | 72 | 70 | 71 | 70 |
| A41 | 76 | 74 | 89 | 76 | 77 | 76 | 76 | 77 | 76 | 76 | 75 | 70 | 71 | 72 |

(2020) 032014

5
After collecting all valuation data, the normalization process was carried out from each assessment table using equation (1) for the benefit attribute.

Table 2. Cont.

|       | Alt |       |       |       |       |       |       |       |       |       |       |       |
|-------|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|       | A51 | 77   | 70   | 70   | 69   | 70   | 76   | 69   | 70   | 70   | 70   | 70   |
|       | A52 | 89   | 89   | 90   | 90   | 90   | 79   | 91   | 89   | 89   | 89   | 89   |
|       | A53 | 87   | 89   | 90   | 88   | 78   | 77   | 87   | 78   | 79   | 81   | 88   |
|       |     | A54   | 88   | 89   | 87   | 86   | 85   | 85   | 80   | 80   | 89   | 85   |
|       |     |       | A55   | 79   | 80   | 88   | 86   | 85   | 84   | 84   | 82   | 82   |
|       |     |       |       | A56   | 76   | 77   | 75   | 78   | 79   | 79   | 76   | 78   |
|       |     |       |       |       | A57   | 70   | 78   | 78   | 78   | 76   | 78   | 80   |
|       |     |       |       |       |       | A58   | 70   | 70   | 70   | 78   | 75   | 75   |
|       |     |       |       |       |       |       | A59   | 76   | 75   | 78   | 76   | 79   |

max 92 89 90 91 91 90 97 91 89 89 90 90 88 88 92 90 89 93 93 90 88

Source: Assessment Form 2019

After collecting all valuation data, the normalization process was carried out from each assessment table using equation (1) for the benefit attribute.

Based on the results of normalized weight calculations, the results from the SAW method assessment calculations from each assessor were obtained and the 5 best alternatives (Alt) were determined according to each assessor of the highest SAW value. The results of the SAW analysis as shown in table 3.

Table 3. SAW result.

| Rank | 1st Assessor | Alt | SAW Value | 2nd Assessor | Alt | SAW Value | 3rd Assessor | Alt | SAW Value |
|------|--------------|-----|-----------|--------------|-----|-----------|--------------|-----|-----------|
| 1    | A52          | 0.99278 |           | A52          | 0.97633 |           | A1           | 0.98357 |           |
| 2    | A2           | 0.97258 |           | A2           | 0.96988 |           | A2           | 0.98241 |           |
| 3    | A1           | 0.96208 |           | A1           | 0.96850 |           | A54          | 0.95233 |           |
| 4    | A54          | 0.94158 |           | A54          | 0.94758 |           | A7           | 0.94155 |           |
| 5    | A55          | 0.92022 |           | A56          | 0.91987 |           | A52          | 0.93823 |           |

The assessment results obtained using the Simple Additive Weighting method from assessor I, II and III as in Table 3, where the three of the assessors have the best ranking of different employees. Based on the preferences obtained, it can be determined the best employee candidates as A1, A2, A7, A52, A54, A55 and A56. The following shows the results of the ranking of employee candidates based on the preferences of each assessor in table 4.

Table 4. Alternative candidate value.

| Rank | 1st Assessor | Alt | SAW Value | 2nd Assessor | Alt | SAW Value | 3rd Assessor | Alt | SAW Value |
|------|--------------|-----|-----------|--------------|-----|-----------|--------------|-----|-----------|
| 1    | A52          | 0.99278 |           | A52          | 0.97633 |           | A1           | 0.98357 |           |
| 2    | A2           | 0.97258 |           | A2           | 0.96988 |           | A2           | 0.98241 |           |
| 3    | A1           | 0.96208 |           | A1           | 0.96850 |           | A54          | 0.95233 |           |
| 4    | A54          | 0.94158 |           | A54          | 0.94758 |           | A7           | 0.94155 |           |
| 5    | A55          | 0.92022 |           | A56          | 0.91987 |           | A52          | 0.93823 |           |
| 6    | A7           | 0.90348 |           | A7           | 0.91455 |           | A55          | 0.90062 |           |
| 7    | A56          | 0.83805 |           | A55          | 0.91440 |           | A56          | 0.89720 |           |
In the table 4 shown SAW Value of every alternative from all assessors. In the next stage, the results of the 7 best candidates were then sorted based on the highest SAW value from each assessor and the highest weight was given according to the number of selected candidates (n) and then the next weight (n-1), where n is the number of candidates elected from the results of SAW analysis. After sorting all alternative candidates based on the results of SAW calculation by the highest value, then count the Borda point. The results of the Borda point calculation for the selected candidates as in table 5.

Table 5. Borda calculation.

| Candidate | 1  | 2  | 3  | Borda Point | Borda Score |
|-----------|----|----|----|-------------|-------------|
| A1        | 0.98357 | 0   | 1.93058 | 0           | 0           |
| A2        | 0   | 2.92487 | 0   | 0           | 0           |
| A7        | 0   | 0   | 0.94155 | 0           | 1.81803     |
| A52       | 1.96911 | 0   | 0   | 0.93823    | 0           |
| A54       | 0   | 0   | 0.95233 | 1.88916     | 0           |
| A55       | 0   | 0   | 0   | 0.92022    | 0.90062     |
| A56       | 0   | 0   | 0   | 0.91987    | 1.73525     |
| Weight    | 7   | 6   | 5   | 4           | 3           |

The results of the Borda method analysis were sorted based on the highest Borda score and resulted 3 best employee dase on GDSS as shown in table 6.

Table 6. GDSS EPE result.

| Rank | Alt |
|------|-----|
| 1    | A2  |
| 2    | A52 |
| 3    | A1  |

Based on the order of Borda scores, there were 3 best alternative employees taken with the alternative employees, as can be seen in Table 6. Based on the results of GDSS calculation using the SAW and Borda methods, it was found that A2 was in the first place with a Borda score of 0.218336, followed by 2 other employees, namely A52 and A1, with a Borda score of 0.206507 and 0.205753, respectively.

Furthermore, in order to find out the comparison between the results of the evaluation using GDSS method and the results of evaluation using ongoing manual calculations, a manual calculation was performed by multiplying directly the alternative values obtained from 1 assessor preference with the weight criteria as shown in Table 1. Then, the three employees with the highest score were selected as the best candidate. The results of the manual calculation evaluation as based on the highest score as in table 7.

Table 7. Manual evaluation result.

| Rank | Alt | Score |
|------|-----|-------|
| 1    | A52 | 90.74 |
| 2    | A2  | 88.84 |
| 3    | A1  | 87.88 |

Based on GDSS and manual calculations, the results showed that the GDSS calculations are in line with manual calculations on the current system for evaluating employee performance. The differences are in Alt A52 and A2 as the manual calculation shows higher results for A52 in its assessment, while the GDSS calculation shows higher results for A2. The results showed that the preferences from other assessors in evaluating employee performance could have an effect on the evaluation results. This shows that this method can be used in evaluating employee performance because it can combine the preference values of several assessments, so that the evaluation does not only come from one, but several preferences that are combined into a group decision support system.
6. Conclusion
The implementation of the Simple Additive Weighting and Borda methods in the design of the Group Decision Support System for evaluating employee performance was carried out with calculation stages that were able to produce value on each employee alternative as the best employee candidate at PT. Krakatau Osaka Steel. The GDSS calculation results showed that this method was in accordance with the needs that could be used to evaluate the performance of employees at PT. Krakatau Osaka Steel by combining several preferences into one evaluation result. It is suggested for future research related to employee performance evaluation that individual decision-making can also use a combination of other methods such as Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE), Analytical Hierarchy Process (AHP) or Profile Matching Method to obtain better results and accuracy.

References
[1] Johansen M S and Sowa J E 2019 Human resource management, employee engagement, and nonprofit hospital performance Nonprofit Management and Leadership 1–19
[2] Zhao J, Karimzadeh M, Snyder L S, Surakitchen C, Qian Z C and Ebert D S 2019 MetricsVis: A Visual Analytics System for Evaluating Employee Performance in Public Safety Agencies, Fellow, IEEE
[3] Setiyowati S, Sumiati, Sutarti, Wibowo A H, Rosalina V and Munandar T A 2019 Group Decision Support System to Determine Regional Development Priority Using the Item-Based Clustering Hybrid Method Journal of Computer Science 15(4) 511-518
[4] Nair S M and Salleh R 2015 Linking Performance Appraisal Justice, Trust, and Employee Engagement: A Conceptual Framework Procedia Social and Behavioral Science 211(2015) 1155 – 1162
[5] Alfurhood B and Silaghi M 2018 A Survey of Group Decision Making Methods and Evaluation Techniques The Thirty-First International Florida Artificial Intelligence Research Society Conference (FLAIRS-31) pp 168-171
[6] Setiawan N, Nasution M D T P, Rossanty Y, Tambunan A R S, Girsang M, Agus R T A, Yusuf, M, Vebrianto R, Purba O N, Fauzi A, Perdana S and Nisa K 2018 Simple Additive Weighting as Decision Support System for Determining Employees Salary Int. J. Eng. Tech. 7(2-14) 309-313
[7] Sahir S H, Rosmawati R and Minan K 2017 Simple Additive Weighting Method to Determining Employee Salary Increase Rate IJSRST 8(3) 42-48
[8] Ashaf D H, Hidayat S W and Ahmadi 2019 Decision Support System Determines the Purchase of House Right Using Analytical Hierarchy Process (AHP) And Borda Methods Int. J. ASRO 10(1) 1-9
[9] Liao H, Wu X, Mi X and Herrera F 2018 An integrated method for cognitive complex multiple expert’s multiple criteria decision making based on ELECTRE III with weighted Borda rule OME 2052 S0305-0483(18) 30407-9
[10] Wang W and Reani M 2017 The Rise of Mobile Computing for Group Decision Support Systems: A Comparative Evaluation of Mobile and Desktop Journal of Human Computer Studies
[11] Rigopoulos G 2015 A group decision support system for collaborative decisions within business intelligence context American J. Inf. Sci. Comp. Eng. 1 84-93
[12] Rossi S, Napoli C D, Barile F and Liguori L 2017 A Multi-Agent System for Group Decision Support Based on Conflict Resolution Styles (New York: Springer International Publishing AG)
[13] Apriliani D, Adi K and Gernowo R 2015 Implementasi Metode Promethee dan Borda dalam Sistem Pendukung Keputusan Pemilihan Lokasi Pembukaan Cabang Baru Bank JSINBIS 02(2015) 145-150
[14] Loll F, Ishizaka A, Gamberini R, Rimini B, Balugani E and Pradini L 2017 Requalifying public buildings and utilities using a group decision support system Journal of Cleaner Production 164(2017)
[15] Grigera J, Garrido A, Zarete P, Camilleri G and Fernandez A 2017 A Mixed Usability Evaluation on a Multi Criteria Group Decision Support System in Agriculture ACM

[16] Aminudin N, Huda M, Kilani A, Embong W H W, Mohamed A M, Basiron B, Ihwani S S, Noor S S M, Jasmi K A, Safar J, Ivanova N L, Maseleno A, Triono A and Nungsiati 2018 Higher education selection using simple additive weighting IJET 7(2-27) 211-217

[17] Hojjati S M H and Anvary A 2013 An Integrated SAW, TOPSIS Method for Ranking the Major Lean Practices Based on Four Attributes World applied Science Journal 28(11) 1862-1871

[18] Kurniawan Y I 2015 Decision Support System for Acceptance Scholarship with Simple Additive Int. Conf. Sci. Tech. and Hum.

[19] Meilina P, Risanty R D and Nurwahyudin E 2018 Key Performance Indicator Application in Performance Assessment of the Best Employees with Simple Additive Weighting Methods On General and HR Division Case Study: Perum Percetakan Negara RI IHASJ 1 58-65.

[20] Tian Z and Chen L 2018 A Multi-Centrality Model based on Borda Count Method for Identification of Important Ports in Maritime Networks ICMESS Advances in Social Science, Education and Humanities Research 176

[21] Orouskhani M and Shi D 2017 Fuzzy adaptive cat swarm algorithm and Borda method for solving dynamic multi-object problems Expert Systems

[22] Orouskhani M, Tashnehlab M and Nekoui M A 2018 Evolutionary dynamic multi-object optimization algorithm based on Borda count method Int. J. Mach. Learn. & Cyber