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Recommendation method for selecting the rice seeds based on group decision support system

Hamdani[1], Masna Wati[1], Didit Suprihanto[2], Nur Maya Salsabila[1], Anindita Septiarini[1], Dita Nurmadewi[3], Viny Christanti Mawardi[4]
[1]Department of Informatics, Faculty of Engineering, Universitas Mulawarman, Samarinda, Indonesia
[2]Department of Electrical Engineering, Faculty of Engineering, Universitas Mulawarman, Samarinda, Indonesia
[3]Department of Information System, Faculty of Engineering and Computer Science, Bakrie University, Jakarta, Indonesia
[4]Department of Informatics, Faculty of Information Technology, Tarumanagara University, Jakarta, Indonesia

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ABSTRACT

In this paper, we provide group recommendations based on each decision makers (DMs) in choosing the best type of rice for replanting. This group decision support system (GDSS) aims to guide stakeholders who have a role in selecting rice types. In this method, we propose using technique for order preference by similarity to ideal solution (TOPSIS) to rank each DM, Borda to rank in groups, and then test it using Spearman's rank correlation to measure the relationship between system results and the method applied. The results of this study show that DM_1 ranks highest in selecting Gelagai rice seeds with a preference of 0.7786. Then DM_2 ranked highest with Ekor Payau rice seeds in preference 0.6529. Meanwhile, DM_3 ranked highest in Gelagai rice seeds with a selection of 0.7728. The final group voting system uses Borda, where Gelagai rice seeds occupy the highest rank with the most accumulated votes from each DMs. The best option or the highest rating based on the assessment of the three DMs, DM_1 as a farmer is the first rank A10 Gelagai with a score of Borda 26 in the decision group selection of superior rice seeds.

Corresponding Author:

Hamdani
Department of Informatics, Faculty of Engineering, Universitas Mulawarman
St. Sambaliung 9, Gunung Kelua, Samarinda, Indonesia
Email: hamdani@unmul.ac.id

1. INTRODUCTION

Rice (*Oryza sativa*) is a primary staple food providing a larger share of food energy for more populations than any other cereal crop [1]. In Indonesia, rice is the main food crop consumed with a relatively high need, indicating that daily absorption depends on grain [2]. The Government of Indonesia continues to develop sustainable food self-sufficiency programs by increasing national food security through extension programs. One of the instruments is to open new rice fields, but if you look at land in Indonesia, it is still dominated by primary forest. The area of new rice fields in Indonesia is 222,442 ha, spread over Sumatra, Kalimantan, and Papua Islands [3]. The role of the food and plantation crops sub-sector is quite dominant in the growth structure of the agricultural sector, where the rice cultivation sector with world rice production rank third after corn and wheat [4]. However, rice is the primary source of carbohydrates for the majority of the population in Asia. Until now, the selection of quality rice seeds has been the leading choice in several Asian countries, such as Indonesia [2], [3]. The need for grain in Indonesia is essential, considering that in Indonesia, currently, many rice variants need to be selected, so it is necessary to choose high-quality rice types for development [2], [5].

In this paper, we collaborate with the agricultural extension technical implementation unit belonging to Muara Bengkal Ilir village government, Muara Bengkal Ulu, Benua Baru, Ngayau, Senambah, and Mulupan in East Kalimantan, Indonesia. We see that many variants of rice seeds significantly influence farmers' productivity to increase agricultural business, so it is necessary to select high-quality, superior, and local sources. This study provides a guide to the sustainability of farmer and government group decision-making for the sustainability of agricultural development [1], [3]. A group decision-making model is needed to help solve the problem of how to choose quality rice [6]. The group decision support system (GDSS) aims to assist stakeholders in providing vital information to produce decisions together [7]. Furthermore, what is needed is the process of making group decisions that are carried out anywhere and anytime by stakeholders [8]. Where stakeholder involvement is needed for group decision-making involving many people, it is essential for those with other interests [9]–[11]. For this group decision model, we propose the technique for order preference by similarity to ideal solution (TOPSIS) method for each decision makers (DMs) ranking [12]. Then group decisions use Borda so that the decision results of each stakeholder can be used together [13], [14]. The group decision model is very appropriate to accommodate the interests of each DMs with different decision-making views [15]. This research aims to combine the TOPSIS and Borda methodologies to create a model of a GDSS for choosing rice seeds. It used seven parameters, including rice type, rice grains, rice shape, rice color, water, fertilizer, and pesticide.

2. PROPOSED METHOD

For this group decision model, we propose the TOPSIS method for each DMs ranking. Then group decisions use Borda so that the decision results of each stakeholder can be used together. The group decision model is very appropriate to accommodate the interests of each DMs with different decision-making views [15]. The stages that we propose can be seen in Figure 1.

Based on Figure 1, we propose a new method for selecting superior rice grains to enable each stakeholder in group decision-making. Here we use three stakeholders in decision-making consisting of DM_1 as a farmer, DM_2 non-government organization (NGO), and DM_3 government. Furthermore, each DMs gives an assessor and weight based on its importance to produce a ranking using the TOPSIS method. From each DMs ranking, voting is done using the Borda method to make a group decision. We tested the results of the group decisions using the Spearman rank correlation method to find out the ranking difference from the closest to the group decision.

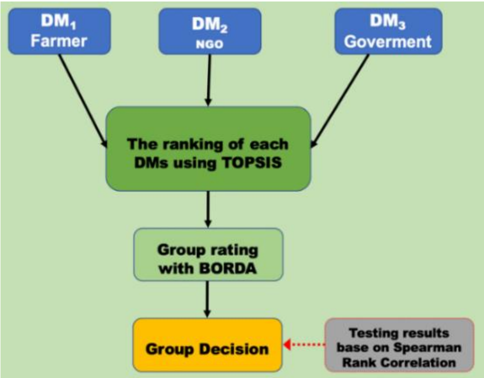

Figure 1. The proposed method on the recommendation in GDSS

2.1. TOPSIS

In this study, we used the TOPSIS method for each ranking of each DMs, and then the results for each DMs were analyzed as a group. This method is suitable for integrating each stakeholder because the DMs carries out the weighting model [16]. The TOPSIS method in this problem requires a performance rating for each alternative A_i on each normalized C_i criterion [17], [18] with five stages:

– The first step is determining the normalized r_{ij} normalized decision matrix like (1).

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{1}$$

The value of i and j are 1, 2,. . . m and j = 1, 2,. . . n, respectively. The parameter m and n present the alternatives and criteria or sub criteria. Whereas, the value of x_{ij} indicates the element value of each criterion or sub-criteria of the alternative, while r_{ij} is the value elements of the normalized matrix.

– Determine the normalized weight of the decision matrix. The criterion weight value is calculated from the results of the y_{ij} value using the (2). The parameter of y_{ij} is the result of the element value of the normalized matrix. Meanwhile, w_i is the preference weight value for each criterion or sub-criterion.

$$y_{ij} = r_{ij}\ w_i \tag{2}$$

– Determining the positive ideal solution (PIS) matrix and the negative ideal solution (NIS) matrix can be determined based on the normalized weight rating (y_{ij}), which can be seen from (3) and (4). Where y_1^+ is an element of the PIS matrix, which also uses y_1^- for the NIS matrix element.

$$PIS = \{y_1^+, y_2^+, \dots, y_j^+\}, where\ y_j^+ = \begin{cases} max \left(y_{ij} \,|\, i = 1,2,\dots, \quad m \right) if\ j \in J_1 \\ min \left(y_{ij} \,|\, i = 1,2,\dots, \quad m \right) if\ j \in J_2 \end{cases} \tag{3}$$

$$NIS = \{y_1^-, y_2^-, \dots, y_j^-\}, where\ y_j^- = \begin{cases} min \left(y_{ij} \,|\, i = 1,2,\dots, \quad m \right) if\ j \in J_1 \\ max \left(y_{ij} \,|\, i = 1,2,\dots, \quad m \right) if\ j \in J_2 \end{cases} \tag{4}$$

– Determine the distance between the values of each alternative with the PIS matrix and the NIS matrix. This process can be seen in (5) and (6). The parameters of D_i^+ is the alternative distance with the PIS.
Distance between alternative PIS:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_i^+ - y_{ij} \right) 2} \tag{5}$$

Distance between alternative NIS:

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(y_{ij} - y_i^- \right) 2} \tag{6}$$

Where D_i^- is an alternate distance with NIS.

– The preference value for each alternative V_i can be seen in (7). The parameter of V_i is the value of a preference for each alternative.

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \tag{7}$$

2.2. Borda

Borda is a voting method used in GDSS for single-winner or multiple-winner elections, in which voters rank the chosen alternative [19], [20]. Borda determines the winner by giving a certain number of points for each alternative according to the rating provided by each voter [13]. The winner is determined from the total number of final points for each alternative collected by each voter, with the highest points selected as the winner [14]. Before applying the final selection methodology, the purchaser must have this identification carried out by experts with a weighted Borda function [21].

Each expert gives the order of each. The hypothesis is that there are n firms in the firm set, and each expert will provide an order for them. Then the score of each company will be given sequentially. The first DMs will get a score of n -1; similarly, the second one will score n -2; and the latter will score zero. Furthermore, the total score of each company will be calculated with reference to (8). Finally, potential DMs will be taken based on the score of each other DMs [22]. The Borda function is stated as:

$$f_B(x) = \sum_{y=A\{x\}} N\ (x \succ_i\ y) \tag{8}$$

$$B = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_b \end{array} \begin{array}{c} A_1 \quad A_2 \quad \dots \quad A_n \\ \left| \begin{matrix} 0 & b_{12} & \cdots & b_{1n} \\ b_{21} & 0 & \cdots & b_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{n1} & b_{n2} & \cdots & 0 \end{matrix} \right| \end{array} \begin{array}{c} \text{row sum} \\ S_1 \\ S_2 \\ \vdots \\ S_n \end{array} \tag{9}$$

Where i and j respectively indicate affected clusters and affected clusters, and n is an element of the cluster in question. Each calculation step with the Borda method using weighting by the DMs can be carried out by giving a value to the first-choice alternative. For the second choice alternative and the value 0 is for the last alternative choice. Furthermore, the alternative that has the highest value is the winner [23]. Furthermore, we can calculate the integrated weights with TOPSIS. Assume that the weight of variable i in the network layer under variable j in the control layer is w_{ij}, and the weight of the control variable j under the destination is w_j, so the integrated weight of variable i is stated as (10).

$$w_i = w_j \times w_{ij} \tag{10}$$

2.3. Spearman rank correlation

Spearman's rank correlation tests the correlation hypothesis with a minimal ordinal variable scale [24]. In the Spearman rank correlation test using a data scale for the two correlated variables originating from a different scale (ordinal data scale with numerical data scale) or the same (ordinal data scale with ordinal data scale) [25]. The formula for Spearman's rank correlation can be seen in (11).

$$rs = 1 - \frac{6\sum D^2}{n(n^2-1)} \tag{11}$$

The parameter of rs is the result of the Spearman rank correlation coefficient. Meanwhile, D parameter is the difference in rank for each n sample of data used. As for knowing the level of correlation strength between two variables, the Spearman rank correlation method provides criteria for the level of correlation strength, consisting of very low, fair, strong, very strong, and excellent with the scale value of 0.00-0.25, 0.26-0.50, 0.51-0.75, 0.76-0.99, and 1, respectively.

2.4. Criteria weight data and alternatives

Data design was used to determine criteria and alternatives so that they become parameters in group decision-making. Furthermore, this study used ten rice alternatives in the village. The rice consists of national and local rice quality, which have been grouped based on the quality of the required criteria. This study used seven parameters as the judging criteria (C_i) including, rice type (C_1), rice grains (C_2), rice shape (C_3), rice color (C_4), water (C_5), fertilizer (C_6), and pesticide (C_7). In designing criteria and alternatives to be used as variables in determining superior rice seeds in the Muara Bengkal District, the rice data set as a reference in this study which can be seen in Table 1.

Table 1. Rice data sets

A_i.	Alternative	Criteria (C_i)					
		C_1	C_2	C_3	C_4	⋯	C_7
A_1	Rice seeds of IR64	excellent	half contain	oval	chocolate	⋯	2 times
A_2	Rice seeds of Ciherang	excellent	half contain	fat	chocolate	⋯	3 times
A_3	Rice seeds of Raja Lele	excellent	contain	fat oval	chocolate	⋯	3 times
A_4	Rice seeds of Serai	local rice	contain	oval	dark yellow	⋯	1 times
A_5	Rice seeds of Sarti	excellent	empty	fat	dark yellow	⋯	3 times
A_6	Rice seeds of Elpi	local rice	contain	fat	chocolate	⋯	1 times
A_7	Rice seeds of Kunyit	local rice	contain	oval	light yellow	⋯	2 times
A_8	Rice seeds of Ekor Payau	excellent	half contain	fat oval	dark yellow	⋯	1 times
A_9	Rice seeds of Pahu	local rice	contain	fat	chocolate	⋯	2 times
A_{10}	Rice seeds of Gelagai	local rice	contain	fat oval	light yellow	⋯	2 times

The weight is determined, determining each criterion weight based on its level of importance according to the DMs. The weight values of each criterion—5, 3, and 2—represent the corresponding variables of very good, good, and poor, respectively. Each criterion has a weight value so that each DM_i can use it in assigning criteria weights. Each DM_i consists of farmers as DM_1, NGO as DM_2, and government DM_3. Furthermore, to find out the final ranking of each DMs, we use the TOPSIS method based on the subjective weight of each DMs, as seen in Table 2.

Table 2. Criteria weight of each DMs

DMs	C1	C2	C3	C4	C5	C6	C7
Farmer (DM_1)	3	5	5	2	5	3	2
NGO (DM_2)	3	3	2	3	5	5	2
Goverment (DM_3)	5	3	2	5	5	3	2

3. RESULTS AND DISCUSSION

3.1. Decision matrix results

In this paper, the first stage of generating formed a decision matrix. It was the decision matrix based on the data set in Table 2. The value has been converted to sub-criteria values, as presented in Table 3.

Table 3. Decision matrix

A_i	Alternative	C1	C2	C3	C4	C5	C6	C7
A_1	Rice of IR64	5	3	1	1	5	1	3
A_2	Rice of Ciherang	5	3	3	1	3	5	1
A_3	Rice of Raja Lele	5	5	5	1	5	3	1
A_4	Rice of Serai	3	5	1	5	1	3	5
A_5	Rice of Sarti	5	1	3	5	3	1	1
A_6	Rice of Elpi	3	5	3	1	3	3	5
A_7	Rice of Kunyit	3	5	1	3	1	5	3
A_8	Rice of Ekor Payau	5	3	5	5	1	5	5
A_9	Rice of Pahu	3	5	3	1	3	3	3
A_{10}	Rice of Gelaigai	3	5	5	3	5	1	3
	Sum of square roots	13,0384	13,3416	10,6770	9,8994	10,6770	10,6770	10,6770

3.2. Determine the normalized decision matrix

This step generated the normalized decision matrix results using (1). It was obtained by dividing the elements per column of the decision matrix with the square root results from Table 4. Based on the results acquired by calculations that form r_{ij} or normalized decision matrices as shown in Table 5.

$$r_{11} = \frac{1}{13.0384} = 0.3835 \qquad r_{12} = \frac{3}{13.3416} = 0.2249 \qquad \cdots \qquad r_{107} = \frac{3}{10.6770} = 0.2810$$

Table 4. Matrix of PIS and NIS

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
PIS+	1.1504	1.1243	0.9366	1.5152	2.3415	2.3415	0.9366
NIS-	0.6903	0.2249	0.1873	0.3030	0.4683	0.4683	0.1873

Table 5. Normalized decision matrix

A_i	Alternative	C1	C2	C3	C4	C5	C6	C7
A_1	Rice of IR64	0.3835	0.2249	0.0937	0.1010	0.4683	0.0937	0.2810
A_2	Rice of Ciherang	0.3835	0.2249	0.2810	0.1010	0.2810	0.4683	0.0937
A_3	Rice of Raja Lele	0.3835	0.3748	0.4683	0.1010	0.4683	0.2810	0.0937
A_4	Rice of Serai	0.2301	0.3748	0.0937	0.5051	0.0937	0.2810	0.4683
A_5	Rice of Sarti	0.3835	0.0750	0.2810	0.5051	0.2810	0.0937	0.0937
A_6	Rice of Elpi	0.2301	0.3748	0.2810	0.1010	0.2810	0.2810	0.4683
A_7	Rice of Kunyit	0.2301	0.3748	0.0937	0.3030	0.0937	0.4683	0.2810
A_8	Rice of Ekor Payau	0.3835	0.2249	0.4683	0.5051	0.0937	0.4683	0.4683
A_9	Rice of Pahu	0.2301	0.3748	0.2810	0.1010	0.2810	0.2810	0.2810
A_{10}	Rice of Gelaigai	0.2301	0.3748	0.4683	0.3030	0.4683	0.0937	0.2810

3.3. Determine weighted normalized decision matrix

The weighted decision matrix was determined using (2). It was calculated by multiplying the elements r_{ij} in Table 5 with W_{ij}. Table 6 shows the weight of each DMs for the following findings. The calculations yield a weighted normalized decision matrix, as shown in Table 6.

$$y_{11} = 0.3835 * 3 = 1.1504;\ y_{12} = 0.2249 * 3 = 0.6746;\ ...\ y_{107} = 0.2810 * 2 = 0.5620$$

3.4. Determine the positive ideal solution matrix and the negative ideal solution matrix

The positive and NIS were determined using (3) and (4), respectively. Those were implemented to find the maximum and minimum values per column of the weighted normalized decision matrix based on Table 6. The results are presented in Table 4. The PIS distance (D_i^+) was performed using (5). Based on the results of the PIS distances carried out, a PIS distance matrix is formed, as shown in Table 7. The (6) was used to get the NIS distance (D_i^-). Table 8 shows NIS distance.

$$D_1^+ \sqrt{\begin{matrix}(1.1504 - 1.1504)^2 + (1.1243 - 0.6746)^2 + (0.9366 - 0.1873)^2 + (1.5152 - \\ 0.3030)^2 + (2.3415 - 2.3415)^2 + (0.4683 - 0.4683)^2 + (0.1873 - 0.5620)^2\end{matrix}} = 1.5406$$

$$D_2^+ \sqrt{\begin{matrix}(1.1504 - 1.1504)^2 + (1.1243 - 0.6746)^2 + (0.9366 - 0.5620)^2 + (1.5152 - \\ 0.3030)^2 + (2.3415 - 1.4049)^2 + (0.4683 - 2.3415)^2 + (0.1873 - 0.1873)^2\end{matrix}} = 2.4896$$

$$\vdots$$

$$D_4^+ \sqrt{\begin{matrix}(1.1504 - 0.6903)^2 + (1.1243 - 1.1243)^2 + (0.9366 - 0.9366)^2 + (1.5152 - \\ 0.9091)^2 + (2.3415 - 2.3415)^2 + (0.4683 - 0.4683)^2 + (0.1873 - 0.5620)^2\end{matrix}} = 0.8482$$

$$D_1^- \sqrt{\begin{matrix}(1.1504 - 0.6903)^2 + (0.6746 - 0.2249)^2 + (0.1873 - 0.1873)^2 + (0.3030 - \\ 0.3030)^2 + (2.3415 - 0.4683)^2 + (0.4683 - 2.3415)^2 + (0.5620 - 0.9366)^2\end{matrix}} = 2.7517$$

$$\vdots$$

$$D_{10}^- \sqrt{\begin{matrix}(0.6903 - 0.6903)^2 + (1.1243 - 0.2249)^2 + (0.9366 - 0.1873)^2 + (0.9091 - \\ 0.3030)^2 + (2.3415 - 0.4683)^2 + (0.4683 - 2.3415)^2 + (0.5620 - 0.9366)^2\end{matrix}} = 2.9826$$

Table 6. Weighted normalized decision matrix

A_i	Alternative	C1	C2	C3	C4	C5	C6	C7
A_1	Rice of IR64	1.1504	0.6746	0.1873	0.3030	2.3415	0.4683	0.5620
A_2	Rice of Ciherang	1.1504	0.6746	0.5620	0.3030	1.4049	2.3415	0.1873
A_3	Rice of Raja Lele	1.1504	1.1243	0.9366	0.3030	2.3415	1.4049	0.1873
A_4	Rice of Serai	0.6903	1.1243	0.1873	1.5152	0.4683	1.4049	0.9366
A_5	Rice of Sarti	1.1504	0.2249	0.5620	1.5152	1.4049	0.4683	0.1873
A_6	Rice of Elpi	0.6903	1.1243	0.5620	0.3030	1.4049	1.4049	0.9366
A_7	Rice of Kunyit	0.6903	1.1243	0.1873	0.9091	0.4683	2.3415	0.5620
A_8	Rice of Ekor Payau	1.1504	0.6746	0.9366	1.5152	0.4683	2.3415	0.9366
A_9	Rice of Pahu	0.6903	1.1243	0.5620	0.3030	1.4049	1.4049	0.5620
A_{10}	Rice of Gelaigai	0.6903	1.1243	0.9366	0.9091	2.3415	0.4683	0.5620

Table 7. PIS distance matrix

A_i	Alternative	C_1	C_2	C_3	C_4	C_5	C_6	C_7	D+
A_1	Rice of IR64	0.0000	0.2022	0.5614	1.4694	0.0000	0.0000	0.1404	1.5406
A_2	Rice of Ciherang	0.0000	0.2022	0.1404	1.4694	0.8772	3.5088	0.0000	2.4896
A_3	Rice of Raja Lele	0.0000	0.0000	0.0000	1.4694	0.0000	0.8772	0.0000	1.5319
A_4	Rice of Serai	0.2118	0.0000	0.5614	0.0000	3.5088	0.8772	0.5614	2.3918
A_5	Rice of Sarti	0.0000	0.8090	0.1404	0.0000	0.8772	0.0000	0.0000	1.3515
A_6	Rice of Elpi	0.2118	0.0000	0.1404	1.4694	0.8772	0.8772	0.5614	2.0340
A_7	Rice of Kunyit	0.2118	0.0000	0.5614	0.3673	3.5088	3.5088	0.1404	2.8807
A_8	Rice of Ekor Payau	0.0000	0.2022	0.0000	0.0000	3.5088	3.5088	0.5614	2.7895
A_9	Rice of Pahu	0.2118	0.0000	0.1404	1.4694	0.8772	0.8772	0.1404	1.9278
A_{10}	Rice of Gelaigai	0.2118	0.0000	0.0000	0.3673	0.0000	0.0000	0.1404	0.8482

Table 8. NIS matrix

A_i	Alternative	C1	C2	C3	C4	C5	C6	C7	D-
A_1	Rice of IR64	0.2118	0.2022	0.0000	0.0000	3.5088	3.5088	0.1404	2.7517
A_2	Rice of Ciherang	0.2118	0.2022	0.1404	0.0000	0.8772	0.0000	0.5614	1.4117
A_3	Rice of Raja Lele	0.2118	0.8090	0.5614	0.0000	3.5088	0.8772	0.5614	2.5553
A_4	Rice of Serai	0.0000	0.8090	0.0000	1.4694	0.0000	0.8772	0.0000	1.7764
A_5	Rice of Sarti	0.2118	0.0000	0.1404	1.4694	0.8772	3.5088	0.5614	2.6017
A_6	Rice of Elpi	0.0000	0.8090	0.1404	0.0000	0.8772	0.8772	0.0000	1.6443
A_7	Rice of Kunyit	0.0000	0.8090	0.0000	0.3673	0.0000	0.0000	0.1404	1.1475
A_8	Rice of Ekor Payau	0.2118	0.2022	0.5614	1.4694	0.0000	0.0000	0.0000	1.5636
A_9	Rice of Pahu	0.0000	0.8090	0.1404	0.0000	0.8772	0.8772	0.1404	1.6864
A_{10}	Rice of Gelaigai	0.0000	0.8090	0.5614	0.3673	3.5088	3.5088	0.1404	2.9826

3.5. Determining the preference value for each alternative

Determine the preference value (V_i) was determined using (7). The distance of the NIS was divided by the distance of the NIS plus the distance of the PIS. Based on the steps of the TOPSIS method that have been carried out, the results of calculating preferences regarding each DMs are presented in Table 9. The results of preference values based on NGO calculations (DM_2) and government calculations (DM_3) in Table 9.

$$V_1 = \frac{2.7517}{2.7517+1.5406} = 0.6411;\ V_2 = \frac{1.4117}{1.4117+2.4896} = 0.3519;\ \ldots\ V_{10} = \frac{2.9826}{2.9826+0.8482} = 0.7789$$

Table 9. Preference value of DM_1, DM_2, and DM_3

	DM_1			DM_2			DM_3	
A_i	Preference	Ranking	A_i	Preference	Ranking	A_i	Preference	Ranking
A10	0.7789	1	A8	0.6529	1	A10	0.7228	1
A5	0.6581	2	A10	0.5743	2	A5	0.6287	2
A1	0.6411	3	A3	0.5529	3	A4	0.5197	3
A3	0.6252	4	A4	0.5474	4	A3	0.5180	4
A9	0.4666	5	A9	0.5463	5	A1	0.4893	5
A6	0.4470	6	A6	0.5263	6	A8	0.4708	6
A4	0.4262	7	A7	0.5170	7	A9	0.4182	7
A2	0.3619	8	A5	0.5131	8	A6	0.4033	8
A8	0.3592	9	A2	0.4607	9	A7	0.3856	9
A7	0.2849	10	A1	0.3377	10	A2	0.3329	10

3.6. Application of the borda method

After calculating the TOPSIS method, in order to get the ranking results of superior rice seeds from each DMs, apply the Borda method to get the final result as a group decision. To get a group decision, you can use the ranking from TOPSIS for each DMs multiplied by the Borda score. The Borda weight is the amount of data $(n)-1$ for the first alternative, $n-2$ for the second alternative, and 0 for the last alternative, then added up for each alternative. The matrix of calculation results and rankings using the Borda method can be seen in Table 10. Multiplication and addition are done in the following:

$$A_1 = (0*9)+(0*8)+(1*7)+(0*6)+(1*5)+(0*4)+(0*3)+(0*2)+(0*1)+(1*0) = 12$$

$$A_2 = (0*9)+(0*8)+(0*7)+(0*6)+(0*5)+(0*4)+(0*3)+(1*2)+(1*1)+(1*0) = 3$$

$$\vdots$$

$$A_{10} = (2*9)+(1*8)+(0*7)+(0*6)+(0*5)+(0*4)+(0*3)+(0*2)+(0*1)+(0*0) = 26$$

The results of Table 10 show that the Borda score and the Borda method ranking based on the results of the group decision serve as an alternative. The best option or the highest rating is based on assessing the three DMs from DMs. The DM_1 as a farmer is the first rank A_{10} Gelagai with a score of Borda 26. The following, the second rank A_3 Raja Lele with a score of Borda 19, the third rank A_5 Sarti with a value of 18, and the last rank in the decision group selection of superior rice seeds is A_2 Ciherang with a value of 3.

Table 10. Borda calculation results

A_i	Alternative	TOPSIS rating results										Borda score	Ranking
		1	2	3	4	5	6	7	8	9	10		
A_1	Rice of IR64			1		1					1	12	7
A_2	Rice of Ciherang								1	1	1	3	10
A_3	Rice of Raja Lele			1	2							19	2
A_4	Rice of Serai			1	1			1				16	4
A_5	Rice of Sarti		2						1			18	3
A_6	Rice of Elpi						2		1			10	8
A_7	Rice of Kunyit							1		1	1	4	9
A_8	Rice of Ekor Payau	1					1			1		14	5
A_9	Rice of Pahu					2		1				13	6
A_{10}	Rice of Gelagai	2	1									26	1
	Borda's weight	9	8	7	6	5	4	3	2	1	0		

Method testing is carried out to measure how strong the correlation between system results and actual data. It was performed using (11). Calculations were carried out regarding ten alternative data choices. Starting with calculating the correlation between group results and system results, then calculating the correlation between each DMs and system results. The auxiliary table obtained from the Spearman rank correlation test and the corerelation results can be seen in Tables 11 and 12.

After using Spearman's rank correlation analysis, calculation results obtained rs=0.176 and compared to the correlation in Table 6, shows a deficient correlation strength for group decisions. Then the same test was carried out for each DMs to obtain the conclusion of the Rank spearman correlation results as in Table 12. The results of the Spearman rank correlation calculations carried out for group decisions, and each DMs obtains a level of correlation strength, namely, DM_1=0.055 indicates a meager correlation strength, DM_2=0.442 shows a reasonably muscular correlation strength. In contrast, DM_3=0.067 indicates an insufficient correlation strength.

Table 11. Spearman rank correlation test

A_i	Alternative	System-based group decision (X)	Actual data (Y)	D	D^2
A_1	Rice of IR64	7	5	2	4
A_2	Rice of Ciherang	10	8	2	4
A_3	Rice of Raja Lele	2	6	-4	16
A_4	Rice of Serai	4	7	-3	9
A_5	Rice of Sarti	3	10	-7	49
A_6	Rice of Elpi	8	9	-1	1
A_7	Rice of Kunyit	9	3	6	36
A_8	Rice of Ekor Payau	5	4	1	1
A_9	Rice of Pahu	6	2	4	16
A_{10}	Rice of Gelaigai	1	1	0	0
		$\sum d^2$			136

Table 12. Spearman rank correlation results

No.	Decision	$6\sum d^2$	$n(n^2-1)$	$6\sum d2/n(n2-1)$	rs
1.	Group	816	990	0.82424	0.176
2.	Farmer (DM_1)	936	990	0.94545	0.055
3.	NGO (DM_2)	552	990	0.55757	0.442
4.	Goverment (DM_3)	924	990	0.93333	0.067

4. CONCLUSION

The results of this paper, the TOPSIS and Borda methods, were successfully applied to the GDSS concept. The highest index value for each DM using the TOPSIS method was obtained, DM_1 in the highest rank was Gelagai seeds with a value of 0.7786, DM_2 in the highest rank was Ekor Payau seeds of 0.6529 and DM_3 ranked highest were Gelagai seeds of 0.7728. The Borda method can determine group decisions with a voting system in which Gelagai seeds are ranked highest with the most accumulated votes. The test results to calculate the difference in ranking using Spearman rank correlation yield DM_2 showing a reasonably strong correlation relationship, so the results in the DM_1 and DM_2 group decisions show meager correlation results. For further research, we propose creating a multi-group decision model that involves more complex groups and provides tiered decisions.

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BIOGRAPHIES OF AUTHORS

Hamdani is a professor in Department of Informatics at Mulawarman University, Indonesia. He holds a Bachelor of Engineering in Informatics, Master of Computer Science in 2009, and Ph.D. in Department of Computer Science and Electronics Gadjah Mada University in 2018, besides several professional certificates and international skills. He is a member of the Institute of Electrical and Electronics Engineers (IEEE) and Indonesian Computer, Electronics, and Intrumentation Support Society (IndoCEISS). His research areas of interest are group decision support system/decision model, social networks analysis, intelligent system, and information security. He can be contacted at email: hamdani@unmul.ac.id.

Masna Wati holds a Bachelor of Science in Mathematics Science and a Master of Engineering in Informatics Engineering from Hasanuddin University, Indonesia. She has lectured in the Department of Informatics at Mulawarman University, Indonesia, since 2014. She is a member of the Indonesia Society of Engineers and the Institute of Electrical and Electronics Engineers (IEEE). Her research areas of interest include machine learning, smart systems, and data science. She can be contacted at email: masnawati@fkti.unmul.ac.id.

Didit Suprihanto holds a Bachelor of Engineering in Informatics Engineering, Master of Information System, Ph.D. in Department of Computer Science and Electronics Gadjah Mada University, besides several professional certificates and skills. He is currently lecturing with the Department of Electronics Engineering at Mulawarman University, Samarinda, Indonesia. He is a member of the Indonesian Computer, Electronics, and Intrumentation Support Society (IndoCEISS). His research areas include computer networks security, e-Government related issues, and security assessment. He can be contacted at email: didit.suprihanto@ft.unmul.ac.id.

Nur Maya Salsabila is a student of informatics. His research areas of interest decision support system, artificial intelligent, and social informatics. She can be contacted at email: salsabilanur951@gmail.com.

Anindita Septiarini is a professor in Department of Informatics at Mulawarman University, Indonesia. She holds a Doctoral degree in Computer Science from Gadjah Mada University, Indonesia, specializing in image analysis. She is also a researcher and got a grant from the Ministry of Education, Culture, Research, and Technology of Indonesia from 2016 until the present. Her research interests lie in artificial intelligence, especially image processing and computer vision. She held several administrative posts with the Department of Informatics, Mulawarman University, Indonesia, from 2018 to 2020, including the head of department and the head of laboratory. She can be contacted at email: anindita@unmul.ac.id.

Dita Nurmadewi obtained her Bachelor's degree in Computer Science with a focus on Information Systems in 2016, and Master's degree in Computer Science in 2021. Currently, she teaches at the Department of Information Systems, Bakrie University, Indonesia. In addition to her role as a lecturer, she also serves as the Head of IT Operational and Labs at Bakrie University. She is a member of the APTIKOM and AISINDO Associations. Her research interests include decision support systems, data science, enterprise systems, business process management, and software engineering. She can be contacted at email: dita.nurmadewi@bakrie.ac.id.

Viny Christanti Mawardi is a lecturer of Information Technology graduated from Master of Computer Science Universitas Indonesia. Her research fields are information retrieval and natural language processing. In her 17 years as a lecturer at Tarumanagara University, she is experienced in research and community engagements in various fields that implement IT in daily life. In the last 5 years, she focuses on using information technology to create innovations in the field of education, such as creating spelling correction and making Chatbot in Indonesian language. Her research was then implemented in society, especially in the field of education. Her interest is creating applications related to chatbot and sentiment analysis in Indonesian language. She can be contacted at email: vinym@fti.untar.ac.id.