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Application of SMART and TOPSIS in determining beneficiaries of latrine construction assistance

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ABSTRACT

In Bangun Raya Village there are still many people who defecate in the open (BABS) because they do not have latrines, resulting in an increase in disease transmission in Bangun Raya Village. To deal with this incident, the government of Bangun Raya Village provided assistance in building latrines to the less fortunate with predetermined criteria. However, the determination of beneficiaries for the construction of latrines is still based on manual calculations. The first thing the author did was to collect data from the poor family cards directly. To avoid mistakes in providing assistance for latrine construction, a decision support system is needed that can be used by the village apparatus in processing data. So that residents who receive assistance are residents who really need it and with the construction of a computerized decision support system, the decision making regarding the provision of latrine assistance can be more effective and efficient. By combining two methods, namely the SMART method as the stage for assessing the weight of the criteria data obtained and the stage for calculating the relative value of the assessment of weights and the TOPSIS method as the stage for normalizing the final result of calculating the relative value and the stage for ranking the results of normalization. The results of this study resulted in the Hilaluddin Harahap house in hamlet 2 being selected as the location for the construction of a 1st rank latrine with an accuracy value of 96% based on the desired criteria.

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Introduction

As the years change, information technology develops rapidly in various fields of technology, for that the government is required to make changes(Ardiansyah et al., 2020; Maria & Junirianto, 2021). One of the changes made is the digitalization of public services. Digitalization of public services or often referred to as electronic government (E-Gov) is one of the efforts to provide services effectively and efficiently by utilizing information technology both at the central, regional and village levels(Han et al., 2020). One of these technologies is used to help make a decision called a decision support system as a form of technology that makes it easier for individuals or organizations to make decisions, including decision support systems in determining recipients of latrine construction assistance(D. Maulana et al., 2023; Muljadi et al., 2020; Tahir & Botutihe, 2022).

Bangun Raya Village is one of the villages in Barumun District, Padang Lawas Regency, North Sumatra Province, which defecates carelessly because it does not have a latrine, resulting in increased disease transmission in Bangun Raya Village(A. Maulana et al., 2019). To deal with this incident, the Bangun Raya Village government provided latrine construction assistance to underprivileged communities with predetermined criteria. However, the determination of the recipients of the latrine construction assistance is still based on manual calculations. The first thing the Bangun Raya Village government did was that village officials collected data seen from poor family cards. In collecting this data, village officials still use books as a tool to record every data collected, after data from all criteria are collected, then manual calculations are carried out, allowing errors in determining prospective beneficiaries.

To avoid mistakes in providing assistance for the construction of latrines, a decision support system is needed that can be used by the village apparatus in processing data. So that residents who receive assistance are residents who really need it and with the construction of a computerized decision support system, in decision making the determination of the provision of latrine assistance can be more effective and efficient(Kusumawardhany, 2020; Manik et al., 2021; Sukamto et al., 2020).

Related research on the implementation of the SMART and TOPSIS methods, namely as the SMART method, related research is contained in a research journal by Celina Pertiwi and Anita Diana. in the Journal budi luhur information technology Vol. 17 No. 1 of 2020, entitled " Application of the Best Employee Assessment Decision Support System Using the AHP and SAW Methods" explained that this study used two methods in making decisions on providing incentives based on performance appraisal. AHP method and SMART method with studies at Panca Budi Medan Development University Lecturers. Performance assessment using the AHP method only 3 lecturers out of 10 lecturers are entitled to incentives. Analysis using the SMART method obtained 4 lecturers from 10 lecturers who were entitled to incentives. From the results of data analysis in this study, it was also found that the assessment of incentive decisions was more appropriate using the SMART method than using the AHP method(Pertiwi & Diana, 2020). Then, as a TOPSIS method, related research is contained in a research journal by Haida Dafitri, DKK. In the journal computer research Vol. 9 No. 5 of 2022, entitled " Comparative Analysis of Decision Support Systems for Selection of the Best Teachers Using the TOPSIS and WASPAS Methods " explained that the proposed methods in solving this exemplary teacher selection problem are the Prometheee and TOPSIS methods. The results of the system test showed that the selection of exemplary teacher candidates resulted in precision, recall, and accuracy values for the PROMETHEE method respectively 91.19%, 54.31%, and 88.41%, and 90.50%, 74.91% and 94.34% for the TOPSIS method. Thus, the TOPSIS method has a better performance compared to the PROMETHEE method.

The results of the comparison between methods in related research there are SMART and TOPSIS methods are superior methods and the author uses the SMART and TOPSIS methods to be applied in this study(Ratnasari & Prasasti, 2021; Wita & Siagian, 2023). The flow of the combination of these two methods is for the SMART method as a stage of weight assessment on the criteria data obtained and the calculation stage looks for the relative value of the weight assessment. As for the TOPSIS method as the normalization stage of the final result of the calculation of relative values and the ranking stage of the normalization result(Wang et al., 2020).

Method

The SMART method is a multi-criteria decision-making method developed by Edward in 1977(Annisa et al., 2020; He et al., 2021; Kumar et al., 2020). SMART is a multi-criteria decision-making technique based on the theory that each alternative consists of a number of criteria that have values and each criterion has a weight that describes how important it is compared to other criteria(Sihombing et al., 2022).
The steps in the SMART method include the following:

1. Determine the criteria used.
2. Give criteria weight to each criterion by using intervals of 1-100 for each criterion with the most important priority.
3. Calculates the normalized weight of each criterion by comparing the value of the criterion weight to the sum of the criteria weights, using the equation:

$$\textbf{Normalisasi} = \frac{w_j}{\sum w_j} \quad \text{.....(1)}$$

4. Providing a criterion value for each alternative, the criterion value for each alternative can be in the form of quantitative data (numbers) or in the form of qualitative data, for example the value for the price criterion can be ascertained in quantitative form while the value for the facility criterion can be qualitative (very complete, complete, less complete). If the criterion value is qualitative then we need to change to quantitative data by parameterizing the criterion value, for example very complete means 3, complete means 2 and incomplete means 1(Azmi et al., 2022).
5. Define utility values by converting the criteria values on each criterion into raw data criteria values. The value of this utility depends on the nature of the criteria themselves.

$$u_i(a_i) = \frac{(c_{max} - c_{out})}{(c_{max} - c_{min})} \quad \text{.....(2)}$$

6. Criteria that are "more desirable greater value", usually in the form of profit (e.g. criteria of tank capacity for the purchase of a car, quality criteria and others).

$$\boldsymbol{u_i(a_i)} = \frac{(c_{out} - c_{min})}{(c_{max} - c_{min})} \quad \text{.....(3)}$$

7. Determine the final value of each by multiplying the value obtained from the normalized value of the criterion by the normalized value of the criterion weight.

$$(\boldsymbol{a_i}) = \sum_{J=1}^{m} \boldsymbol{w_j}\, \boldsymbol{u_i(a_i)} \quad \text{.....(4)}$$

8. The results of the final value calculation are then sorted from the largest value to the smallest, the alternative with the largest final value indicates the best alternative(Umbu et al., 2022).

Topsis is one of the multicriterion decision-making methods or alternative options which is an alternative that has the smallest distance from the positive ideal solution and the largest distance from the negative ideal solution from a geometric point of view using Euclidean distances(Du et al., 2022). However, the alternative that has the smallest distance from the positive ideal solution does not necessarily provide the greatest distance from the negative ideal solution.

System Development Methods

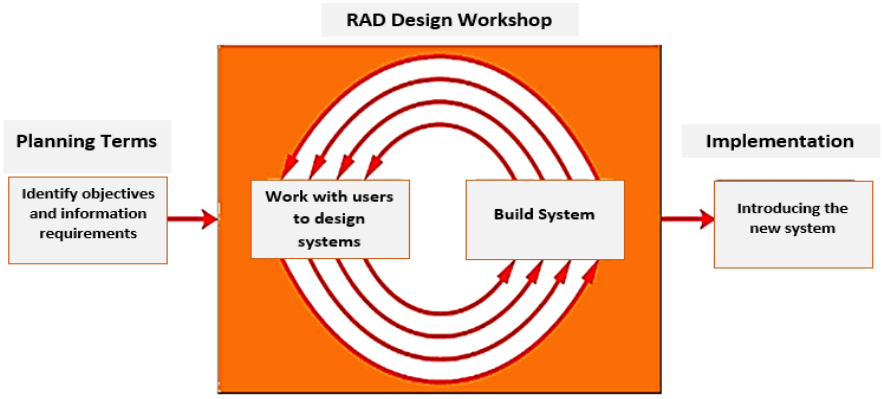

Figure 1. RAD System Development Cycle

The system development method used in this study is RAD (Rapid Application Development), a software process model that emphasizes a short development life cycle. RAD is also a rapidly adapted

version of the Waterfall method model, using a component construction approach(Ayudia et al., 2021; Umbu et al., 2022). RAD is a combination of various structured techniques with prototyping techniques and joint application techniques to accelerate system / application development. The definition of the RAD concept is a model that emphasizes application development in a relatively faster time. The stages of RAD consist of three stages where these stages are structured and interdependent(Harianja, 2021).

Data Collection

The data used in this study were obtained are the criteria for recipients of latrine construction assistance in Bangun Raya Village, data collected through previous studies or books related to the research theme that became the basis or reference in making several questions during the interview. The determination of the criteria in this study was based on the results of interviews with the Bangun Raya Village, namely the Village Head. In this study, 5 criteria were obtained used in determining the recipients of latrine construction assistance, namely: having a latrine, the physical condition of the house, the number of occupants of the house, socioeconomic status and land availability. Based on these 5 criteria, each criterion has parameters. This parameter is obtained from observations and interviews aimed at assessing each alternative criterion to be used in the Simple Multi Attribute Rating Technique (SMART) method.

Results and Discussion

Decision Support System Calculation Stage

This stage explains the calculation in determining the recipients of latrine assistance using the Simple Multi Attribute Rating Technique (SMART) method and the Technique for Others Preference by Similarity to Ideal Solution (TOPSIS) method(Yulita, 2021).

1. In the decision support system for determining the recipients of latrine assistance, the Bangun Raya Village determines the criteria that are used as a reference for assessment in decision making. There are 5 assessment criteria, namely having a latrine, the physical condition of the house, the number of occupants of the house, socioeconomic status and land availability.
2. Weighting criteria with values from 1 to 100, based on the importance of the criteria. The value given to this criterion weight is based on the decision maker's assessment as presented in the table below(Su et al., 2023).

Table 1. Criterion Weights

Criterion	Weight
Has a Latrine	25
Physical Condition of the House	15
Number of House Occupants	15
Socioeconomic Status	20
Land Availability	25
Sum	100

Calculating the utility value uses the benefit criteria formula which is contained in equation2, because all criteria used are "greater value is desirable". After making observations and interviews, value parameters are obtained to assess each alternative criterion to be used(Zhang et al., 2022). The weight of each alternative is shown in the following table.

Table 2. Weighting DataSet

No	Alternative Name	Has a Latrine	Physical Condition of the House	Number of House Occupants	Socioeconomic Status	Land Availability
1	Ahmad Riadi Hasibuan	100	75	70	100	50
2	Ahmad Rosidi dly	100	100	80	100	50
3	Hubbi Dly	100	100	70	100	50
4	Ahmad Husein Nasution	50	75	90	75	50

No	Alternative Name	Has a Latrine	Physical Condition of the House	Number of House Occupants	Socioeconomic Status	Land Availability
5	Abdul Rahaman Hsb	50	75	80	75	50
6	Ali Sahbana	100	100	80	100	100
7	Khoiruddin Hsb	100	100	90	100	100
8	Badarun Hsb	50	50	80	50	50
9	M. Asminan HSb	100	75	80	100	100
10	Asnawi Nasuton	100	75	90	100	100
11	Hilaluddin Hrp	100	100	100	100	100
12	Khoirun Saleh	50	100	90	75	50
13	Najamuddin Dly	50	50	90	75	50
14	Ahmad Sofyan Nst	50	50	70	50	50
15	Aslamia Hsb	100	100	70	100	100
Types of Criteria		Benefits	Benefits	Benefits	Benefits	Benefits
Min Value		50	50	70	50	50
Max Value		100	100	100	100	100

After getting the value of grouping the weight data of each alternative as shown in the table above, then in the process of calculating the value of the utility value using the formula of equation 3 above(Solihin Sopandi et al., 2021), the calculation of the utility value can be seen below as follows:

Ahmad Riadi Hasibuan

$C_1 = 100\frac{100-50}{100-50} = 100$

$C_2 = 100\frac{75-50}{100-50} = 50$

$C_3 = 100\frac{70-70}{100-70} = 0$

$C_4 = 100\frac{100-50}{100-50} = 100$

$C_5 = 100\frac{50-50}{100-50} = 0$

Ahmad Rosidi Dly

$C_1 = 100\frac{100-50}{100-50} = 100$

$C_2 = 100\frac{100-50}{100-50} = 100$

$C_3 = 100\frac{80-70}{100-70} = 33{,}333$

$C_4 = 100\frac{100-50}{100-50} = 100$

$C_5 = 100\frac{50-50}{100-50} = 0$

Ahmad Husein Nasution

$C_1 = 100\frac{50-50}{100-50} = 0$

$C_2 = 100\frac{75-50}{100-50} = 50$

$C_3 = 100\frac{90-70}{100-70} = 66{,}667$

$C_4 = 100\frac{75-50}{100-50} = 50$

$C_5 = 100\frac{50-50}{100-50} = 0$

In the calculation above is a calculation of sample data from the 15 data above in table 2, from 3 calculation data with information C1 is having a latrine, C2 physical condition of the house, C3 Number of occupants of the House, C4 economic sausage status, C5 Land Availability so as to get utility calculation data for each alternative as in the Table below.

Table 3. Criteria Data

No	Alternative Name	C1	C2	C3	C4	C5
1	Ahmad Riadi Hasibuan	100	50	0	100	0
2	Ahmad Rosidi dly	100	100	33,333	100	0
3	Hubbi Dly	100	100	0	100	0
4	Ahmad Husein Nasution	0	50	66,667	50	0
5	Abdul Rahaman Hsb	0	50	33,333	50	0
6	Ali Sahbana	100	100	33,333	100	100
7	Khoiruddin Hsb	100	100	66,667	100	100
8	Badarun Hsb	0	0	33,333	0	0
9	M. Asminan HSb	100	50	33,333	100	100
10	Asnawi Nasuton	100	50	66,667	100	100
11	Hilaluddin Hrp	100	100	100	100	100
12	Khoirun Saleh	0	100	66,667	50	0
13	Najamuddin Dly	0	0	66,667	50	0
14	Ahmad Sofyan Nst	0	0	0	0	0
15	Aslamia Hsb	100	100	0	100	100

The table above is the result of the benefit of utility value data for each alternative, so that the data will be processed by calculation processors on the topsis method that will determine the population data that is eligible to receive latrine construction assistance funds.

In the topsis method, researchers will process normalization calculations first on the previous weight data, normalization using the equation 1 formula above. After calculating the normalization of

each alternative, then calculate the root value of the sum of each criterion before, as in the following table.

Table 4. Yield root values normalization matrix

C1	C2	C3	C4	C5
900	950	600	1100	600
30	30,822	24,495	33,166	24,495

In the table above is the result of the root value of the normalization matrix that has been done in the previous calculation, then look for the weighted normalization value, namely normalized data * weight, normalized data multiplied by the weight of the criterion will produce the weighted normalization as follows.

Ahmad Riadi Hasibuan	Ahmad Rosidi Dly	Ahmad Husein Nasution
$C_1 = 3{,}333 * 0{,}25 = 0{,}833$	$C_1 = 3{,}333 * 0{,}25 = 0{,}833$	C1 =0*0,25=0
$C_2 = 1{,}622 * 0{,}15 = 0{,}243$	$C_2 = 3{,}244 * 0{,}15 = 0{,}487$	C2 =1,622*0,15= 0,243
$C_3 = 0 * 0{,}15 = 0$	$C_3 = 1{,}361 * 0{,}15 = 0{,}204$	C3 =2,722*0,15 = 0,408
$C_4 = 3{,}015 * 0{,}2 = 0{,}603$	$C_4 = 3{,}015 * 0{,}2 = 0{,}603$	C4 =1,508*0,2 = 0,302
$C_5 = 0 * 0{,}25 = 0$	$C_5 = 0 * 0{,}25 = 0$	C5 =0*0,25 = 0

After calculating the normalized value of weights, then calculating the matrix value of positive and negative ideal solutions, by calculating the positive and negative matrices will get the value of the species in the following table.

Table 5. A+ grade and A- grade

	C1	C2	C3	C4	C5
A+	0,833	0,487	0,612	0,603	1,021
A-	0	0	0	0	0

In the table above is the result of calculating the value of A + and value A-, which will later be combined with the value of preference calculation, from these results will get the value of the ideal alternative solution in the final result of each criterion that has been calculated, then the researcher will calculate the value of the proximity of an alternative to the value of the ideal solution as follows:

Ahmad Riadi Hasibuan $= \frac{1{,}057}{1{,}057 + 1{,}215} = 0{,}465$

Ahmad Rosidi Dly $= \frac{1{,}156}{1{,}156 + 1{,}099} = 0{,}513$

Hubbi Dly $= \frac{1{,}138}{1{,}138 + 1{,}190} = 0{,}489$

Ahmad Husein Nasution = $\frac{\mathbf{0{,}563}}{\mathbf{0{,}563 + 1{,}388}} = 0{,}288$

After doing the overall calculation of the existing data, we will get the final tilapia from the calculation of smart and topsis methods, where the results can become a benchmark and tool for the village in determining the acceptance of the construction of latrines that are right on target in accordance with the desired criteria, the calculation results can be seen as follows:

Table 6. Final reference value after ranking

Alternative Name	Reference Value	Ranking
Hilaluddin Hrp	1	1
Khoiruddin Hsb	0,886	2
Asnawi Nasuton	0,828	3
Ali Sahbana	0,791	4
M. Asminan Hsb	0,757	5
Aslamia Hsb	0,714	6
Ahmad Rosidi Dly	0,513	7
Hubbi Dly	0,489	8

Alternative Name	Reference Value	Ranking
Ahmad Riadi Hasibuan	0,465	9
Khoirun Saleh	0,340	10
Ahmad Husein Nasution	0,288	11
Najamuddin Dly	0,259	12
Abdul Rahaman Hsb	0,234	13
Badarun Hsb	0,114	14
Ahmad Sofyan Nst	0	15

After obtaining the ranking results based on normalization values and preference values according to the desired criteria, the final result of this study is to obtain the initial ranking decision value which will get assistance for the construction of latrines on behalf of Mr. Hilaluddin Hrp with a very high construction location. good results and get 96% accuracy results based on the dataset studied, from these results the head of Bagun Raya village decides which family heads are entitled to receive latrine construction assistance from the government through the village head, so that the community can jointly benefit from the construction of public latrines and provide excellent changes to the environment of Bangun Raya village in the future.

The interface display of the system development built in this study, which will be used by the village head as follows :

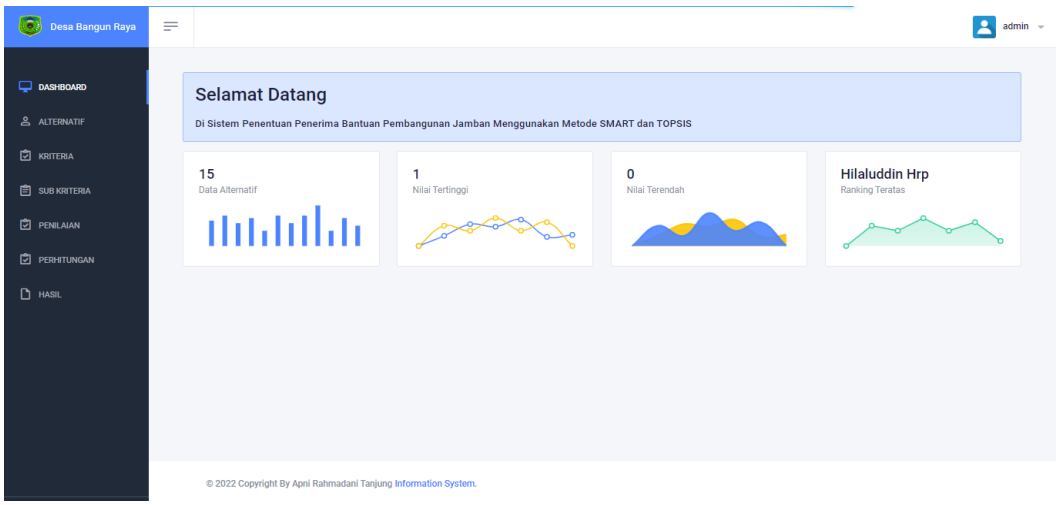

Figure 2. Initial view of the Implementation system

Above is one of the admin views for logging in, and the initial dashboard display if the admin has successfully entered, which in this view consists of several menus including alternative menus, criteria menus, sub criteria menus, assessment menus, and calculation menus in the SMART and TOPSIS methods, Meanwhile, the final result can be seen in the following image:

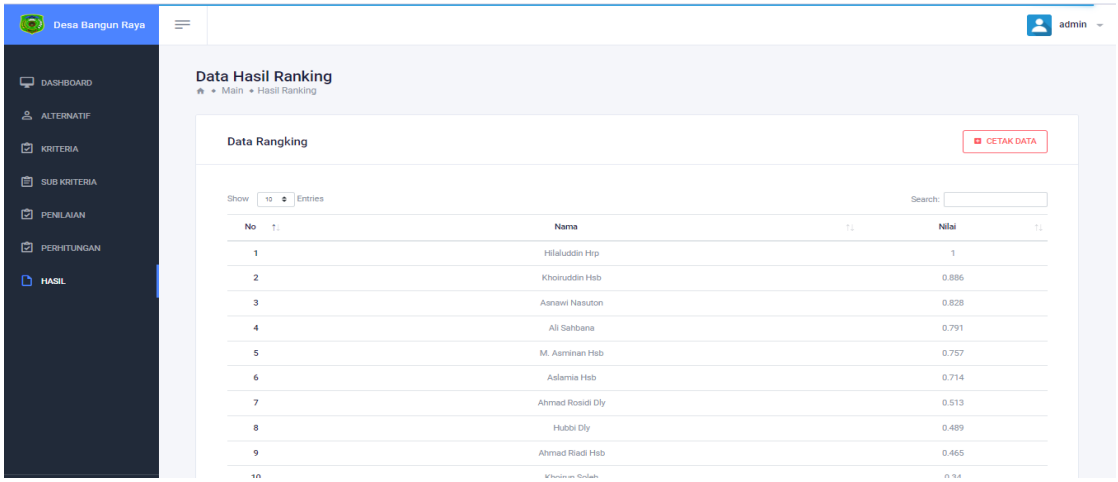

Figure 3. Display of relief determination results

In Figure 3 there is a display of the final result data menu which is a display of the calculation results of the two SMART and TOPSIS methods, the final results shown in the figure produce the highest ranking order that will receive latrine development assistance with criteria determined based on government regulations using a website-based system to facilitate head of the village quickly and precisely.

Conclusions

The results of this study resulted in the application of the SMART and TOPSIS methods with the aim of facilitating the Bangun Raya village community in determining the selection of the head of the family who is entitled to receive a latrine construction based on the results of previous population data rankings. and accurate, the research results obtained are the head of the family with Mr. Hilaluddin Hrp with the first serial number and an accuracy value of 96% declared as a place to build a latrine, and for the recipient of the second latrine assistance is Mr. Khoiruddin Hsb with a value of 0.886% at an accuracy rate of 92%, as well as the third recipient of assistance on behalf of Asnawi Nasution with a value of 0.828% at an accuracy rate of 80%, from the ranking results above. The author's suggestion for further research is to build a system with other combination methods and be able to build an Android-based system to make it more accessible, as well as provide good or useful features.

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