

Decision Support System for Determination of Water Supply Distribution Decisions Using the Technique for Order Preference Method by Similarity to Ideal Solution (TOPSIS)

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ARTICLE INFO	ABSTRACT
<p>Article history:</p> <p>Received Jun 10, 2021 Revised Jul 20, 2021 Accepted Jul 29, 2021</p> <p>Keywords:</p> <p>Decision Support System; TOPSIS.</p>	<p>The Water Supply Decision Support System is a computer-based information system that can be used to help support the quality of human life in terms of providing clean water. In this system, the results will be in the form of priority decisions for the provision of clean water for each candidate area. In the Social Service Office of Sragen Regency itself, there are criteria in determining decisions according to the results of the proposals submitted by each regional candidate including the number of families who need clean water (KK), the number of people in each region (SOUL), the number of water drops in each region (TANK), and the number of hamlets that need clean water in each area (DUKUH). TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is the method used in this system, determine the results of relative proximity to the ideal solution so that it can produce priority values from several areas. This method was chosen because it considers the distance to the positive ideal solution and the distance to the negative ideal solution by taking relative proximity to the positive ideal solution. Based on the comparison to the relative distances, an alternative priority arrangement can be reached. Based on the comparison to the relative distances, an alternative priority arrangement can be reached. From the results obtained, it can be used to help procure clean water to areas that meet priorities, and its nature only helps to find priority values according to relative proximity to the ideal solution and is not the final goal for decision making. This method was chosen because it considers the distance to the positive ideal solution and the distance to the negative ideal solution by taking relative proximity to the positive ideal solution. Based on the comparison to the relative distances, an alternative priority arrangement can be reached. From the results obtained, it can be used to help procure clean water to areas that meet priorities, and its nature only helps to find priority values according to relative proximity to the ideal solution and is not the final goal for decision making.</p> <p><i>This is an open access article under the CC BY-NC license.</i></p>



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1. INTRODUCTION

Sragen Regency is one of the regencies in Central Java Province. Geographically, Sragen Regency is located on the border between Central Java and East Java. The boundaries of Sragen Regency are to the east of Ngawi Regency (East Java Province), to the west of Boyolali Regency, to the south of Karanganyar Regency, and to the north of Grobogan Regency. The area of Sragen Regency is 941.55 km² which is divided into 20 sub-districts, 8 sub-districts, and 200 villages. Physiologically, the district of Sragen is divided into 40,037.93 Ha (42.52%) of wet land (rice fields), 54,117.88 Ha (57.48%) of dry land. Sragen Regency is located at 7 15 south latitude to 7 30 south longitude and 110 45 east longitude to 111 10 east longitude. The area of Sragen Regency is in the plains with an average height of 109 M above sea level. Sragen has a tropical climate with daily temperatures ranging from 19 - 31 C. The average rainfall is below 3000 mm per year with less than 150 rainy days per year. The population of Sragen based on 2005 data is 865,417 people, consisting of 427,253 male residents and 438,164 female residents. The average population density is 919 people/km². area : 94,155 ha, paddy field area : 40,129 ha, and dry land : 54,026 ha.

Arifin and Hartati studied the distribution of clean water under the title Clean Water Decision Support System with Fuzzy Interger Transportation. In this study, the resulting goal is to solve distribution problems with a fuzzy integer transportation model approach showing better results, namely the minimum total distribution costs with the total distributed water approaching customer expectations (Arifin A & Hartati S, 2011).

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is a multi-criteria decision-making method. This method is widely used to complete practical decision making. This is because the concept is simple and easy to understand, computationally efficient, and has the ability to measure the relative performance of decision alternatives. In determining the allocation of clean water supply distribution, there are several criteria used by the Sragen district government. These criteria include: the number of families and the number of hamlets that need clean water in each area according to the proposals submitted by each sub-district, the total number of people per area, and the number of tanks to be distributed.

2. METHOD

This research aims to determine the priority areas for clean water assistance. The input used is in the form of mapping data which becomes the criteria in determining including the number of households that need clean water, the number of people in each area, the number of water drops in each area, and the number of hamlets that need clean water assistance. The data will be processed to produce the final calculation output. Later the system is expected to be able to assist DINSOS in determining priorities for areas that need clean water. Research design :

- a. Study of literature
Learn the theory of decision-making assistance systems and the TOPSIS method (Technique For Others Reference by SimiLarity to Ideal Solution) in the construction of SPPK. Literature source in the form of international journals, supporting websites, and books related to decision-making support systems.
- b. Data collection
The data collection method used in writing this final project.
- c. Data used
The data used is data from mapping the need for clean water in each region the period of 15 July to 17 November 2015. The mapping data produces data on the number of households, the number of people, and hamlets that need clean water in each area and demand water drops net in tank units. The data is also used for testing basis this system.
- d. Data collection technique
Interviews were conducted with the head of DINSOS (Social Service) of Sragen Regency and IT staff of PDAM of Sragen Regency. The purpose of conducting the interview is related to the procedure criteria.

3. RESULTS AND DISCUSSIONS

The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method is based on the concept that the best chosen alternative only has the shortest distance from the positive ideal solution but also has the longest distance from the negative ideal solution. The following is one of the resolutions of the clean water allocation case from the mapping results for the period 15 July to 17 November 2015: Determining the Alternatives and Aspects to be used.

Table 1.
Mapping data table for the period 15 July to 17 November 2015

No	Village Name	KK	SOUL	TANK	HAMLET
1	Bagor	169	563	12	2
2	Baleharjo	239	1003	12	2
3	Banyurip	1085	3275	35	4
4	Cepoko	198	292	16	2
5	Dawung	162	642	12	2
6	Hamlet	428	1171	18	3
7	Galeh	125	503	30	3
8	Gebang	184	736	9	1
9	shaking	226	1076	16	1
10	Gesi	95	370	8	1
11	Gilirejo	217	1037	25	3
12	New Gilirejo	440	1523	36	3
13	guard	350	1050	13	2
14	Jenar	215	938	18	3
15	Jono	120	534	6	1

1. Normalization Matrix

From the results of the data table for the mapping of water dropping for the period 15 July to 17 November 2015, it will be normalized. Here are the steps:

a. Obtaining the X_{ij} . value

The case was taken from Bagor village, the mapping data table obtained the value: KK 169, SOUL 563, TANK 12, HAMLET 2

Table 2.
Calculation Table

Village Name	KK	SOUL	TANK	HAMLET
Bagor	28561	316969	144	4
Baleharjo	57121	1006009	144	4
Banyurip	1177225	10725625	1225	16
Cepoko	39204	85264	256	4
Dawung	26244	412164	144	4
Hamlet	183184	1371241	324	9
Galeh	15625	253009	900	9
Gebang	33856	541696	81	1
shaking	51076	1157776	256	1
Gesi	9025	136900	64	1
Gilirejo	47089	1075369	625	9
New Gilirejo	193600	2319529	1296	9
guard	122500	1102500	169	4
Jenar	46225	879844	324	9
Jono	14400	285156	36	1

b. Getting the root value of the X_{ij} . subtotal

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

Table 3.
Table of roots of the whole sum 2

	KK	SOUL	TANK	HAMLET
TOTAL	2760408	32890411	10474	144
ROOT	1661.45	5735.016	102.343	12

Getting the results of the Normalized matrix

$$r_{ij} = \frac{K_{ij}}{\sqrt{\sum_{i=1}^m K^2_{ij}}}$$

After going through several stages starting from obtaining the value of X_{2ij} to the root of the total value of X_{2ij} , then from the 30 villages the value of each village will be normalized. The normalized value is obtained from the X_{2ij} value and then divided by the root of the X_{2ij} subtotal value. Here's the solution:

Table 4.
Normalization matrix value table r_{ij}

No	Village Name	KK	SOUL	TANK	HAMLET
1	Bagor	0.101718528	0.098169	0.11725	0.16667
2	Baleharjo	0.143850462	0.174891	0.11725	0.16667
3	Banyurip	0.653044986	0.571053	0.34199	0.33333
4	Cepoko	0.119173186	0.050915	0.15634	0.16667
5	Dawung	0.097505334	0.111944	0.11725	0.16667
6	Hamlet	0.257606686	0.204184	0.17588	0.25
7	Galeh	0.075235597	0.087707	0.29313	0.25
8	Gebang	0.1107468	0.128334	0.08794	0.08333
9	Shaking	0.13602596	0.187619	0.15634	0.08333
10	Gesi	0.07179054	0.064516	0.07817	0.08333
11	Gilirejo	0.130608997	0.180819	0.24428	0.25
12	New Gilirejo	0.264829303	0.265562	0.35176	0.25
13	Guard	0.210659673	0.183086	0.12702	0.16667
14	Jenar	0.129405228	0.163557	0.17588	0.25
15	Jono	0.072226174	0.093112	0.05863	0.08333

c. Weighted Matrix Normalization

In this problem, the weight of each independent criterion is obtained, the following is the weight value of W_j :

Table 5.
Weight Value Table

Weight			
KK (w1)	SOUL (w2)	TANK (W3)	hamlet (W4)
5	2	5	3

$$V_{ij} = W_j \times R_{ij}$$

Of the 15 villages listed to get a weighted normalization value, the normalization value is multiplied by the available weight value, the following is the solution:

Table 6.
Weighted normalized matrix table ij

	Village Name	KK	SOUL	TANK	HAMLET
1	Bagor	0.508592639	0.196338	0.58627	0.5
2	Baleharjo	0.719252312	0.349781	0.58627	0.5
3	Banyurip	3.265224931	1.142107	1.70994	1
4	Cepoko	0.595865932	0.011831	0.78169	0.5
5	Dawung	0.487526672	0.223888	0.58627	0.5

	Village Name	KK	SOUL	TANK	HAMLET
6	Hamlet	1.288033429	0.408369	0.8794	0.75
7	Galeh	0.376177987	0.175414	1.46567	0.75
8	Gebang	0.553733998	0.256669	0.4397	0.25
9	shaking	0.680129801	0.375239	0.78169	0.25
10	Gesi	0.28589527	0.129032	0.39084	0.25
11	Gilirejo	0.653044986	0.361638	1.22139	0.75
12	New Gilirejo	1.324146516	0.531123	1.7588	0.75
13	Guard	1.053298365	0.366172	0.63512	0.5
14	Jenar	0.647026138	0.327113	0.8794	0.75
15	Jono	0.361130868	0.186224	0.29313	0.25

d. Calculating Positive and Negative Separation Distance

After the weighted normalization results are obtained, then the maximum and minimum values for each criterion are searched.

$PIS = A^+ = \{V_1^+, V_2^+, \dots, V_n^+\}$, where: $V_j^+ = \{(\max_i (V_{ij}) \text{ if } j \in J); (\min_i V_{ij} \text{ if } j \in J')\}$

$NIS = A^- = \{V_1^-, V_2^-, \dots, V_n^-\}$, where: $V_j^- = \{(\min_i (V_{ij}) \text{ if } j \in J); (\max_i V_{ij} \text{ if } j \in J')\}$

The maximum and minimum values are to determine the positive ideal solution and the negative ideal solution. The following are the maximum and minimum results obtained from the weighted normalization table:

Table 7.
Table of Positive and Negative Ideal Solutions

	KK	SOUL	TANK	HAMLET
MAX	3.265224931	1.142107	1.7588	1
MIN	0.087273293	0.038361	0.19542	0.25

Calculate the separation size. This separation measure is a measurement of the distance from an alternative to a positive ideal solution and a negative ideal solution.

Get a positive ideal solution value:

$$S_{i+} = \sqrt{\sum_{j=1}^m (V_{ij} - V_j^+)^2} \text{ dengan } i=1,2,3,\dots,m$$

Of the 15 villages listed to get a positive ideal solution, the normalized value of each alternative is reduced by the maximum value which is then squared, along with the solution.

Table 8.
Calculation Table

	Village Name	KK	SOUL	TANK	HAMLET
1	Bagor	(0.508592 3.265224931) = 7.599022	(0.196342 1.142107) = 0.89448	(0.586272 1.7588) = 1.37483	(0.52 1) = 0.25

Then it continues in each village with the same calculation. After each alternative is calculated. Next find the value of the root, the following is the solution

$$S_{i+} = \sqrt{\sum_{j=1}^m (V_{ij} - V_j^+)^2}$$

Table 9.
Calculation Table si+

1	Bagor	3.180933
2	Baleharjo	2.955434
3	Banyurip	0.048856
4	Cepoko	3.067963
5	Dawung	3.19117
6	Hamlet	2.298587
7	Galeh	3.070751
8	Gebang	3.230899
9	Shaking	2.964464
10	Gesi	3.512339
11	Gilirejo	2.789969
12	New Gilirejo	2.050265
13	Guard	2.647139
14	Jenar	2.890506
15	Jono	3.472485

Get the value of the negative ideal solution:

$$S_{i-} = \sqrt{\sum_{j=1}^m (V_{ij} - V_j^-)^2} \text{ dengan } i=1,2,3,\dots \dots m$$

Of the 15 villages listed to get a negative ideal solution, the normalized value of each alternative is reduced by the minimum value which is then squared, along with the solution.

Table 10.
Calculation Table si+

No	Village Name	KK	SOUL	TANK	HAMLET
1	Bagor	(0.508592 0.087273293) = 0.17751	(0.19634 2 0.038361) = 0.02496	(0.58627 2 0.19542) = 0.15276	(0.5 2 0.25) = 0.0625

Then it continues in each village with the same calculation. After each alternative is calculated. Next find the value of the root, the following is the solution.

$$S_{i-} = \sqrt{\sum_{j=1}^m (V_{ij} - V_j^-)^2}$$

Table 11.
Calculation Table si+

1	Bagor	0.64632
2	Baleharjo	0.84359
3	Banyurip	3.76482
4	Cepoko	0.81786
5	Dawung	0.64022
6	Hamlet	1.51544
7	Galeh	1.40206
8	Gebang	0.57001
9	Shaking	0.89926
10	Gesi	0.29302
11	Gilirejo	1.31423
12	New Gilirejo	2.11348
13	Guard	1.13864
14	Jenar	1.05571
15	Jono	0.3262

e. Calculating Relative Proximity

From the results of a positive ideal solution and a negative ideal solution, from the 15 villages the preference values for each alternative can be calculated.

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}, 0 \leq C_i \leq 1$$

Of the 30 villages listed to get a preference value, the value of the negative ideal solution for each alternative is divided by the value of the negative ideal solution plus the positive ideal solution, as follows:

Table 12.
Relative Proximity calculation table

No	Village Name	Relative Proximity
1	Bagor	0.168872
2	Baleharjo	0.222054
3	Banyurip	0.987189
4	Cepoko	0.210474
5	Dawung	0.167099
6	Hamlet	0.397333
7	Galeh	0.313463
8	Gebang	0.149968
9	Shaking	0.232745
10	Gesi	0.077002
11	Gilirejo	0.320217
12	New Gilirejo	0.507592
13	Guard	0.300768
14	Jenar	0.267525
15	Jono	0.085873

Ranking

From the 30 villages, it is found that relatively clean water is allocated to support the quality of human life. Here are the ranking results:

Table 12.
Ranking Table

No	Village Name	Rank
1	Banyurip	0.98719
2	Cooking	0.51534
3	New Gilirejo	0.50759
4	Ngargotirto	0.42154
5	Hangout	0.41447
6	Hamlet	0.39733
7	Gilirejo	0.32022
8	Galeh	0.31346
9	Guard	0.30077
10	Jenar	0.26752
11	Katelan	0.24358
12	Shaking	0.23274
13	Pare	0.22293
14	Baleharjo	0.22205
15	Cepoko	0.21047

Allocation

From the 30 villages with alternative ranking results, the provider provides the amount of water discharge in the form of tanks, 1 truck tank containing 5000 liters. In the period from 15 July to 17 November 2015 the Social Service Office of Sragen Regency provided 7 trucks each month with a total of 5000 liters of each truck tank. Here's the review: Water supply = (7 tanks x 5000 liters) x 5 months = 175000 liters. From the ranking results, the total value of each alternative is obtained. The following is the total value obtained: So with the total results of each alternative and the available water supply, the clean water allocation is calculated as follows:

Table 13.
Allocation Table

Village Name	Liter
Banyurip	23214.79683
Cooking	12118.75464
New Gilirejo	11936.50536
Ngargotirto	9912.950349
Hangout	9746.691965
Pare	5242.430188
Baleharjo	5221.736075
Cepoko	4949.420363
Slendro	4898.390562
Kedawung	4444.766204
Tlogotirto	4432.537864
Poleng	3988.08476
Dawung	3929.529827
Gebang	3526.700109
Jono	2019.32212

After testing the system and manual calculations on the data for the period 15 July to 17 November 2015 by applying the TOPSIS (Technique For Others Reference by Similarity to Ideal Solution) method, it was obtained that the relative priority for clean water distribution assistance was Banyurip Village with a value of 0.98719, which means approaching the value of the ideal solution. The results of the allocation of clean water in Banyurip Village are 23214,79683 liters. Then the output is obtained as a benchmark for consideration of the distribution of clean water from the village with the biggest priority to the village with the smallest priority.

4. CONCLUSION

Based on the results of the research and discussion that have been described previously, it can be concluded that the TOPSIS (Technique For Others Reference by Similarity to Ideal Solution) method can be applied in a Decision Support System for the provision of clean water supply assistance. The test results manually using Microsoft excel and the system created give the same results.

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